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Effect of *Curcuma zedoaria* and *Zingiber officinale var. officinale* as Feed Additive on Intestinal Villus Characteristics of Broiler

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***Abstract*—** *This study aims to determine the effects of phytobiotics from white turmeric (Curcuma zedoaria) and giant ginger (Zingiber officinale var. officinalr) as phytobiotics on villus characteristics of broiler. This form of phytobiotics are divided into two forms, powder and encapsulation forms. The total of 224 DOC Lohman broiler strains were used which were not differentiated by sex gender and maintained for 35 days. The variables observed in this study included villus height, villus number, crypt depth and villus surface area. The experimental design used was Completely Randomized Design which included seven treatments and four replications. The treatments given were P0 (control), phytobiotic forms of powder P1, P2, P3 (0.6, 0.8 and 1%) and encapsulation P4, P5, P6 (0.6,0.8, and 1%). The results of this study showed that both of the powder phytobiotics (white turmeric and giant ginger) mixture and encapsulation significantly improved (P <0.01) villus height, villus number and crypt depth, but did not affect the villus surface area (P> 0.05). Conclusion show that the encapsulation form gives better results to villus characteristics on broiler with optimal levels reaching 1%.*

***Keywords*—** *Phytobiotic, villus characteristics, encapsulation, broiler, white turmeric ,giant ginger.*

I. INTRODUCTION

Feed additives in broiler feed are commonly used. One of the main goals of feed additives given to broilers is as growth promoter. So far, the use of feed additives is considered to be able to improve feed efficiency. The common feed additive used for growth promoters is antibiotic growth promoter (AGP). However, besides being able to increase growth, AGP also has a negative impact. Antibiotics used in animal feed cause antibiotic-resistant strains in bacteria including *Salmonella* spp., *Campylobacter* spp., *Escherichia coli*, and *Enterococcus* spp. [1] The use of AGP as a feed additive for livestock has now been banned by the Indonesian government through the Minister of Agriculture Regulation number 14 of 2017.

Another type of feed additive that can replace antibiotics is phytobiotics. Phytobiotics can select microorganisms because of antimicrobial activity. Through this mechanism, incoming nutrients can be used and absorbed or stimulate the immune system. In general, the benefits of using phytobiotics in feed contain natural herbal elements, do not cause residual effects, and not harmful for animals [2].

White turmeric or *Curcuma zedoaria* are herbaceous and rhizomatous plants which are commonly used for medicinal purposes. In the white turmeric rhizome there are several active substances which are very useful, such as curcuminoid and essential oils [3]. Other herbal plants that are known to have benefits are giant ginger *(Zingiber officinale var. officinale)*. The primary active substance in ginger is gingerol, with other analog gingerols such as shogoals, paradol and zingerone also found in ginger rhizomes [4]. Based on [5], the use of ginger with a level of 1% in broiler feed affects the villus height, villus width crypt depth. White turmeric is also reported to have a positive effect on feed consumption, body weight gain and feed conversion of broiler [6].

The active compounds and essential oils contained in herbal plants may be lost during the heating and grinding process. Even though the active compounds and essential oils will be utilized by the animal. So it is necessary to use encapsulation technology. The encapsulation process usually uses a spray dryer, but can be replaced by using a microwave with temperatures below 60^{o}C [7]. The aim of this study was to determine the effect of using white turmeric and giant ginger as feed additive in the form of powder and encapsulation with several level on intestinal villus characteristics.

II. MATERIALS AND METHODS

A. Birds and Diets

The total DOC broiler used in this study was two hundred and twenty four and maintenance for 35 days. The type of broiler used is the Lohman (unsex) strain. Each cage contains eight broilers with a total of twenty-eight units. The size of the cage used is 1x1x0.7 m^2. The equipment in the cage used are heating lamp, drinker, feeder, and the litter covered by paper from newspaper during starter periode to keep the heat in the cage.

Feeding and drinking water are given in ad libitum. Feeds are given to two phases, starter periode (1-21 days) and finisher periode (22-35 days).

TABLE I. Nutrient content of basal diet

Nutrient content	Starter diet	Finisher diet
Dry matter (%)	89.58	89.27
Ash (%)	5.86	5.16
Crude protein (%)	20.13	21.22
Ether extract (%)	5.65	5.52
Crude fiber (%)	1.60	1.84
Calcium (%)	1.01	1.32
Phosphor (%)	0.65	0.67

Based on analysis of Laboratory of Animal Feed, Departement of Animal and Fisheries, Blitar District, 2019.

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B. Preparation of Phytobiotic

The phytobiotics used are divided into two forms, powder and encapsulation forms. The types of herbal plants used are white turmeric and giant ginger rhizome. Powder phytobiotic is obtained by cleaning the rhizome of the two plants, then cut into small pieces, dried, mashed to powder form. The form of encapsulation is obtained through the encapsulation process using a microwave. The steps are: cleaning the rhizome, extract the rhizome, add whey, gum arab and BHT, mix until homogeneous using a mixer, apply it to a ceramic plate, put it in a microwave at 55^{o}C for 20 minutes.

C. Experimental Design

The method used in this study was in vivo for the maintenance of chickens, then continued by observing using a microscope for villus characteristics. The design used in this study was Completely Randomized Design with seven treatments and four replications using eight chickens on each replication. Treatment given:

P0: Basal feed without addition of phytobiotic (control)
P1: Basal feed plus 0.6% mixture of white turmeric and giant ginger in powder form
P2: Basal feed plus 0.8% mixture of white turmeric and giant ginger in powder form
P3: Basal feed plus 1% mixture of white turmeric and giant ginger in powder form
P4: Basal feed plus 0.6% mixture of white turmeric and giant ginger in encapsulatin form
P5: Basal feed + 0.8% mixed with white turmeric and giant ginger in the form of encapsulation
P6: Basal feed plus 1% mixture of white turmeric and giant ginger in encapsulation form

D. Research Variable

The variables observed in this study were the characteristics of ileum villus on broilers. Intestine samples of the ileum of 4-5 cm long, cut, excreted, ileum cleaned with 0.01% physiological NaCl solution, then soaked in 10% formalin solution. Then the sample is made into a preparation for further observation [8]. The preparations were then observed under the Olympus BX51 DIC microscope and measured using Image Raster software. Variables observed includes:

1. Villus height

The height of the villi was measured from the basal part of the villi to the apical villi (µm).

2. Villus number

The number of villi is calculated based on how many villi grow on one lumen (per lumen).

3. Crypt depth

Measurement of crypt depth starts from the base (part of the lamina propria) to the base of villi (µm).

4. Villus surface area

Villus surface area was estimated from the trigonometric relationships of villus basal width, villus apical width and villus height [9].

E. Data Analysis

The data obtained were then analyzed using ANOVA. Duncan's multiple range is used for further testing to find out the differences between treatments.

III. Result and Discusion

The average characteristics of villi ileum broilers with the addition of phytobiotics can be seen in the table presented below.

TABLE II. Effect of white turmeric and giant ginger on intestinal villi characteristics of broiler.

Treatment	Variable			
	Villus height (µm)	Villus number (no/lumen)	Crypt depth (µm)	Villus surface area (µm^2)
P0	500.79±47.13^{AB}	173.25±3.07^{A}	131.30±5.24^{ab}	1314.92±202.97
P1	438.56±70.46^{A}	174.63±3.88^{AB}	131.89±6.52^{ab}	1125.25±255.94
P2	568.97±44.94^{B}	175.63±2.32^{AB}	129.38±5.15^{a}	1338.87±176.40
P3	492.42±30.15^{AB}	174.00±5.76^{A}	136.37±7.91^{abc}	1071.32±59.31
P4	534.51±47.15^{AB}	185.38±8.93^{B}	137.05±1.50^{bc}	1291.96±203.63
P5	512.52±82.66^{AB}	184.13±1.03^{B}	132.71±1.87^{ab}	1295.42±307.57
P6	603.18±18.39^{B}	200.63±3.04^{C}	142.51±6.57^{c}	1394.73±226.95

$^{A-C}$ different superscripts within colums showed highly significant differences (P<0,01).
$^{a-c}$ different superscripts within colums showed significant differences (P<0,05).

A. Villus Height

Based on the results of the villus height analysis presented in the table above it was concluded that the treated feed gave a difference (P <0.05) to the villus height of the broiler's ileum. In general it can be concluded that the treatment using the form of encapsulation showed better results than the treatment in the form of powder and control treatment. The addition of 1% white turmeric and giant ginger encapsulation in the feed showed the best results in the villus height with 603.18 ± 18.39 µm. Another study conducted by [10] showed similar results that the use of turmeric and ginger in the form of encapsulation gave better results than powder form, in the study reported villus height reached 717.14 µm with the use of 0.6% encapsulation of turmeric and ginger. Based on other studies by [11] it was reported that feed additive in the form of encapsulation gave better results in villus height on crossbred duck.

The villi structure in the digestive tract can describe and give information regarding nutrient absorption in animal. The villus height increase indicates an increase in nutrient absorption [12]. To get an increase in broiler production, we need an optimal height of villus.

Encapsulation for phytobiotics aims to protect the active component of the herbal ingredients so it can give benefit when it is in the digestive tract. Meanwhile in the form of powder it is possible that the active components including essential oils have been lost due to the drying process.

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B. Villus Number

Based on the results of the villus number analysis presented in the table above, it was concluded that the feed treatment gave a very significant difference (P <0.01) to the number of villus numbers. The addition of 1% phytobiotic mixture of white turmeric and giant ginger in the form of powder can produce villus number up to 174.00 ± 5.76/lumen. However, if the phytobiotic is protected, the villus number will increase as in the addition of 1% phytobiotic in the form of encapsulation resulting in villus number 200.63 ± 3.04/lumen. The treatment using feed additives protected by encapsulation showed better results than the form of powder. More and more villus numbers can allow better absorption of nutrients by animal. Another study conducted by [10] showed similar results that encapsulation in phytobiotics was able to produce more villus numbers than powder-shaped phytobiotics.

Active components and essential oils in white turmeric and giant ginger are not much lost with protection by encapsulation. According to [13] white turmeric contains active components in the form of curcuminoid, demethoxycurcumin and bisdemethoxycurcumin and essential oils. White turmeric is known to have antibacterial, antioxidant and anti-inflammatory activities. According to [14] giant ginger contains active components in the form of gingerol, shogaol and zingerone and essential oils which are brown in color. Ginger in the medical world is known to be able to help digestive stimulation.

C. Crypt Depth

The results of the crypt depth analysis in the table above show that the feed treatment of phytobiotic addition gave very significant difference (P <0.01) to crypt depth. The crypt depth is getting deeper with the use of encapsulated phytobiotics. The addition of 1% white turmeric and giant ginger in the form of encapsulation gave the best crypt depth reaching 142.51 ± 6.57 µm.

The function of the crypt is as a reservoir of nutrients that will be absorbed by the crypt can also be called the base of the villi. The thicker the crypt, the faster mechanism for tissue replacement for renewal of villi [15]. In addition, the crypt thickness indicates the increasing number of nutrients that can be absorbed and distributed to the animal's body.

Crypt depth in broilers was influenced by microbial activity in the ileum [16]. The results of that study stated that the increasing number of non-pathogenic microorganisms such as *Lactobacillus* sp., *Streptococcus* sp., *Bifidobacterium* sp. and *Aspergillus oryzae*, the thicker crypt depth in broilers.

D. Villus Surface Area

The average results on villus surface area showed that the feed treatment did not have a significant effect (P> 0.05) on the villus surface area. However, it can be concluded that in treatment P6 the best results with villus surface area reached 1394.73 ± 226.95 µm^2. According to [17] there are several factors that affect the growth of villi in the intestine. These factors include the environment, feed ingredients, the composition of the active components included in certain plant extracts needed in feed can affect the growth of intestinal villus.

The wider the area of villus surface, indicates the wider area of absorption of nutrients in the villi. This concludes a positive effect because the better nutrient absorption is carried out. So that it will be able to increase feed consumption and improve production in broilers.

Villus surface area can be influenced by active components and essential oils in white turmeric and giant ginger because of its anti-bacterial ability. Pathogenic bacteria in the digestive tract of broiler can cause damage to villi by causing erosion of the mucous layer of the villi. The damage causes a decrease in the thickness of the villi. According to [18] antibacterial components in white turmeric and giant ginger come from essential oils in them. Essential oils contain compounds that play a role to reduce harmful pathogenic bacteria in the digestive tract of broilers.

IV. CONCLUTION

Based on the results of this study, it can be concluded that white turmeric and giant ginger can be used as feed additives in broilers. The mixture of the two phytobiotics in the form of encapsulation gave better results than the powder form. White turmeric and giant ginger in the form of encapsulation with a level of use of 1% gave the best results for the villus characteristics of broilers.

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