Influence of Noni (*Morinda citrifolia L*) Fruit Extract Supplemented with Cu and Zn in Diet on Performance of Sentul Chickens

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Abstract: Many studies investigate the use of noni (*Morinda citrifolia L*.) fruit as natural additive in broiler diets but there is a lack of information on the e ect of Noni in diets on local chickens. The current study aims to determine the effect of Noni fruit extract supplemented with Cu and Zn on production performance of Sentul Chickens. A total of 100 birds of Grey Sentul Chickens aged one day were assigned randomly into 5 treatment groups, each with four replicates and each group treatment contained 5 birds in a completely randomized design. The treatments were basal diet added with different level of Noni fruit extract supplemented by inorganic minerals ($CuSO_4$ and ZnO). The results showed that the addition of Noni fruit extract supplemented with Cu and Zn significantly increased feed intake (in Month II), body weight and body weight gain (in Month III) and carcass weight. However, the treatments reduced the height and width of villi in the intestinal organ of Sentul chickens. The study indicates that increasing Noni fruit extract in diets at a certain level had positive effects on chicken performance.

INTRODUCTION

Sentul Chicken is a local chicken from West Java Province, Indonesia. Sentul being characterized by its plumage that is dominated by grey color. The chicken is raised as dual-purpose chicken and can be productive in a harsh environment as well as in the low quality of diets. The population of Sentul chickens is in decline; therefore, it needs conservation. Some efforts have been conducted through genetic and feed improvements to maintain Sentul chickens. In terms of feed improvement, studies about natural feed additives to enhance the production performance of Sentul chickens are required.

The use of synthetic additives in chicken feeds, for example, for growth promoters, is prohibited because of its hazardous effect on humans. Natural additives from plant extracts are alternatives to synthetic products. Noni (*Morinda citrifolia L*) is a medical plant used for livestock and poultry[1]. Noni inhabits humid tropical environments[2] including in Indonesia. It has been used as medicinal plants for human health problems[3] and it is the main product in the human health industry[4].

Noni can act as an anti-inflammatory, analgesic, anti-cancer, anti-diabetic and anti-hypertensive properties[5]. Therefore, Noni is the potential to cure obesity and its metabolic abnormality[6]. It is found 200 phytochemical

compounds in Noni[5]. However, the part of the plant contains different phytochemical content[7]. The main chemical groups in the plant are polyphenols that can be divided into three main subclasses: the flavonoids, phenolic acids and the stilbenoids[8]. Flavonoids, glycosides and triterpenoids are some phytochemicals components identified in Noni[5].

The advantages of Noni in poultry have been reported by many researchers[9-12][2]. These studies have demonstrated the benefit of Noni fruit to enhance the production performance of broiler. A study about Noni fruit on egg production of Sentul chickens showed that the birds treated with Noni fruit juice in drinking water have better egg production, egg quality and better feed efficiency compared to control birds[13]. Different from the previous study, the current study used Noni fruit extract supplemented with Cu and Zn in diets. The utilization of minerals aimed to stabilize Noni fruit extract. Cu and Zn were reported by Surai [8] to have the capacity of binding polyphenolic compounds in Plant bioactive compounds. The investigations about the role of Noni as a natural feed additive for local chickens are limited; thus, the current study will fill the gap of the lack of information about Noni fruit on the production performance of local chickens. Also, the result may be a significant input for Sentul management and conservation.

MATERIALS AND METHODS

The study was carried out at Test Farm House, Faculty of Animal Husbandry, Universitas Padjdjaran, West Java, Indonesia.

Animals and treatments: The study applied a Completely Randomized Design (CRD). A total of 100 birds of Grey Sentul Chickens (unsexed) aged one day were assigned randomly into five treatment groups with four replications for each treatment group and each group contained five birds. The birds were reared in 20 pens sized of 75 cm×90 cm×60 cm in which rice husks were used as bedding material. Drinking water was provided ad libitum in manual drinking facilities. Also, the pens equipped with manual feeder facilities by which the diet was available twice a day (morning and evening).

The chickens were fed with a basal diet containing different levels of Noni extract supplemented with various dosage of CuSO4 and ZnO minerals. The basal feed was formulated based on diet formulation for Sentul chicken at the starter phase. The diet contained 17% of crude protein with Metabolism Energy (ME) of 2,750 kcal kg^{-1}. Table 1 shows the feed ingredients and nutrient composition of the diets.

The Noni extraction process was conducted through several steps. Firstly, Noni fruit was chopped and dried in the sun. Secondly, dried Noni fruit was mashed up using a blender to have Noni fruit meal. Thirdly, the Noni fruit meal was added with ethanol 96% by the ratio of 1:1 and then macerated for two days (2×24 h). Fourthly, macerated Noni extract was filtrated and evaporated using an evaporator with a temperature of 60°C to separate from ethanol. Lastly, Noni extract was dried in an oven with a temperature of 60°C to have Noni extract powder. Then, Noni extract powder was supplemented with $CuSO_4$ and ZnO minerals.

Table 1: Feed ingredients and nutrient composition of diet

Ingredients	Amount (%)
Yellow corn	56.00
Soy-bean meal	12.00
Rice bran meal	21.50
Fish meal	9.25
$CaCO_3$	0.50
Bone meal	0.75
Nutrient composition:	
Metabolism energy (kcal kg^{-1})	2.781
Crude protein	17.04
Crude fat	5.92
Crude Fiber	4.51
Calcium	1.16
Phosphorus	0.36
Lysine	1.21
Methionine	0.40

The combination of treatments consisted of basal diet (T0), T0 added with noni extract 50 mg kg^{-1} ration supplemented with 2 mg ZnO and 0.25 mg CuSO4 minerals (T1), T0 added with noni extract 150 mg kg^{-1} ration supplemented with 6 mg ZnO and 0.75 mg CuSO4 minerals (T2); T0 added with noni extract 250 mg kg^{-1} ration supplemented with 10 mg ZnO and 1.25 mg $CuSO_4$ minerals (T3) and T0 added with noni extract 350 mg kg^{-1} ration supplemented with 14 mg ZnO and 1.75 mg $CuSO_4$ (T4). The use of minerals in the study base on the recommendation by Scott etc. that stated that the requirements of Cu in poultry are of 5 ppm while Zn is 40 ppm. An example of calculation of the number of minerals is below (for T1 treatment) (Table 2):

$$\text{Zn}\frac{40\text{ mg}}{\text{l}}\times 0.05\text{ l} = 2\text{ mg}$$

$$\text{Cu}\frac{5\text{mg}}{\text{l}}\times 0.05\text{ l} = 0.25\text{mg}$$

Production parameters: The birds were reared for 12 weeks. The parameters in this study were the performance of Sentul chickens included Body Weight (BW), Body Weight Gain (BWG), Feed Intake (FI) and Feed Conversion Ratio (FCR). Also, the study observed Carcass Weight (CW) and Carcass Percentage (CP) as well as the weight of internal organs such as gizzard, heart, liver and intestinal tract. Besides, fat abdominal and villi morphometry were measured. Body weight was measured every week to have body weight gain while feed intake was calculated daily. Data on weekly body

Table 2: Performance of Sentul chickens fed with diet containing Noni extract supplemented with Cu and Zn

	Treatment						
Month/Variables	T0	T1	T2	T3	T4	SEM	p-values
I							
BW (g)	153.90	149.49	151.59	161.51	158.86	2.602	0.607
BWG (g)	130.95	135.23	130.00	132.73	132.05	2.080	0.960
FI (g/month/bird)	307.21	318.66	350.19	366.21	324.07	8.443	0.148
FCR	2.35	2.36	2.69	2.79	2.47	0.074	0.223
II							
BW (g)	403.65	393.34	398.46	418.74	416.66	7.083	0.780
BWG (g)	197.53	220.23	200.73	196.10	198.94	6.58	0.806
FI (g/month/bird)	1,038.15^{a}	1,039.70^{a}	1.188.79^{ab}	1,221.48^{b}	1,071.25^{a}	25.442	0.029
FCR	5.42	4.77	6.11	6.30	5.40	0.229	0.222
III							
BW (g)	731.31^{a}	761.96^{a}	749.69^{a}	875.88^{b}	766.20^{a}	16.622	0.029
BWG (g)	276.88^{a}	305.65^{a}	289.50^{a}	395.03^{b}	286.00^{a}	13.320	0.012
FI (g/month/bird)	1.775.03	1.664.85	1.867.33	1.948.89	1.774.91	38.006	0.164
FCR	6.42	5.48	6.54	4.94	6.54	0.241	0.094

BW = Body Weight; BWG = Body Weight Gain; FI = Feed Intake = FCR = Feed Conversion Ratio; ^{a,b}values in rows denoted by different letters differ significantly ($p \leq 0.05$)

weight gain and feed intake were used to determine the feed conversion ratio. At week 12, one bird weighing closest to the mean of the pen was chosen from each replicate for the carcass, intestinal organ, fat abdominal, and villi morphometry measurements.

Statistical analysis: The results were verified by one-way Analysis of Variance (ANOVA). Duncan's multiple comparison test at 0.05 level determined the differences between treatments. Data analysis was performed using The statistical package program of SPSS Version 22.

RESULTS AND DISCUSSION

Table 2 shows that Body Weight (BW), Body Weight Gain (BWG), Feed Intake (FI) and Feed Conversion Ratio (FCR) were similar in the first month of research. There were no significant differences between variables among groups. The differences among treatment groups were observed in months II and III. In month II, the group of T3 significantly had higher FI compared to other groups. BW, BWG and FCR did not significantly differ among a group of treatments this month. In month III, BW and BWG of T3 were significantly higher from those of other treatment groups (Fig. 1). T3 had the highest FI and the lowest FCR; however, FI and FCR of T3 did not differ significantly from other treatments.

Table 3 indicates that treatments influence carcass weight in which the group of T3 significantly had higher CW compared to the control group (T0). In terms of carcass percentage, there were no significant differences among groups. However, carcass percentage tends to be higher in the groups with a higher dosage of Noni extracts. Internal organs and abdominal fat were similar among groups of treatments.

Table 4 shows that the height of intestinal villi decreases for treatment groups. In particular, the villi

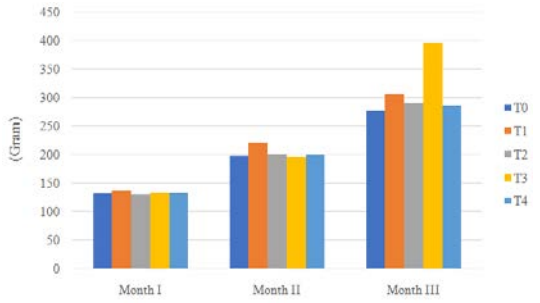

Fig. 1: Body weight gain of sentul chickens

height of T1 and T4 are significantly lower than that of T0. In terms of villi width, the effect of treatments varies among groups. However, T2 is significantly different compared to T3.

The present study shows that Sentul chickens respond to treatments at older ages and a higher dosage of Noni extract. The Noni did not affect BW, BWG, FI, and FCR of chickens in the first month of study. The response of Noni extract addition in rations was able to be observed in the age period of 2 to 3 months. In the first month of study, Sentul chickens were in the initial development period. In this phase, metabolism as well as absorption of the nutrient, may not function optimally. Hence, the treatments may be difficult to observe in this period.

In months II and III, FI tended to be higher in groups with a higher dosage of Noni extract and increasing level of minerals. In the second month of the study, the FI of the group with a dosage of 250 mg kg^{-1} of Noni extract was significantly higher compared to those of other groups. This finding is contrary to those of other studies that investigated Noni powder on broiler performance[2] and Noni juice on the performance of Japanese Quails[14].

Table 3: Carcass weight, carcass percentage and internal organs of Sentul chickens fed with diet containing Noni extract supplemented with Cu and Zn

	Treatment						
Month/Variables	T0	T1	T2	T3	T4	SEM	p-values
CW (g)	450.50^{a}	534.25^{ab}	594.50^{b}	664.50^{b}	529.00^{ab}	21.902	0.011
CP (%)	65.54	66.63	71.91	72.11	69.79	1.284	0.382
Gizzard (g)	24.25	23.50	25.25	29.50	23.75	0.951	0,256
Heart (g)	5.00	5.25	5.25	5.00	4.25	0.198	0.529
Liver (g)	26.50	23.25	23.25	25.75	26.00	0.698	0.426
Intestine (g)	33.50	30.50	34.25	33.75	30.75	0.578	0.087
Abdominal fat (g)	2.00	2.50	2.25	2.50	2.00	0.099	0.293

CW = Carcass weight; CP = Carcass Percentage; $^{a, b}$ values in rows denoted by different letters differ significantly ($p \leq 0.05$)

Table 4: Intestinal morphometry of Sentul chickens fed with diet containing Noni extract supplemented with Cu and Zn

	Treatment						
Month/Variables	T0	T1	T2	T3	T4	SEM	p-values
Villi height (µm)	367.21^{b}	284.56^{a}	336.24^{ab}	312.50^{ab}	300.20^{a}	10.889	0.000
Villi width (µm)	136.71^{ab}	134.32^{ab}	197.15^{b}	126.98^{a}	171.24^{ab}	5.194	0.000

$^{a, b}$ values in rows denoted by different letters differ significantly ($p \leq 0.05$)

Also, the current study does not support a study that reported that Noni had potential as an appetite suppressant[4].

The utilization of Noni products in poultry was influenced by several factors included the processing method and composition of the basal diet[2]. In the current study, the mineral supplementation of Noni extract in particular with Zn, seems to increase the feed intake of chickens. It reported that Zn was a mineral that increasing feed appetite[15]. In general, Zn has a crucial role in enzyme systems. It is commonly accepted that deficiency of Zn in some enzyme activity may cause loss of appetite and taste. Some studies showed that increasing levels of Zn in diets induced feed intake of broiler chicks[16-18].

The current study found the positive effect of Noni extracts in diets for local chicken. The body weight, body weight gain and carcass weight of chickens are higher in the group with Noni extract. However, feed efficiency and internal organs, as well as abdominal fats, are similar among groups. This finding supports the study that investigated the utilization of Noni in the broiler[11]. It generally agreed that Noni fruit is abundant with nutritional compounds such as amino acids, monosaccharides, vitamins and minerals [1,4]. The Noni fruit content may enrich diet resulting positive effect on body performance. Also, it reported that Noni fruit contains alkaloids such as Xeronine[1, 4] This alkaloid modulates specific proteins needed in the metabolic process. Other phytochemical content in Noni fruit, anthraquinone, plays an important role; in reducing the pH of the digestive tract. In lower pH, the protein-breaking enzyme would have optimal performance [19]. As a result, this process may enhance nutrient absorption in the digestive tract.

The supplementation of trace minerals may also play an important role; in increasing body performance in the current study. The application of trace minerals such as Zn and Cu had a positive effect on broilers[20]. In particular, Zn[16, 17] and Cu[12] influenced the body weight of poultry. The benefits of Zn in the growth performance of broilers due to its metabolic process and capacity to act as an antioxidant that plays an important role in the digestion of poultry nutrition[15]. In humans, Zn is involved in the processes of Carbon dioxide (CO_2) regulation and digestion of proteins while Cu roles in biological electron transport and oxygen transportation[21].

This current study indicates that the dosage of Noni extracts should be given at a certain level in the diet of Sentul chickens. The performance of Sentul chickens started to be lower at 350 mg kg^{-1} ration (T4). The addition of Noni extracts <350 mg kg^{-1} ration might worsen chicken performance. Regardless of its positive effects, polyphenolic compounds could reduce the apparent digestibility of protein as it binds digestive enzymes[8]. Polyphenol could restrain enzymes such as a-glucosidase and pancreatic lipase[23].

Also, it was reported that polyphenol had a negative effects of on villus height and width in poultry[24]. The current study found another adverse effect of Noni extracts on histological structure of the intestine. The height of villi in a group of treatments tends to decrease, along with a higher dosage of Noni fruit extract. However, the villi width varies among treatment groups in which the villi width of chickens with noni extract 250 mg kg^{-1} ration supplemented with 10 mg ZnO and 1.25 mg $CuSO_4$ minerals are the lowest. This current study finding indicates that the use of Noni extract may have a contrary effect and should be given in a particular amount to maintain the villi structure of the intestinal tract.

Some studies indicated the contrary effect of Noni on animal[24-26]. A higher dosage of Noni might cause edema and inflammatory infiltrate in the mucosal and

submucosal layers of rat intestine[26]. Anthraquinones and coumarins in Noni were assumed to be hepatoxic, hence, these compounds might cause adverse effects to humans[27]. Anthraquinone may play as an antibacterial agent in the digestive tract of animals[19]. The content of anthraquinone in Noni fruit is higher than that of in aloe vera leaves. In particular, anthraquinone content in Noni fruit arrays from 5-36 g/100 g of Noni dry ingredients[28]. More research about phytochemical properties of Noni fruit extract and its effect on villi of Sentul chickens are needed to establish this current finding.

Date simple summary: Chicken Sentul is one of the local chickens in Indonesia. It was reported that the population of Sentul chickens is in decline; thus conservation for these chickens is required. One way to maintain the population of Sentul chicken is by improving the performance of the chickens. It includes providing rations containing natural feed additives to enhance their production performance. Noni (*Morinda citrifolia L.*) is a natural feed additive that is often used for poultry, especially broilers. This current research was conducted to determine the effect of noni in the diet on the performance of Sentul chickens. The results showed that giving Noni to some extent in the diet of Sentul chicken gave good results. However, its use needs to be limited because it affects the digestive tract of Sentul chickens. The results of this study are very important as information on the use of noni in rations of poultry and fill the gap of the limited evidence about the use of Noni fruit on the production performance of local chickens. Also, the knowledge is important as input in the conservation of Sentul chickens.

CONCLUSION

The study shows significant evidence about the influence of Noni fruit extract in diets on the performance of Sentul chickens. The birds treated with Noni fruit extract have better body weight, body weight gain and carcass weight; however, feed efficiency is similar among treatments. Interestingly, the study finds that a high dosage of Noni fruit extract may harm performance and villi morphometry of Sentul chickens. Further research is required to have a better understanding of the phytochemical properties of noni fruit extract in the diets of Sentul chickens.

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