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# The effect of *Morinda citrifolia* L. (Noni) in drinking water on egg production and egg quality of Sentul Chickens

**Indrawati Y. Asmara*, Tuti Widjastuti, Iwan Setiawan, Abun**

Faculty of Animal Husbandry, Universitas Padjadjaran.
Jl. Raya Bandung-Sumedang Km 21, Jatinangor, Sumedang 45363, West Java, Indonesia

*E-mail address: indrawati.yudha@unpad.ac.id

**ABSTRACT**

*Morinda citrifolia* (Noni) is a common plant used as alternative to synthetic feed additive in poultry production. The study was aimed to determine the effect of Noni juice in drinking water on production and egg quality of Sentul Chickens. Sentul Chicken is an indigenous chicken of Indonesia that has dual purpose potential. A total of 20 birds of female Grey Sentul Chickens aged 22 weeks were reared for eight weeks. The observed variables were hen day production, yolk and albumen indexes, as well as cholesterol content of yolk egg. The results showed that addition of Noni fruit juice to drinking water significantly increased egg production and reduced the yolk index. Moreover, the treatments reduced the cholesterol of yolk of Sentul Chickens. The study reveals that increasing levels of Noni fruit juice in drinking water also had positive effects on egg production and egg quality. Further studies are, however, needed to have better understanding about the use of Noni fruit in enhancing egg production and egg quality of Sentul chickens.

***Keywords*:** Sentul chickens, egg production, egg quality, *Morinda citrifolia*

## 1. INTRODUCTION

In the poultry industry, the usage of synthetic feed additives such as growth promoter antibiotics in chicken feeds is prohibited due to their residue in poultry products. Feed additive

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from plant-based compounds have thus become alternatives to synthetic products. *Morinda citrifolia* (Noni) is a plant native to Southeast Asia used in herbal medicines for a variety of human health problems (Torres et al. 2017). As a medical plant, Noni contains anti-oxidant, anti-inflammatory, analgesic, anti-cancer, anti-diabetic and anti-hypertensive properties (Thyaga Rajan et al. 2015). In particular, Inada et al (2017) reported the potential of Noni in obesity and its metabolic dysfunction. Due to its properties, Noni juice has become a major product in the human health and wellness industry (Singh, 2012). Up to 200 phytochemical compounds have been identified in Noni juice. Among the phytochemical components of Noni are flavonoids, glycosides and triterpenoids (Thyaga Rajan et al. 2015). In addition, the identified compounds of medical importance in Noni include, for example, octanoic acid, cyclopropyl, sorbitol, mannitol, glycerin and gammatocopherol (Rivera et al. 2012). What is more, Sunder et al. (2016) have reported that Noni is very rich in essential amino acids, minerals and vitamins. In addition, it contains proxeronine - which is needed in cell metabolism.

The benefit of Noni for poultry health and production has been reported by, among others, Sunder et al. (2011, 2013) and Más-Toro et al. (2015). Sunder et al. (2011, 2013) showed that the use of Noni as feed additive is beneficial for egg production and egg quality of poultry in general, and enhanced the egg production and egg quality in Japanese quail (Sunder et al. 2011) and in Nicobari fowl, in particular, while Más-Toro et al. (2015) revealed the same effect in White leghorn birds. However, studies on Noni as natural feed additive in local chicken are still limited; thus more studies are needed. In the current work, the benefit of Noni fruit for Sentul chicken will be investigated. The purpose of this study was to determine the influence of Noni fruit in drinking water on the egg production and egg quality of Sentul chickens. Sentul Chicken is one of indigenous chickens in Indonesia and is considered local to the Ciamis region, West Java Province, Indonesia. In general, chickens in Indonesia are part of the cluster *Gallus gallus gallus* and *Gallus gallus spadiceus* from Thailand and neighboring regions (Akishinonomiya et al. 1996). However, Sulandari et al. (2008) believes that chickens in Indonesia are different from those in Asia, as well as from that of other countries in the world; thus Sulandari et al. (2008) argue that Indonesia is one of three chicken domestication centers (the other two being China and India). Unfortunately, the population of Sentul chickens is in decline. Still, some studies report that these grey chickens are able to adapt to severe environment and remain productive despite low quality diets. Furthermore, the chickens hold potential to be raised under organic farming systems. This type of production is characterized by the use of natural inputs for production processes. Thus, the current study will fill the gap in studies about the benefit of Noni for local chickens in Indonesia. In addition, the study will be important as input for management of local chickens in Indonesia.

## 2. MATERIAL AND METHODS

### 2. 1. Material

This study involved a total of 20 birds of female Grey Sentul Chickens aged 22 weeks. The birds were kept in 20 bamboo cages with dimension of 22 cm × 40 cm × 40 cm. The cages were equipped with feeding and drinking facilities. The birds were fed with basal feed formulated based on diet formulation for Sentul chicken developed by Widjastuti (1996). The diet contained 15% of crude protein with Metabolism Energy (ME) of 2,750 kcal/kg. Table 1 shows feed ingredients and nutrient composition of the diets.

**Table 1.** Feed ingredients and nutrient composition of diet

| Ingredients | Amount |
|---|---|
| | % |
| Yellow corn | 51.85 |
| Soy-bean meal | 13.89 |
| Rice bran meal | 18.52 |
| Fish meal | 6.48 |
| $CaCO_3$ | 3.70 |
| Bone meal | 5.56 |
| *Nutrient composition*: | |
| Metabolism Energy (kcal/kg) | 2,757 |
| Crude Protein | 16.63 |
| Crude Fat | 5.14 |
| Crude Fiber | 4.16 |
| Calcium | 3.28 |
| Phosphorus | 1.39 |
| Lysine | 1.06 |
| Methionine | 0.35 |

(A) (B) (C)

**Figure 1.** Image of Noni Fruit and Noni Juice Processing; (A) Noni Fruit; (B) Crushing Process; (C) Noni Fruit Juice

The treatments were Noni fruit juice (Figure 1A-C) added to drinking water. The variety of Noni is *Morinda citrofolia* L derived from the Ciparanje Area in Jatinangor Sub-District, Sumedang Regency, West Java Province, Indonesia (where the research was carried out).

The Noni fruit juicing process was performed via a method reported by Fenita (2008) (Illustration 1). The process was conducted daily to provide birds with fresh Noni fruit juice.

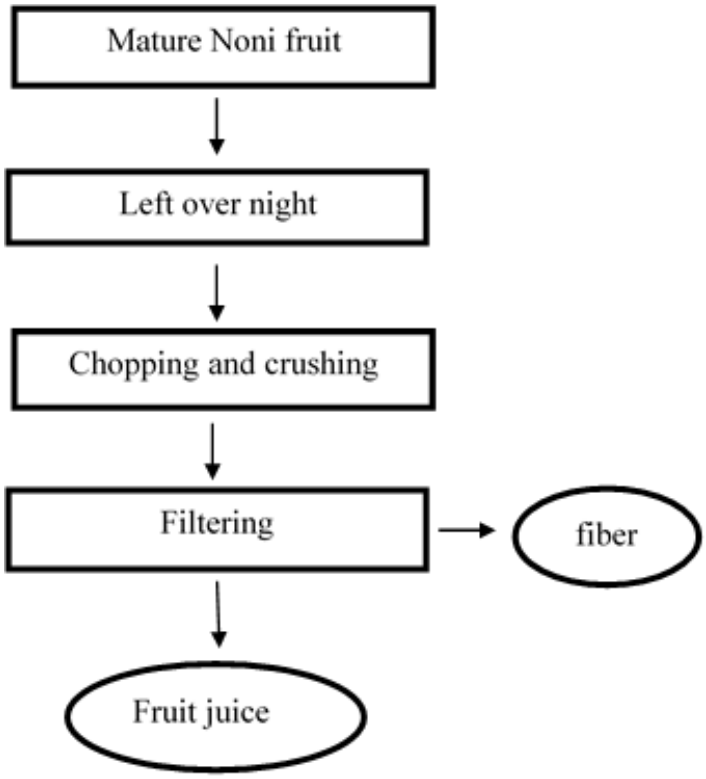


**Illustration 1.** Juicing process of Noni fruit

## 2. 2. Methods

A completely Randomized Design (CRD) was applied in the study. The chickens were randomly distributed into 5 groups and each group contained 4 birds. The groups consisted of control and 4 treatment groups. In the control group, the birds were given drinking water without Noni fruit juice, while in the treatment groups, the birds were given drinking water with different levels of Noni fruit juice (1, 2, 3 and 4 mL of fruit juice in 1 L of drinking water, respectively). The feed was given twice a day (morning and evening), while water was provided ad-libitum. The birds were kept for 8 weeks. The observed parameters in this study were egg production and egg quality. The egg production was measured by hen day production and Feed Conversion Ratio (FCR), while egg quality was assessed through yolk index (YI) and albumen index (AI). In addition, yolk cholesterol was determined using the CHOD PAP Method. The egg production was measured every week after all hens started to lay their eggs (from week 26 to week 29). Number of eggs, egg weight and feed consumption was recorded daily to calculate weekly hen-day egg production and FCR. Hen day was calculated by dividing the number of eggs produced weekly, by the number of birds, and multiplying by 100%. Feed conversion was

obtained by dividing the amount of feed consumption, by weekly total weight of eggs. The egg quality was measured by way of the following formulas:

$$AI = \frac{H}{[L + W]}$$

where H = albumen height; L = albumen length; W = albumen width

$$YI = \frac{H}{D}$$

where H = yolk height; D = yolk diameter

Data was analyzed using Analysis of variance. The statistical package program of SPSS version 22 was accessed for data analysis. Duncan's multiple comparison test at 0.05 level was applied to determined differences between treatments.


(A) (B)

**Figure 2.** Image of Sentul Eggs; (A) Egg collection; (B) Egg weighing Process

## 3. RESULTS AND DISCUSSION

Table 2 shows feed consumption, egg weight, egg production and feed efficiency of Sentul chickens during the first four weeks of the laying period. In terms of feed consumption, there were no significant differences among groups. However, Table 2 indicates that in week III and IV, the Noni fruit juice groups tended to consume lower amounts of feed compared to the control group. It was reported by Singh (2012) that Noni could perform as an appetite suppressant. According to the work of Pu et al. (2004) in rats, Noni controls the rate of food consumption in the stomach by stimulating cholecystokinin (CCK) secretion and activating $CCK_1$ receptors. CGK, in turn, stimulates secretion of the pancreatic enzyme, hence, inhibiting gastric emptying and suppressing food intake. As a receptor of CGK, $CCK_1$ are found primarily in peripheral tissues.

**Table 2.** Feed consumption, egg weight, egg production and feed efficiency of Sentul chickens.

| Week | Variable | Group | | | | |
|---|---|---|---|---|---|---|
| | | Control | 1 mL/L | 2 mL/L | 3 mL/L | 4 mL/L |
| I | Feed consumption (g/day/bird) | 79.74 | 79.68 | 79.70 | 79.55 | 79.48 |
| | Number of egg | 4 | 4.25 | 4.75 | 5 | 4.5 |
| | Egg weight (g) | 36.36 | 38.39 | 40.03 | 40.18 | 41.54 |
| | Hen day (%) | 57.14 | 60.71 | 67.86 | 71.42 | 64.28 |
| | FCR | 4.71 | 3.45 | 3.14 | 2.96 | 3.01 |
| II | Feed consumption (g/day/bird) | 79.35 | 79.74 | 79.69 | 79.52 | 79.52 |
| | Number of egg | $3.25^{a}$ | $4^{a}$ | $4,25^{ab}$ | $5.25^{bc}$ | $5.5^{c}$ |
| | Egg weight (g) | 38.15 | 40.40 | 41.61 | 41.58 | 45.04 |
| | Hen day (%) | $46.42^{a}$ | $57.14^{a}$ | $60.71^{ab}$ | $74.99^{bc}$ | $78.57^{c}$ |
| | FCR | $4.60^{a}$ | $3.33^{b}$ | $3.29^{b}$ | $2.60^{b}$ | $2.40^{b}$ |
| III | Feed consumption (g/day/bird) | 79.67 | 79.67 | 79.01 | 79.03 | 75.36 |
| | Number of egg | $3.25^{a}$ | $5^{b}$ | $4.75^{b}$ | $4.75^{b}$ | $4.5^{b}$ |
| | Egg weight (g) | 39.67 | 41.30 | 41.11 | 40.60 | 45.51 |
| | Hen day (%) | $46.42^{a}$ | $71.43^{b}$ | $67.86^{b}$ | $67.85^{b}$ | $64.29^{b}$ |
| | FCR | $4.45^{a}$ | $2.59^{b}$ | $2.86^{b}$ | $2.96^{b}$ | $2.61^{b}$ |
| IV | Feed consumption (g/day/bird) | 79.39 | 77.16 | 74.26 | 74.43 | 78.12 |
| | Number of egg | 3.75 | 3.25 | 3.75 | 3 | 3.75 |
| | Egg weight (g) | 38.45 | 40.67 | 40.46 | 41.06 | 46.09 |
| | Hen day (%) | 53.57 | 46.43 | 53.57 | 42.85 | 53.57 |
| | FCR | 4.05 | 3.54 | 3.83 | 4.48 | 3.53 |

a, b, c, d: means with no common superscript differ significantly ($p<0.05$)

In the current study, egg weight of birds in each treatment did not show significant differences. However, the egg weight tends to be higher with higher dosage of Noni fruit juice addition. The number of eggs and hen day production, as well as the FCR of all groups were

also not significantly different in the first and last week of observation (Table 2; Figures 3 & 4), but the egg production and FCR showed significant differences among groups in the second and third week of study. In the second week of observation, birds treated with 4 mL/L Noni fruit juice had the highest egg production, and birds treated with Noni fruit juices (1-4 mL/L) had the lowest FCR, compared to the control group. Moreover, in the third week, birds treated with Noni fruit juices (1-4 mL/L) had the highest egg production and the lowest FCR, compared to control group. In general, the egg production was found higher in groups treated with Noni fruit juice, while they had lower FCR compared to the control group. This is because the treated groups had lower feed consumption, yet the egg weight and production was higher compared to the control group.

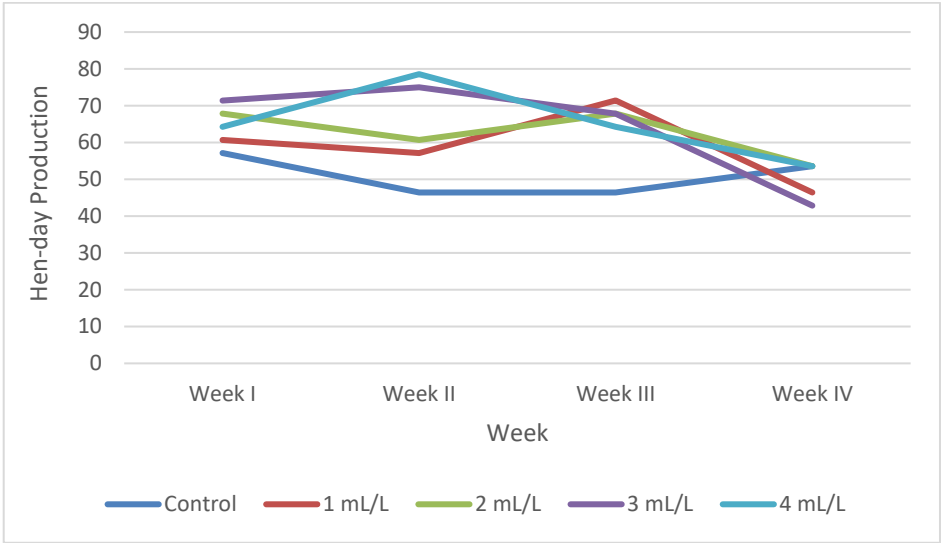


**Figure 3.** Weekly Hen-day Production

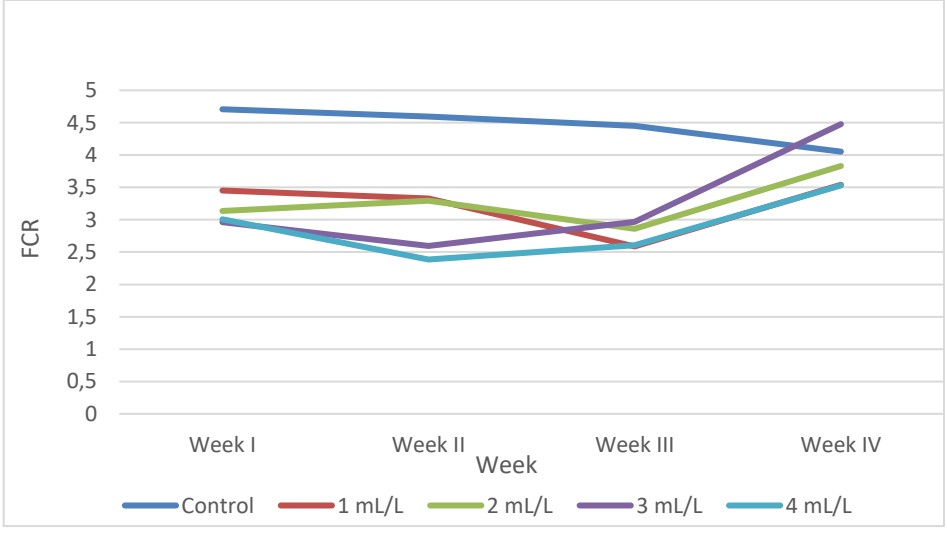


**Figure 4.** Weekly Feed Conversion Ratio (FCR)

These findings are in agreement with the findings of an earlier study conducted by Sunder et al. (2013), who studied the benefit of Noni fruit juice in Nicobari fowl, the native poultry of the Andaman and Nicobar Islands.

The Noni fruit is very rich in nutritional compounds. It contains amino acids, monosaccharides, vitamin and minerals, as well as alkaloids (Singh et al. 2008; Singh, 2012; Sunder et al. 2016). The content may contribute to nutrient absorption in the digestive tract and make nutrient utilization more efficient (Sunder et al. 2011; Sunder et al. 2013). Singh et al. (2008), Singh (2012) and Sunder et al. (2016) report that Noni fruit is rich in xeronine, an alkaloid that is derived from the proxeronine precursor. Heinicke (1985) states that the xeroninine in Noni fruit results from the conversion of proxeronine by proxeroninase. Xeronine is believed to control the conformation and stability of specific proteins that are needed in metabolic process such as in food digestion.

Besides its benefits, the use of herbal medicines like Noni fruit are assumed to have adverse effects to humans, as reported, for example, by Yüce et al. (2006). The compound groups found in Noni that are presumed to be toxic are anthraquinones and coumarins. These compounds have been known to be hepatoxic. While, complete analysis regarding the degree of presence of these compounds is required (Yüce et al. 2006), yet, the use of higher dosage of Noni fruit juice, as it was found in current study, might indicate the opposite effect. Toxicity studies of Noni on animals have been conducted by Rosly et al. (2011), West et al. (2011) and de-Sousa et al. (2017). All of these studies indicated that Noni consumption did not cause significant toxicity to animals. However, de-Sousa et al. (2017) showed that higher dosage of Noni fruit juice induced larger edema and greater inflammatory infiltrate in the mucosal and sub mucosal layers of rat intestine. Further studies about the effect of Noni fruit juice on the intestinal organ of Sentul are, therefore, required.

**Table 3.** Egg quality and yolk cholesterol content.

| Variable | Group | | | | |
|---|---|---|---|---|---|
| | Control | 1 mL/L | 2 mL/L | 3 mL/L | 4 mL/L |
| Yolk height (cm) | 1.65 | 1.61 | 1.69 | 1.70 | 1.72 |
| Yolk diameter (cm) | 3.52 | 3.63 | 3.57 | 3.56 | 3.75 |
| Yolk Index | $0.47^{a}$ | $0.44^{b}$ | $0.47^{a}$ | $0.48^{a}$ | $0.46^{a}$ |
| Albumen height (cm) | 0.74 | 0.71 | 0.72 | 0.73 | 0.75 |
| Albumen length (cm) | 6.53 | 6.75 | 6.37 | 6.92 | 7.08 |
| Albumen width (cm) | 5.02 | 5.43 | 5.37 | 5.67 | 5.53 |
| Albumen Index | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 |
| Yolk Cholesterol (mg/dL) | $361.69^{a}$ | $330.25^{b}$ | $299.65^{c}$ | $282.21^{cd}$ | $148.06^{d}$ |

a, b, c, d: means with no common superscript differ significantly ($p<0.05$)

Table 3 shows that the variables of egg quality were not significantly different except for yolk index. The birds treated with 1 mL/L Noni fruit juice had the lowest yolk index. Indeed, even though yolk height and diameter did not differ significantly, the height and diameter of yolks in birds treated with Noni fruit juice 2-4 mL/L tend to be higher, compared to the birds treated with Noni fruit juice 1 mL/L and the control birds. This effect may reflect the egg weight. These were higher for the birds with higher dosages of Noni fruit juice. The results of current study are in agreement with the findings in studies conducted by Sunder et al. (2011), who demonstrated the beneficial properties of Noni on the egg quality of Japanese quails, and that of Sunder et al. (2013), who did the same with Nicobari fowls.

Albumen and yolk index reflect the freshness of the eggs, and the index decreases along with storage duration (Eke, 2013). In addition, hen age and laying duration influences the yolk and albumen index. The indexes also decrease with the progression of the laying period (Zita et al. 2012). This suggests that the effect of Noni fruit juice would be more clearly observed in older hens and in longer laying period.

The current study shows that Noni fruit juices reduced the level of yolk egg cholesterol. Yolk cholesterol is synthesized mainly by the liver. Here, the 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMG-CoA reductase) catalyses the formation of mevalonic acid. Mavalonic acid plays an important role in cholesterol synthesis (Kurtoglu et al., 2004). Cholesterol absorption, endogenous cholesterol synthesis, and utilization for the synthesis of bile acids and steroids in turn influence cholesterol homeostatics (Kuang et al., 2018).

With regard to the aforementioned, the husbandry system (Radu-Rusu et al., 2014) and feed manipulation (Chowdhury et al., 2002; Mottaghitalab & Tarazinfluence, 2004; Akbarian et al., 2011; Cayan & Erener, 2015) influence the cholesterol of the eggs. The cholesterol-depressing effect of a herbal-based supplement has been reported by Chowdhury et al., 2002, Mottaghitalab & Tarazinfluence, 2004, Akbarian et al., 2011 and Cayan & Erener, 2015. In general, the phenolic compounds found in herbal supplements such as garlic (Chowdhury et al., 2002) and olive leaf (Cayan & Erener, 2015) may act as cholesterol lowering agents by inhibiting HMG-CoA reductase in hens, and, subsequently, reducing egg cholesterol.

The phenolics are the main secondary metabolites in plants that are of important in metabolic processes (Lin et al., 2016). Among the phenolic compounds found in Noni fruit are flavonoids. These have been studied extensively because of their capability to moderate some metabolic process such carbohydrate and lipid metabolism (Inada et al. 2017). Another phenolic compound, chlorogenic acid found in Noni juice, is reported to have the capability of decreasing plasma and hepatic lipid by stimulating β-oxidation of fatty acids and inhibiting fatty acids and cholesterol biosynthesis. As a consequence, daily fecal lipid and bile acid output increases (Lin et al., 2013).

## 4. CONCLUSIONS

The study provides important information about the use of Noni fruit juice in drinking water to enhance egg production, egg quality and yolk cholesterol content of Sentul chickens in the initial months of the laying period. The birds treated with Noni fruit juice had better egg production and egg quality, as well as better feed efficiency compared to control birds. The present study also shows the potential of Noni fruit juice in magnifying the cholesterol-depressing effect in the egg yolk of chickens. A longer observation, however, is required to

have better understanding about the use of Noni fruit in enhancing the egg production and egg quality of Sentul chickens. In addition, studies to determine the adverse effects of Noni fruit to Sentul chickens may be required in the future.

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