

Application of Noni Fruit (*Morinda citrifolia* L.) Extract with Cu and Zn Supplemented in the Ration on Performance Chicken Sentul of Phase Developer

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Abstract—Noni fruit is a herbal plant that has the potential to be used as additional feed to replace Antibiotic Growth Promoters (AGP) and contains bioactive compounds that can increase the absorption of nutrients in the digestive tract. The study aims to determine the effect of adding noni extract with Cu and Zn supplemented in the ration on the performance of Sentul chicken in the developer phase. The research used an experiment method, using 40 female Sentul chickens aged 16 weeks and maintained until 24 weeks of age. The study used an experimental method with an experimental design used was a Completely Randomized Design (CRD). The treatments consisted of P0 = basal ration, P1= basal ration + 0.3%/kg noni fruit extract supplemented with Cu and Zn (ENFm), P2 basal ration + 0.6% /kg ENFm, P3 = basal ration + 0.9% / kg ENFm, P4 = basal ration + 1.2%/kg ENFm. Each treatment was repeated four times, and each repetition consisted of 2 Sentul chickens. The results showed that the P3 (0.9 ENFm) treatment had an influence on body weight gain and feed conversion but did not affect feed consumption and age of sexual maturity, and the addition of 0.6% (P2) level in the ratio could be the best performance on early production of chicken Sentul. This shows that ENFm products can be used as feed additives in Sentul chickens to replace an Antibiotic Growth Promoter (AGP) role.

Keywords—Cu and Zn; developer; Noni fruit extract; age of sexual maturity; early production.

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I. INTRODUCTION

Sentul Chicken is a local chicken from West Java Province, Indonesia. Sentul is characterized by its plumage that is dominated by grey color. The chicken is raised as dual-purpose and can be productive in a harsh environment and low-quality diets [1]. Sentul chicken is in great demand, especially its meat and eggs, which provide many benefits to the body and do not have side effects due to their natural maintenance. To produce optimal production, the maintenance of the developer phase is a decisive phase for future egg productivity. Sentul chickens require a balanced nutritional intake to perform well [2]. This developer phase is a phase where the amount of fiber will not increase, but the volume of fiber will increase, affecting the poultry quality. The performance effects of fiber supplementation vary widely and are not always consistent [3]. Sexual maturity in Sentul chickens is 5-6 months [4]. During the development period, it is also necessary to pay attention because many factors can

cause population growth and low productivity in Sentul on livestock [5].

Besides, the growth phase can influence the process reproduction [6]. Increasing the productivity of Sentul chickens in the developer phase must be supported by proper management during rearing to achieve uniform growth and proper sexual maturity. Efforts to improve the performance are by giving antibiotic growth promoter (AGP) as a feed additive. In many countries, animal feed is generally supplemented with low concentrations of antibiotics as growth promoters to increase feed efficiency, weight gain and animal health [7].

In recent years, the use of AGP in poultry has been banned because it can cause residues in meat and eggs, which will endanger consumers' health. Therefore, it is necessary to find a replacement for AGP using noni fruit (*Morinda citrifolia* L.). Noni fruit contains bioactive compounds that function as antioxidants and antibacterials. These compounds can be used to counteract free radicals. *Skopoletin*, *anthraquinone*, *acubin*, and *alizarin* function as antiseptic and antibacterial

agents [8], [9]. *Scopoletin* is one of the main coumarin constituents that occur in the fruits of *noni*, which contributes to the antioxidative, anti-inflammatory, immunomodulatory, and hepatoprotective properties [10], [11]; coumarins in *morinda* play an important role in the regulation of plants growth and metabolites [12]. Specifically, noni fruit contains antimicrobial flavonoids and phenolic compounds to be used as an alternative to antibiotics in poultry. Phenolic compounds, phenolic acids, quinones, saponins, flavonoids, tannins, coumarins, terpenoids, and alkaloids are the main chemical constituent groups that influence antibacterial and antioxidant activity [13]. Anthraquinones have effectiveness in inhibiting the growth of several *antimicrobe*, including *Staphylococcus aureus*, *Bacillus subtilis*, *E. Coli*, *Salmonella*, *Shigella dysenteries*, *Candida albicans* and *C. utilis* [13], [14]. Feeding natural compounds from phytogetic plants can strengthen the chicken's immune system [15]. Anthraquinones can affect the pH of the digestive tract to become more acidic [16] so that protein-breaking enzymes can work optimally, and the body absorbs more ration protein. Noni fruit as a supplementary feed must be processed first because of its high crude fiber content, anti-nutritional compounds, and active compounds that are easily oxidized. One type of processing can be done by extraction with the maceration method.

This noni fruit extract has unsaturated (short chain) organic acid compounds, which tend to be unstable (easily ionized). Therefore, the noni fruit extract must be stabilized with a metal catalyst such as Zn and Cu in micro-minerals to become a chain bonding compound cross (epoxy). Mineral Cu is useful for inhibiting the growth of disease-causing microorganisms. Zn minerals are micro-minerals found in animal and plant tissues and are involved in metabolic functions [17]. The Zn content in the body of young hens before the laying period (age 120-150 days) increased from 30 mg to 40 mg. The Zn mineral can increase appetite, hatchability, egg production, and bone growth, so it will have a good effect on the formation of reproductive bones during development. Anthraquinone is mainly absorbed in the intestine and distributed mainly to tissues and organs with abundant blood flow [16]. In addition, saponin compounds in noni fruit can also increase the permeability of cell walls so that the use of feed will be efficient and increase the hen-day production of Sentul chickens. [18] The ability of saponins is determined by their ability to disrupt membrane lipids and induce positive membrane curvature stress.

Furthermore, in [19], it is explained that the compounds contained in noni fruit include *xeronine* and *proxeronine*, which help the intestines absorb nutrients. In the intestine, *proxeronase* enzymes and other substances will convert *proxeronine* into *xeronine*, which xeronine produced in the body is an essential alkaloid for cell regulation (body cells absorb to activate inactive proteins, regulate cell structure, and repair function). Increased absorption of nutrients by the intestinal villi increases egg production and reduces the conversion value of the ration [20]. Based on this, it is important to conduct this research to determine Sentul chickens' performance in the developer phase given various levels of noni fruit extract (*Morinda citrifolia* L.) supplemented with cu and zn.

II. MATERIALS AND METHODS

The study was carried out at Test Farmhouse, Faculty of Animal Husbandry, Universitas Padjadjaran, West Java, Indonesia. The birds used were 40 female Sentul chickens, reared from 16 to 24 weeks of age. Chickens were divided randomly into 40 units of cages—the average body weight 1301.1 grams, with a coefficient of variation in body weight 7.23 %. The cage is used in as many as 40 cages, measuring 110 cm long, 42 cm wide, and 35 cm high, for 1 Chicken. Drinking water was provided ad libitum in manual drinking facilities. Also, the pens were equipped with manual feeder facilities by which the diet was available twice daily (morning and evening). Diets were prepared based on protein and metabolic energy requirements for the local chicken developer phase, i.e., 15% protein and 2750 Kcal/kg in Table 1. The treatments consisted of P0 = basal ration, P1= basal ration + 0.3%/kg noni fruit extract supplemented with Cu and Zn (ENFm), P2 basal ration + 0.6% /kg ENFm, P3 = basal ration + 0.9% / kg ENFm, P4 = basal ration + 1.2%/kg ENFm.

TABLE I
NUTRIENT COMPOSITION OF BASAL DIET

Ingredients	%
Yellow corn	51.85
Rice bran	18.52
Fish meal	6.48
Soybean meal	13.89
Bone meal	5.56
CaCO ₃	3.70
Chemical Composition (calculated)	
Crude protein (%)	15.63
Crude Fat (%)	5.14
Crude fiber (%)	4.16
Calcium (%)	3.28
Phosphorus (%)	1.39
Lysine (%)	1.06
Methionine (%)	0.35
Metabolizable Energy (kcal/kg)	2757

Experimental design Completely Randomized Design (CRD) was used with four treatments, and each treatment was replicated five times. Furthermore, treatment differences were tested using Duncan Multiple Range Test. Noni fruit extract is made in the laboratory by maceration method using ethanol solvent for 2 days, then filtered, and noni fruit filtrate is evaporated with a Rotary evaporator Bunchi R-300 with a temperature of 60⁰C, which aims to separate 96% ethanol with noni fruit extract and then added with mineral Zn and Cu then dried in an oven with a temperature of 80⁰C to get ENFm. Data collection for egg production begins when the hens produce 5% and is carried out for two months. The measured variables are as follows:

- Feed consumption was measured daily during the study by reducing the amount of the initial ration given with the remaining rations.
- Daily weight gain is calculated based on the difference between the final and initial body weights. Body weight gain is calculated every two weeks during maintenance.
- The feed conversion ratio was calculated from the number of rations consumed divided by body weight gain in the same unit.
- Age of sexual maturity: Observe when the chicken lays its first egg.

- Egg production was evaluated by dividing the average number of eggs laid per bird per week by the average number of birds multiplied by seven, and the result was multiplied by 100.
- The feed conversion ratio (FCR) was calculated by dividing the feed consumption by the egg mass produced when feed consumption was measured.
- Egg weight was observed everyday by weighing per egg.

III. RESULTS AND DISCUSSION

A. Effect of Treatment on Feed Consumption

Table 2 shows that the average consumption of rations ranges from 55.88 – 59.96 grams, and protein consumption 8.38– 8.99 g. Results of variance analysis show that adding fruit extract noni supplemented with Cu and Zn in the ration has no significant effect ($P>0.05$) on consumption rations. Added fruit extract noni supplemented with Cu and Zn up to

a level of 1.2% does not negatively affect ration consumption. Feed consumption is almost the same and does not differ. The real difference between treatments is due to the use of noni fruit cooked (already white), so the characteristic astringent taste of noni fruit is not too felt so not interfere with palatability, resulting in feed consumption of each treatment is not much different. The phenol, antioxidants and ascorbic acid content in noni fruit increases gradually from the green stage to the hard white stage [21] so that the poultry that consumes feed contains fruit extracts *Noni* does not feel astringent overpowering. Different in taste, fruity aroma ripe noni has a very strong and distinctive aroma or sometimes smells bad. This is appropriate with [22] that noni fruit is rich in nutrients but has a foul smell and is difficult to process, making it difficult to sell on the market. By making the extract odor contained in the fruit extract *Noni* has decreased, it does not affect chicken touch's palatability (taste and aroma) to noni fruit extract because one thing can affect ration consumption.

TABLE II
PERFORMANCE DEVELOPER PARAMETERS IN THE TREATMENT OF ADDITION ENFM

Variables	P0	P1	P2	P3	P4
Feed consumption (g/bird/day)	55.88 a	59.96 a	58.35 a	58.95 a	59.76 a
Daily weight gain (g/bird/day)	4.62 a	4.91 a	5.02 b	5.63 b	5.35 b
Feed conversion	12.78 b	12.27 b	11.04 ab	10.54 a	11.29 ab
Age of sexual maturity (Day)	168 a	173.25 a	180.25 a	185.50 a	185.50a

B. Effect of Treatment on Body Weight Gain

In various treatments, weight gain Sentul per tail per day for eight weeks ranged from 4.62 g to 5.35 g. The increase occurred on treatment P0 to treat P3, but on treatment P4 decreased. The average body weight gain from the highest was found in the treatment P3 of 5.63 g/head, and the lowest was at P0 of 4.62 g per bird. Results analysis shows that the addition of noni fruit extract supplemented with Cu, Zn in rations significantly increases body weight ($P<0.05$). Treat P3 (0.9%), the added fruit extract rations *Noni* supplemented with Cu and Zn gave positive results on the body weight gain of chickens touching the developer phase.

This can occur because noni fruit extract has an active substance in the form of antioxidants that works fine, so body weight gain of Sentul chickens is higher compared to treat control P0. The active substance contained among them is *Proxeronase* and *Proxeronine* (alkaloids), which can form active forms of *xeronine* in the body Sentul chicken. [23] Noni also has alkaloid which is a group of organic compounds can be used as a treatment, so that can do well in the growth of body tissue to improve body weight growth.

Added fruit extract noni supplemented with Cu and Zn in the ration at treatment P3 (0.9%), increasing the highest body weight. This can happen because of the process of extraction of noni fruit. Process extract noni fruit can remove substances from the nutrients contained in the fruit noni, and only the active substance remains very influential, increasing the permeability of the cell membrane intestine, so it will be easier right absorb nutrients from the feed given. Feed is an important regulator of the mucosal barrier, and interactions between dietary factors, the immune system, and the microbiota are critical for modulating intestinal permeability and maintaining gastrointestinal homeostasis [24].

Treat P4 (1.2%) experienced a decrease from the previous. This can happen because the dosage is too high, so the fruit extract noni, which has a substance that can activate enzymes and regulate the formation of these proteins, will produce excess protein. This agrees with [25], which states that *xeronin* in noni fruit activates enzymes and regulates enzyme formation. Protein is very important for poultry, but when the protein is in excess poultry, the body will experience decreased growth. This is appropriate with [26] stating that weight gain is affected by the availability of tissue-forming amino acids, so protein consumption is directly related to the growth process.

C. Effect of Treatment on Feed Conversion

Analysis results show that the addition Noni fruit extract supplemented with Cu, Zn in rations gives an influence significant ($P<0.05$) to conversion rations. Feed conversion values P2, P3 and P4 has the same result ($P>0.05$), but on a real P3 treatment ($P>0.05$), lower feed conversion compared to P0 and P1. However, on treating P4, the results are no different than the control treatment. Treat P3 shows the value of the least ration conversion of others and responds positively because this happens because of fruit extracts *Noni* has an active substance that can help with digestion are *flavonoids* and *steroids*, which serve to inhibit work pathogenic bacteria in the gut. The same substance found in noni fruit extract is *flavonoids*. *Flavonoids* and their microbiota-derived metabolites exhibit antibacterial potential and have the ability to inhibit pathogenic bacteria [27] resulting in better absorption of nutrients in the intestines and not disturbed. [28] *Flavonoids* are an ideal alternative for controlling intestinal diseases in livestock production. Therefore, flavonoid content is very important for optimal health and productivity in poultry.

The body of the phase developer is getting slower than during the starter phase, but ration consumption is high. Chicken diets are supplementary feeds to optimize production and increase efficiency in the breeding process [29]. The developer phase is a growth phase that has already decreased or slowed, but ration consumption of this ration is used to prepare the formation of reproductive organs for the reproductive phase, and there is also an increase in the size of cells to achieve growth and a good framework to enter the reproductive phase. In this phase, there is development on the body's skeleton until it reaches perfect shape for the production phase. Another factor that causes feed conversion during this developer period to be high is due to the age factor of the chicken. It leads to the end growth and development already close to maximum. The older the chicken, the higher the conversion value of the ration, so with age, the chicken will need food for lots of trees and growth anyway, but the growth process is already within maximum limits and tends to slow down. The conversion value increases for the older chicken [20].

D. The effect of treatment on age of sexual maturity

Sentul chickens fed noni fruit extract supplemented with Cu and Zn have no experience with the difference, and the results are nearly the same in each treatment. This is evident from the results of the analysis of variance that the results have no significant effect ($P>0.05$). Until sexual maturity, the administration of noni fruit extract supplemented with Cu and Zn had no effect. Factors that cause an age of sexual maturity are not significantly different due to the active substance in

noni fruit, namely *xeronin*, which can naturally reduce cholesterol. Noni contains the active substance *xeronin*, which can reduce cholesterol levels. When cholesterol levels decrease, the ovaries will be obstructed in synthesizing the hormone estrogen, so Follicle formation is also inhibited and will lead to sexual maturity, also getting longer in line with [30]. namely, the function of cholesterol is as a precursor molecular to the sex hormone estrogen or testosterone, so with increased use of fruit extracts *noni* will reduce activity cholesterol and cause inhibition of follicle formation because the ovary takes a long time to synthesize the hormone estrogen and will affect mature sex. It is proved that the age of sexual maturity is not much different from each good treatment given the noni fruit extract or not. Thus, the higher the extract content given, the slower it matures the age of sexual maturity.

E. Effect of Treatment on Early Production

The results of the measurement of production performance treated with the addition of noni fruit extract supplemented with Cu and Zn minerals in the ration can be seen in Table III. The average consumption that the addition of fruit extract noni supplemented with Cu and Zn (ENFm) in the ration has no significant effect ($P>0.05$) on feed consumption. Adding ENFm up to a level of 1.2% does not hurt ration consumption. Besides that, the rations given during the study had the same composition of nutrients in terms of quality and quantity, so the feed's palatability was relatively the same, which caused the nutrients consumed in each treatment not to be significantly different.

TABLE III
AVERAGE RATION CONSUMPTION, EGG WEIGHT, HENDAY PRODUCTION AND SENTUL CHICKEN RATION CONVERSION VALUE

Variables	P0	P1	P2	P3	P4
Feed consumption (gr)	64.8 _a	64.3 _a	64.05 _a	64.76 _a	64.90 _a
Egg Weight (gr)	40.21 _a	41.53 _a	42.06 _a	42.16 _a	42.00 _a
Henday Production	31.06 _a	33.25 _b	33.37 _b	34.01 _b	34.36 _b
Feed Conversion	4.45 _a	3.36 _b	3.18 _b	3.21 _b	4.08 _a

The results of the analysis of variance on egg weight showed that adding noni fruit extract supplemented with Cu and Zn into rations has no significant effect. This matter is because Sentul chicken used for this research is just entering a phase of early laying eggs at 24 weeks old. Chicken Sentul reaches sexual maturity at five months old and starts laying eggs at 6-7 months old (24-28 weeks) [4]. Several factors influence the weight of chicken eggs, namely the age of the chicken, ambient temperature, strains and breeds of chickens, nutritional content in the ration, weight body of the hen, and the time the egg is laid. The average weight of eggs in this study is high enough for Sentul chickens, i.e., ranges from 40.21 to 42.16 grams. Sentul chicken has an egg weight of ± 40.7 grams/item [4].

The Sentul chicken egg production percentage is calculated using the hen day production formula, namely the ratio between the number of eggs produced in a certain period. Based on Table 3, the hen day production of chickens Sentul between treatments P1, P2, P3, and P4 have the same hen day production, but treatment P0 has a hen day value significantly lower production ($P<0.05$) compared to P1, P2, P3, and P4 given ENFm. This means that the addition of fruit extract *Noni* supplemented with Cu and Zn as much as 0.3 % until

1,2 % in basal ration markedly increases hen day Sentul chicken production compared without the addition of fruit extracts *Noni* supplemented with Cu and Zn (P0). This is due to the polyphenolic compounds found in noni fruit extracts as anthraquinone compounds, which can function as an antibacterial agent, thereby solving digestive problems and increasing metabolism. Anthraquinone compounds can fight bacteria that cause infection and increase metabolism [18]. In addition to the existing saponin compounds in noni fruit can also increase the permeability of the cell wall, so the use of feed will be efficient and increase hen day production of chickens' touch. *Saponin* compounds contained therein noni fruit can improve the permeability of the cell wall so that the absorption of nutrients also increases [18]. Extract from noni fruit also contains alkaloids such as *xeronin* and *proxeronine*. Although the *xeronine* contained in noni fruit is in small quantities, the noni fruit contains much *proxeronin*, a constituent element of *xeronin*. *Xeronine* contained in Noni fruit extract functions as an activator of enzymes, repairing the structure and regulating the function of proteins in cells to help digest food, and then egg production will increase. The *xeronine* contained in noni fruit can increase the activation of enzymes in the digestive tract to improve the absorption of

nutrients [23]. The increased nutrient absorption allows more nutrients to be absorbed by the chicken's body. The better the absorption of feed that occurs, the basic needs of life and livestock production needs will be fulfilled optimally to increase the production of hen day. Animal welfare is an important physiological condition to support optimal metabolism and production [30].

Table III shows that the ration conversion for Sentul chickens in the P0 and P4 treatments had the same results, but in the P0 and P4 treatments, the ration conversion values were significantly higher than those in P1 and P2. The feed conversion values for P1 and P2 had the same results, but in the P2 treatment, it was significant ($P < 0.05$) that the ration conversion values were lower than P0, P3, and P4. Therefore, adding fruit extract noni supplemented with Cu and Zn as much as 0.6% (P2) in the basal ration markedly reduced the conversion value of the ration compared to no additions noni fruit extract supplemented with Cu and Zn (P0).

IV. CONCLUSION

The addition of ENFm product as much as 0.9% in ration increases body weight gain and lower conversion rates ration on Sentul chickens phase developer, and 0.6% in the ration increases the hen day production and lowers the value of ration consumption and conversion but not increase the average egg weight on Sentul chickens' early production phase. ENFm products can be used as feed additives in Sentul chickens in replacing the role of an Antibiotic Growth Promoter (AGP)

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