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The potential of extract of *Zingiber zerumbet* (L.) Smith as a feed additive to improve the production performances and meat nutritional composition of broiler chickens

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Abstract. This study aimed at replacing the use of antibiotic growth promoters (AGP) as the feed additive with the *Zingiber zerumbet* (L.) Smith extract (ZZE) to control Salmonellosis in broiler chickens. This study employed the completely randomized design (CRD), five treatments, namely: T0 (basal diet), T1 (basal diet + *S. enteridis* infection), T2 (basal diet + *S. enteridis* infection + 0.33 % ZZE), T3 (basal diet + *S. enteridis* infection + 0.67 % ZZE), and T4 (basal diet + *S. enteridis* infection + 1 % ZZE). The addition of the *Z. zerumbet* extract did not seem to affect the production performances, in which the average feed consumption was 69.38 g $\pm$ 4.43 g to 72.71 g $\pm$ 4.92 g, body weight gain was 35.67 g $\pm$ 1.40 g to 38.30 g $\pm$ 3.85 g, feed conversion was 1.89 $\pm$ 0.11 to 2.04 $\pm$ 0.11, final weight was 1 287.80 g $\pm$ 49.97 g up to 1 380.50 g $\pm$ 134.90 g, and percentage of carcass was 60.90 % to 68.48 %. However, the use of *Z. zerumbet* extract with the highest concentration at 1 % decreased the crude fat of meat.

Keywords: Herbal plant, phytochemicals, antibiotic growth promoters, bacterial resistance.

1. Introduction

The increasing prevalence of Salmonellosis caused by *Salmonella enteritidis* pathogenic bacteria that are transmitted vertically or horizontally [1, 2] in broiler chickens has caused serious problems for the poultry industry due to the loss instigated by growth disturbance, decreasing performance, growing number of rejected chickens, as well as increasing sensitivity of chickens to other diseases [3]. Salmonellosis also means a lot to the public health as the livestock products contaminated with *Salmonella* sp. may cause foodborne disease in human; thus, the products must be destroyed. This eventually results in the loss of many business opportunities in the poultry industry [2]. Meanwhile,



the prevention of Salmonellosis with the use of antibiotic growth promoters (AGP) as feed additives in fact may arouse greater problems, such as increasing resistance to antibiotics, increasing outbreaks of Salmonellosis, bacterial contamination in either poultry products and their surrounding environments, foodborne diseases, as well as antibiotic residues in products which may threaten the public health [4–6].

The potential of herbal plants (phytobiotics) in Indonesia is that they may become an alternative of natural AGP substituents and be used as green products to prevent from Salmonellosis in broiler chickens. One of the phytobiotics that are often used to maintain the livestock health is *Zingiber zerumbet* L. Smith as it contains antibacterial properties [7, 8]. The crude ethanol extracts and their fractions of *Z. zerumbet* has antibacterial activity against negative bacteria, so the extract can be used as a natural feed additive [9].

The specific aim of the study was to find out the right concentration of ethanol to extract the antibacterial substances in *Z. zerumbet* as well as the precise concentration of the extract as feed additives that could replace AGP to prevent the livestock from Salmonellosis caused by *S. enteridis*. Therefore, the improvement of production performance and health of broiler chickens for testing the safety of the *Z. zerumbet* extract as feed additives in broiler chickens can be accomplished. As results, it is essential to conduct a series of experiments in whether or not giving the *Z. zerumbet* extract as feed additives affects the activity of digestive enzymes, production performance and quality of broiler chicken meat which artificially infected with *S. enteridis*.

In the long run, the use of phytobiotics as feed additives is expected to increase the productivity of broiler chickens, so that Salmonella-free broiler meat supply is maintained to meet the domestic demands. Besides, one more important target of using phytobiotics as feed additives is to reduce the level of bacterial resistance to antibiotics, suppress foodborne diseases, and antibiotic residues in both meat and visceral, hence it would contribute to the food security and safety in Indonesia.

2. Materials and methods

2.1. Plant materials and preparation

The *Z. zerumbet* rhizome was obtained from Unit Pelaksana Teknis (UPT) Materia Medica Batu, East Java, Indonesia. This rhizome was initially sort out in order to separate it from any foreign material; then it was washed, drained, sliced, and dried in an oven with a temperature of 45 °C until the water concentration reached ≤ 10 %. Next, the dried rhizome was ground into powder, soaked with 95 % ethanol in a jar and stirred at a speed of 50 rpm for 24 h (1 rpm = 1/60 Hz). The liquid extract was then filtered, vaporized with a rotary evaporator for 1 h and above a water bath for 12 h. At the last step, the thick liquid extract was supplemented with aquadest so that it became a 10 % extract. Finally, the extract was dried in an oven at 40 °C for 2 d and added with 5 % amylum starch until it became powder.

2.2. Diet management

The feed formulation of the broiler chickens is shown in table 1.

Table 1. Feed formulation of the treated broiler chickens.

Feedstuff	Feed formulation	
	Starter	Finisher
	Amount (%)	Amount (%)
Rice bran	0.6	0.4
Yellow corn	59.22	65.11
Fish flour	2.8	2.31
Bone flour	1	2
Meat flour	4.42	-

Continue on next page.

Table 1. Continued.

Feedstuff	Feed formulation	
	Starter	Finisher
	Amount (%)	Amount (%)
Soybean pulp	29	27
Cocunut oil	1.22	1.12
Calcium	0.35	0.5
Salt	0.5	0.5
Lysine	0.7	0.9
Metionine	0.19	0.16
Total (%)	100.00	100.00
Feed Composition		
Metabolic Energy (kkal kg ⁻¹)	3 000.00	3000.00
Crude Protein (CP) (%)	23	20
Crude Fat (CF) (%)	4.00	4.00
Crude Fiber (CFB) (%)	3.55	3.47
Ca (%)	0.89	0.76
P (%)	0.42	0.36
Na (%)	0.15	0.15
AMINO ACIDS:		
Arginine (%)	0.88	0.98
Histidine (%)	0.35	0.38
Isoleucine (%)	0.77	0.82
Leucine (%)	0.98	1.02
Lycine (%)	0.99	1.00
Metionine (%)	0.46	0.40
Phenylalanine (%)	0.76	0.82
Treonine (%)	0.66	0.69
Tryptophan (%)	0.31	0.26
Valine (%)	1.23	1.09

2.3. Dosage test for *Salmonella enteridis* infection

It was conducted through a series of in vivo experiments in a form of *S. enteridis* infection with multilevel doses, i.e. 10^4 , 10^6 , 10^8 , 10^{10} dan 10^{12} in 10-day-old broiler chickens. Then, the clinical symptoms of the chicken were observed for 1 wk after the infection. The expected clinical symptoms were those that showed moderate diarrhea symptoms.

2.4. Care management

The research material consisted of 125 one Day-Old-Chick (DOC) broilers, 125 fish heads of which the initial body weight ranged from 34 g to 47 g, with an average of 39.536 ± 2.481 g and a raising period of 35 d. Then, the ND vaccination was performed on chickens aged 4 d, 17 d and 24 d. Meanwhile, artificial infections using *Salmonella* sp. orally was given on day 10 with optical density (OD) 1×10^{10} CFU, while the *Z. zerumbet* extract powder was given when the chickens were 7-day-old to 35-day-old.

2.5. Research design

The study used an experimental method, Completely Randomized Design (CRD), consisting of five treatments, namely: T0 (chickens fed on basal diet), T1 (chickens fed on basal diet + *S. enteridis* infection), T2 (chicken fed on basal diet + *S. enteridis* infection + 0.33 % *Z. zerumbet* extract of the total feed), T3 (chickens fed on basal diet + *S. enteridis* infection + 0.67 % *Z. zerumbet* extract of the

total feed), and T4 (chickens fed on basal diet + *S. enteridis* infection + 1 % *Z. zerumbet* extract of the total feed). Each treatment was repeated five times and each replication consisted of five chickens.

2.6. Measured variables

The variables measured were the production performances (feed consumption, body weight gain, feed conversion, and carcass percentage) and the composition of meat nutrition (dry matter, crude fat, organic matter, crude protein and water). The production displays were obtained by measuring the weight, meanwhile the meat compositions were attained through a proximate analysis.

2.7. Data analysis

The data were tabulated in the Excel Program; the production display data and meat composition were analyzed using analysis of variance (ANOVA). If there were differences among the effect of each treatment, the Duncan Multiple Range Test (DMRT) was then applied.

3. Results and discussion

3.1. The production performance of broiler chickens

The results showed that the use of *Z. zerumbet* extract powder in feed did not affect the production of broiler chicken, as indicated in table 2.

Table 2. The production performance of broiler chickens

Treatment	Production Display				
	Feed Consumption (g chick ⁻¹ d ⁻¹)	Feed Conversion	Daily Weight Gain (g chick ⁻¹ d ⁻¹)	Final Weight (g)	Carcass Percentage (%)
T0	72.17 ± 5.34 ^a	1.89 ± 0.12 ^a	38.30 ± 3.85 ^a	1380.50 ± 134.90 ^a	65.60 ± 1.30 ^a
T1	71.51 ± 3.62 ^a	1.89 ± 0.11 ^a	37.91 ± 1.20 ^a	1374.40 ± 47.98 ^a	68.48 ± 8.37 ^a
T2	71.72 ± 4.20 ^a	1.96 ± 0.10 ^a	36.50 ± 0.70 ^a	1316.80 ± 24.81 ^a	63.70 ± 4.53 ^a
T3	69.38 ± 4.43 ^a	1.93 ± 0.12 ^a	35.91 ± 2.22 ^a	1297.30 ± 77.59 ^a	64.74 ± 0.72 ^a
T4	72.71 ± 4.92 ^a	2.04 ± 0.10 ^a	35.67 ± 1.40 ^a	1287.80 ± 49.97 ^a	60.90 ± 3.47 ^a

Note: Number which are followed by similar alphabet in the same column are similar during Duncan test of 5 %. Alphabet a means there is no differences of feed consumption, feed conversion, daily weight gain, final weight and carcass percentage between treatments.

The addition of *Z. zerumbet* extract did not affect the production display because the given dose of *S. enteridis* infection (10¹⁰ CFU per mL) was mild, with low virulence, and according to the vaccine dose. Therefore, this condition induces the increase in the body's defense mechanism of the T1 treatment, this caused the production performance similar to those of the the control group (T0). This is in accordance with the report that *S. enteridis* vaccine containing 10¹¹ CFU per mL bacteria is able to improve the body's defense system [3].

The content of curcumin and essential oil in *Z. zerumbet* extract (T2 to T4) has not been able to overcome *S. enteridis* (T1) infection, so it is not optimal in stimulating bile and pancreatic secretions to digest carbohydrate, fat, and protein feed ingredients, so it does not affect feed consumption and the production performance of broiler chickens. The results of this study differ from previous studies which proved that curcumin in *Z. zerumbet* extract was shown to increase bile and pancreatic secretion, thereby increasing feed consumption [10, 11]. In addition, essential oils in *Z. zerumbet* can increase the digestive performance, relax the small intestine by reducing peristalsis movement of the small intestine, so that the ingesta may stay longer in the small intestine and the process of nutrition

absorption may take place maximally [12, 13]. Flavonoids, terpenoids and saponins are antibacterial agents which can suppress the growth of pathogenic bacteria, consequently the better nutrition absorption and increasing growth and final weight of slaughtered chickens can be achieved [14–16]. The compounds of *Z. zerumbet*, including flavonoids, alkaloids, tannins, phenols, polyphenols, terpenoids and essential oils are antibacterial and anti-inflammatory substances [14, 17–19].

The feed nutritions, which consist of: ME, CP, CF, CFB, Ca and P, in experimental chickens meet the needs of chickens and have the same range between each treatment, so that the achievement of the production display, is almost similar. Additionally, The content of each CF, CFB, protein and ME in feed are according to standards, as stated that the need for CF in broiler chicken feed is at most 8.0 %, maximum CFB is 6.0 %, protein in the starter period is 23 % and 20 % in the finisher one, and energy is 3 200 cal g⁻¹ [20].

3.2. Meat nutritions

The compositions of meat nutritions in the broiler chickens are presented in table 3.

Table 3. Compositions of meat nutritions in the broiler chickens

Treatment	Compositions of meat nutritions				
	Dry Matter (DM) (%)	Crude Fat (CF) (%)	Organic Matter (OM) (%)	Crude Protein (CP) (%)	Water (%)
T0	25.78 ± 0.61 ^a	1.83 ± 0.74 ^a	22.93 ± 0.79 ^a	22.86 ± 0.87 ^a	74.22 ± 0.61 ^a
T1	25.69 ± 0.51 ^a	1.21 ± 0.39 ^b	22.91 ± 0.64 ^a	22.91 ± 0.35 ^b	74.31 ± 0.51 ^a
T2	25.46 ± 0.58 ^a	1.17 ± 0.24 ^b	22.43 ± 0.45 ^a	22.64 ± 0.64 ^a	74.54 ± 0.58 ^a
T3	25.34 ± 1.06 ^a	1.23 ± 0.29 ^b	22.39 ± 0.78 ^a	22.39 ± 1.17 ^a	74.66 ± 1.06 ^a
T4	24.99 ± 0.91 ^a	1.09 ± 0.17 ^b	22.26 ± 1.01 ^a	22.04 ± 1.35 ^a	75.00 ± 0.91 ^a

Note:

Number which are followed by similar alphabet in the same column are similar during Duncan test of 5% Alphabet a means there is no differences of DM, OM, CP and water of meat. Alphabet b means there is differences CF of meat between control (T0) with T1, T2, T3 and T4.

According to table 3, it can be seen that *S. enteridis* dose 10¹⁰ CPU (T1) is not affecting the percentage of the meat nutritions compositions since the dose of infection is still low. The low dose of infection is not enough to cause damage to the digestive system so that it was still functioning normally in digesting and metabolizing nutrients and cause the decreasing of CF percentage. The decreasing of CF in treatments T2, T3, and T4, is related to saponin compounds in *Z. zerumbet*, it can bind the fat from feed in the intestinal. Moreover, it also can bind the cholesterol and bile acids, thus reducing the cholesterol absorption and its biosynthesis in the liver.

4. Conclusions

The addition of *Z. zerumbet* extract as feed additives to the level of 1 % has not been able to improve the production performance, such as feed consumption, daily weight gain, feed conversion, final weight and normal percentage of carcasses. Besides, it can also decrease the crude fat in the of meat broiler chickens with Salmonellosis.

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