Implementation of *Curcuma xanthorrhiza Roxb* Encapsulation as a Feed Additive on Production Performance of Broiler

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Abstract. The research aim to determine *Curcuma xanthorrhiza Roxb* encapsulated as a feed additive and its implementation on broiler production performance. The method used was a field experiment using a Completely Randomized Design (CRD), which consisted of 6 treatments and 4 replicates, namely; (P0-) negative control (commercial feed), (P1+) positive control (antibiotic 0.1%), P2 (*C. xanthorrhiza* encapsulation 0.25%), P3 (*C. xanthorrhiza* encapsulation 0.50%), P4 (*C. xanthorrhiza* encapsulation 0.75%) and P5 (*C. xanthorrhiza* encapsulation 1%). The results showed that the addition of temulawak (*Curcuma xanthorrhiza Roxb*) encapsulation in broiler feed can have a very significant effect ($P < 0.01$) on IOFC, a significant effect ($P < 0.05$) on body weight, feed conversion, and gives no significant effect ($P>0.05$) on feed consumption and carcass percentage. The use of temulawak (*Curcuma xanthorrhiza Roxb*) encapsulation at the level of 0.50% in broiler feed, numerically showed positive results on feed consumption, body weight gain, carcass percentage, IOFC and feed conversion. In conclusion, the addition of temulawak (*Curcuma xanthorrhiza Roxb*) encapsulated at the level of 0.50% in broiler feed is recommended as a feed additive to replace antibiotics because it tends to increase broiler production performance.

Keywords: *Curcuma xanthorrhiza* encapsulated, feed additive, broiler, production performance, commercial feed

Introduction

The development in broiler rearing at present is increasingly rapid compared to other types of poultry commodities. is due to consumer demand for chicken meat and the importance of the nutritional value of broilers for human health and affordable selling value for all people. In addition, broilers have nutritional value that is not much different from the product of ruminants. The livestock industry often uses the term broiler to describe chickens raised for meat production (Sudjarwo et al., 2019). The period of raising chickens can be reported by Harimurti and Rahayu (2009) that, the period of raising broilers is getting shorter with a period of 33-35 days, which has a live weight of chickens reaching around 2 kg. Feed is one of the most important factors a successful productivity of broilers optimally, therefore the quantity and quality of feed should always be considered. Furthermore Nuningtyas (2014) states that the cost of feed in broiler farming is the highest cost of the overall production cost of 60-70%. Efforts to increase growth in livestock and efficiency in feed use sometimes encourage farmers to use feed additives to be mixed in feed.

Feed additive is a compound or material that is not a food substance (nutrients) that is added to the feed and then given to livestock with the aim of accelerating growth, increasing the quantity and quality of production and improving the efficiency of feed use and animal health (Widodo, 2017). Farmers often use antibiotics as feed additives to accelerate the growth of broilers. Another effect caused by the use of antibiotics is to endanger the health of humans who consume chicken meat due to chemical residues remaining in the meat of broilers. One alternative that needs to be done is to look for antibiotic substitutes source from herbal plants (Natsir et al., 2016).

One of the materials that have been widely researched, even commercially used as a substitute for antibiotics is bioactive compounds contained in nutritious plants. The *Curcuma xanthorrhiza* is one of the nutritious phytochemical plants that is widely used by humans and has the potential to be used as a feed additive to replace antibiotics in poultry.

xanthorrhiza contains the active substance 'xanthorrhizol' which can inhibit bacterial growth (Sinurat et al., 2009). *C. xanthorrhiza* has cholagogue activity, which plays a role in increasing the production and secretion of bile, stimulating the release of pancreatic sap which can increase the metabolism of feed ingredients of carbohydrate, protein, and fat sources so that the digestive process takes place quickly and optimally (Alipin et al., 2017). Various kinds of compounds in antioxidants contained in xanthorrhiza rhizomes are very well used as feed additives to substitute antibiotics to spur growth and improve broiler health and are immunostimulants, which can be used as an antidote to free radicals (Indrisari, 2021).

Encapsulation is a method used to protect small particles, liquids or gases by using a protective layer or within a protective matrix. There are various advantages that can be obtained from the encapsulation process, namely; 1) active substance compounds can be protected from various phenomena such as oxidation processes, exposure to Ultra Violet light, and also pH variations, 2) the pungent odor of *C. xanthorrhiza* essential oil can be reduced and its evaporation is blocked by a protective layer, 3) the encapsulation process allows *C. xanthorrhiza* extract to be stored in solid form for a long time (Katherine and Sugih, 2015). The results of research by Natsir et al., (2016) that the use of a mixture of turmeric and ginger in the form of encapsulation produced better results than without encapsulation with an optimum level of 0.8%. Based on this, it becomes an important reason to conduct research related to the importance of *C. xanthorrhiza Roxb* encapsulated used as a broiler feed additive as a substitute for synthetic antibiotics.

Materials and Methods

This study used 144 broilers (Day Old Chick) strain produced by PT Japfa Comfeed Indonesia Tbk, with unsex criteria. The feed used in this study is commercial feed produced by PT Japfa Comfeed Indonesia Tbk, namely; Japfa Comfeed brand feed for the starter phase using (Broiler-I) and for the finisher phase (Broiler-II), *C. xanthorrhiza* encapsulated, drinking water is given ad libitum. The stage cage type was litter-shaped with a total of 24 experimental cage plots with the size of each plot 100x100x80 cm^3. Each plot was filled with 6 broiler DOC and the cage was equipped with rice husk, incandescent lamp and gas for lighting and heating. The method used in the study was a field experiment method using a Completely Randomized Design consisting of 6 treatments and 4 replicates, namely:

P0- = Negative control (Commercial feed)
P1+ = Positive control (Commercial feed+antibiotic 0.1%)
P2 = Commercial feed+ *Curcuma xanthorrhiza* encapsulated 0.25%
P3 = Commercial feed+ *Curcuma xanthorrhiza* encapsulated 0.50%
P4 = Commercial feed+ *Curcuma xanthorrhiza* encapsulated 0.75%
P5 = Commercial feed+ *Curcuma xanthorrhiza* encapsulated 1.0%

Research Procedure

Biological test procedures by raising broilers for 35 days to determine the effect of *C. xanthorrhiza* encapsulated as a feed additive on broiler production performance. This study was conducted by preparing the feed additive material, namely *C. xanthorrhiza* encapsulated (it is application based on the specified treatment level), which will be used for mixing the research feed, cage preparation, cage cleaning, cleaning of feed and drinking places, making plots for raising chickens, preparing rice husks as litter mats, preparing DOC (Day Old Chick) and initial implementation of broiler rearing for 35 days. The variables observed in the study consisted of Feed consumption (g/bird); Body weight gain (g/bird); Feed conversion ratio; Carcass percentage (%); Income Over Feed Cost (IOFC) Rp/bird.

Table 1. Curcumin Assay Results of *C. xanthorrhiza* flour and *C. xanthorrhiza* encapsulated

No	Ingredient name	Content	Unit	Methods
1	*Curcuma xanthorrhiza* flour	0,93	% b/b	TLC
2	*Curcuma xanthorrhiza* encapsulated	2,01	% b/b	TLC

The research data analyzed with Analysis of Variance (ANOVA) if any differences between treatments, the Duncan's Multiple Range Test (DMRT) as pos hoc(Harsojuwono et al., 2011)

Based on the results of analyzing the *curcumin* content *Curcuma xanthorrhiza* and *Curcuma xanthorrhiza* encapsulated using the Thin Layer Chromatography (TLC) method, the curcumin content was 0.93% for *Curcuma xanthorrhiza* flour and *Curcuma xanthorrhiza* encapsulated with curcumin content being 2.01%. Duppa (2019) reported that the most important active compound components in *Curcuma xanthorrhiza* that provide medicinal properties are curcumin and essential oil.

Results and Discussion

Feed Consumption

Feed consumption is the amount of feed consumed by an animal in a certain period of time. The results of the study of the effect of *C xanthorrhiza* encapsulated feed additives on broiler feed consumption can be displayed in Table 3. Treatment P2 (Level 0,25%) showed a higher feed consumption of 3,197 g/bird/35 days compared to several other treatments. Based on the results of the analysis of variance (ANOVA) showed that the addition of *C. xanthorrhiza* encapsulation in broiler feed had no significant effect (P>0.05) on feed consumption. This be due to the use of encapsulation technology in addition to protecting bioactive substances from the influence of external factors, it can also help cover the pungent flavor of *C. xanthorrhiza* flour so as to stimulate the palatability of broilers to consume the feed. It seems that *C. xanthorrhiza* encapsulated is able to improve feed palatability so as to increase appetite in chickens. has been shown that the feed consumption of broilers in treatment given *C. xanthorrhiza* encapsulated is not different from the control treatment.

Table 2. Composition and Nutrient Content of Commercial Feed

Nutrient	Broiler-I	Broiler-II
EM (Kcal/Kg)	3000	3100
Moisture content (%)	Max. 12	Max. 12
Ash (%)	Max. 7	Maks. 7
Crude protein (%)	Min. 21	Min. 19
Crude fiber (%)	Min. 5	Min. 5
Calcium (Ca) (%)	0,8 – 1,1	0,8 – 1,1
Phosphorus (P) (%)	Min. 0,50	Min. 0,45
Urea	Non detection (ND)	Non detection (ND)
Total aflatoxin	Max. 50 µg/Kg	Max. 50 µg/Kg
Total amino acid		
✓ Lisin (%)	Min. 1,20	Min. 1,20
✓ Metionin (%)	Min. 0,45	Min. 0,45
✓ Metionin+sistin (%)	Min. 0,80	Min. 0,80
✓ Treonin (%)	Min. 0,75	Min. 0,75
✓ Triptofan (%)	Min. 0,19	Min. 0,19

Source: PT Japfa Comfeed Indonesia Tbk (2022)

The higher curcumin content in the encapsulated form of *Curcuma xanthorrhiza* proves that the addition of encapsulant in the form of maltodextrin is able to protect the active substances in *Curcuma xanthorrhiza* against damage during the drying process into flour form compared to flour form. (Natsir et al., (2016) stated that the active substance content in the form of curcumin can stimulate the secretion of digestive enzymes so that the feed consumed can be utilised efficiently for absorption in the intestinal villi and further increase the growth and production of broiler chickens. Furthermore Djunaidi et al., (2020) stated that essential oils can stimulate the enzymes of the digestive tract, so that the number of enzymes that come out causes the stomach to empty quickly and chickens will consume more feed. The increase in feed consumption is because in general poultry consume rations to meet energy needs, if energy needs are met then ration consumption will decrease (Suprayogi et al., 2018). Environmental factors such as temperature and humidity can also affect feed consumption, higher temperatures can reduce feed consumption, while lower temperatures will increase feed consumption according to Aviati et al. (2014).

Body Weight Gain

The results showed that the addition of *Curcuma xanthorriza* encapsulation in feed to body weight gain can be displayed in Table 3. The weight gain of broilers can be shown from the highest treatment to the lowest, namely the treatment of P3 (2,094 ± 12), P1 + (2,044 ± 55), P5 (2,034 ± 40), P2 (2,026 ± 40), P4 (1,988 ± 93) and P0- (1,988 ± 67) g/bird/35 days. The results of Analysis of Variance (ANOVA) to determine the effect of treatment on body weight gain of broilers, which can show a significant difference ($P < 0.05$) on body weight gain, therefore there is a treatment that can provide an influence on body weight gain of broilers. treatment at the level of 0.50% showed the highest body weight gain of 2,094 g/bird/35 days, although the value of feed consumption in broilers in each treatment was the same. This is likely due to the addition of *Curcuma xanthorriza* encapsulation in feed at a certain level can increase the digestibility and absorption of feed nutrients, so that feed can be converted well into meat, which in turn can increase the body weight. The increase in chicken body weight shows that encapsulated can increase the ability of chickens to metabolize feed into nutrients that can be digested and absorbed by the body which has an impact on optimal weight gain. Gao et al., (2019) reported that generally essential oils improve digestion and absorption processes, reduce colonization of pathogenic bacteria in the intestine, exert antioxidant properties, and strengthen intestinal immunity. The addition of flour at the level of 0.2% per kilogram of feed gives the best response to body weight gain and is directly proportional to the decrease in feed conversion (Indrati et al., 2010). According to Widodo et al., (2019) state that the provision of as a feed additive gave good results on body weight gain and final weight of super native chickens at the level of 0.33%. Essential oil encapsulation as feed additive can improve performance and good nutrient digestibility in the ileum due to increased enzyme secretion in the digestive tract (Hafeez et al., 2016). In addition, the use of oil and fat in the diet will increase growth, because the decrease in flow rate leads to an increase in feed retention time in the intestine so that the digesta process and nutrient absorption are more complete (Sibbald and Kramer, 1980). If digestible energy is converted into metabolic energy that is utilized to produce heat and net energy for basic living and producing activities, the expected growth of broilers will always be normal and as expected (Sahara et al., 2012).

Table 3. Effect of Addition of *Curcuma xanthorrhiza* encapsulated in Broiler Feed on Production Performance

Variable	Level of *C. xanthorrhiza* of encapsulated					
	P0 -	P1+	P2	P3	P4	P5
Feed Consumption (g/bird)	3.186±88,7	3.188±6,6	3.197±17,7	3.181±19,7	3.192±21,8	3.196±6,7
Body Weight Gain (g/bird)	1.988 ±67^{a}	2.044 ±55^{ab}	2.026 ±40^{a}	2.094 ±12^{b}	1.988± 93^{a}	2.034±40^{ab}
Feed Conversion Ratio (FCR)	1.62±0.07^{b}	1.56±0.05^{b}	1.58±0.03^{b}	1.48±0.04^{a}	1.61±0.07^{b}	1.57±0.03^{b}
Carcass Percentage (%)	76±2	75±3	76±2	79±2	77±3	75±1
Income Over Feed Cost (Rp/bird)	5.229±1.402^{B}	6.271±1.031^{B}	5.188±710^{B}	6.115±128^{B}	2.726±1.637^{A}	2.609±683^{A}

Notes: Superscript letters in different notations (a-b) in the same row indicate significantly different P < 0.05) and in notations (A-B) indicate very significantly different (P < 0.01).

Feed Conversion Ratio

The success of broiler rearing can be measured from the feed conversion value, which if the lower the value, the better the quality of feed given. Based on the results of the research can be shown from the highest to the lowest value in order, namely in the treatment of P0- (1.62 ± 0.07), P4 (1.61 ± 0.07), P2 (1.58 ± 0.03), P5 (1.57 ± 0.03), P1 + (1.56 ± 0.05) and P3 (1.48 ± 0.04). According to the results the use of *C. xanthorrhiza* encapsulated as a feed additive in broiler feed based on different levels, where statistical analysis showed significantly different results (P <0.05) on feed conversion. The results showed that feed conversion in the level 0.5% *C. xanthorrhiza* encapsulated was lower than the other treatment levels. The low value of feed conversion is the high value of feed efficiency utilized by broilers for weight gain. This is due to the presence of bioactive substances such as curcumin and essential oils contained in *C. xanthorrhiza* encapsulated, which increases the number of non-pathogenic bacteria in the digestive tract so that it helps in increasing the absorption of nutrients into the body of broilers. Bayoa et al., (2014) stated that the feed conversion rate indicates the level of efficiency of ration use, meaning that the lower the feed conversion rate, the higher the feed efficiency value and the more economical. Furthermore, Natsir et al., (2016) a decrease in feed conversion occurs because feed can be optimally utilized for production. Increased production is due to good nutrient absorption because the digestive process increases due to increased activity of digestive enzymes such as amylase, protease, and lipase. Feed conversion is caused by an increase in feed consumption followed by an increase in body weight and a better digestive process, resulting in increased absorption of food by the small intestine (Indrati et al., 2010). Oils and fats provide the advantage of extra caloric effect as shown by high energy utilization in the ration, improved growth and efficiency of ration use. Rations that contain lower crude fiber and high metabolic energy content, it is not surprising that rations with high nutrient density levels result in better ration conversion (Santoyo and Riyanto, 2004).

Carcass Percentage

According to the results of research on the use of *C. xanthorrhiza* encapsulated as a feed additive in broilers on the basis of different treatment levels, where statistical analysis showed the results of the treatment had no significant effect (P>0.05) on the percentage of broiler carcasses. Based on the results of observations about the effect of treatment on carcass percentage can be shown from the

highest to the lowest value in order, namely in the treatment of P3 (79 ± 2), P4 (77 ± 3), P0- (76 ± 2), P2 (76 ± 2), P1 + (75 ± 3) and P5 (75 ± 1)%. The average results of the treatment of broiler carcass percentage with the addition of *C. xanthorrhiza* encapsulated can't affect each other. However, this result is shown in the level 0,50 % which has the highest average carcass percentage of 79%, this is likely due to *C. xanthorrhiza* encapsulated which has bioactive curcumin compounds that play a role in increasing the body weight gain of broilers, thus having a good effect on the carcass percentage. According to Alipin et al., (2017) *C. xanthorrhiza* as a natural antibiotic and can also increase carcass percentage, lower blood cholesterol and improve the quality of products, especially broilers, so it is safe for consumer health. Aviagen (2006) in Nurmi et al., (2018) stated that broiler carcass weight ranges from 1,750 -1,800 g with carcass percentage between 71-73% of body weight. Live weight is influenced by fees consumption and final body weight, the more ration consumption, and the greater the live weight (Leeson and Summers, 1980). The higher the live weight is in line with the level of carcass weight, the higher the live weight is in line with the high carcass weight and the lower the live weight is in line with the low carcass weight so that the ratio of meat and bone produced is smaller (Samsudin and Suprijatna, 2016).

Income Over Feed Cost (IOFC)

IOFC is the gross income calculated by reducing the income from the sale of live chickens with the total cost for the purchase of feed during the study period. The results of the calculation of Income Over Feed Cost (IOFC) value in broilers given *C.* encapsulated with different treatments can be seen in Table 3. Based on the results of the study, the value of IOFC in each treatment can give unequal results, which are shown numerically from the highest to the lowest value in the treatment P1+ (6,271 ± 1,637), P3 (6,115 ± 128), P0- (5,229 ± 1,402), P2 (5,188 ± 710), P4 (2,726 ± 1,637) and P5 (2,609 ± 683) Rp/head. The results of statistical analysis can show that the addition of *C.* encapsulation in broiler feed on IOFC can show a very significant difference (P<0.01). The results showed that the average IOFC decreased in the level 0,75% and level 1,0% due to the additional cost in making *C. xanthorrhiza* encapsulated, which means increasing the cost of purchasing feed. The high price of feed at each additional level of *C.* encapsulated in the treatment was caused by the high price of *C.* flour and encapsulant material, namely maltodextrin. The high value of IOFC shows that the revenue obtained from the sale of chickens is also higher. Therefore, to obtain the maximum IOFC value, there are several essential things to consider: final body weight, feed consumption, feed price and selling price of broilers. Sjofjan (2008) added that the high and low value of IOFC is caused by the difference between the sale of chickens and the feed costs that must be incurred during the period. Good growth does not necessarily guarantee maximum profit, but followed by good ration conversion and minimal feed costs will get maximum profit (Suprayogi et al., 2018).

Conclusions

The addition of temulawak (*Curcuma xanthorrhiza Roxb*) encapsulation at the level of 0.50% in broiler feed is recommended as a feed additive to replace antibiotics because it tends to increase broiler production performance.

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