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THE EFFECT OF ADDITIONING MICROENCAPSULATION NONI FRUIT EXTRACT (MORINDA CITRIFOLIA LINN.) PRODUCT AS A FEED ADDITIVE ON THE SENTUL LAYING HENS PERFORMANCE

Mutiara Dwina Krishadi[1, a] Tuti Widjastuti[2] , Wiwin Tanwiriah[2]

[1]*Alumni of the Faculty of Animal Husbandry, Universitas Padjadjaran, Kabupaten Sumedang 45363, Jawa Barat*

[2]*Lecturer at Department of Animal Production, Faculty of Animal Husbandry, Universitas Padjadjaran.*

[a]*email:* tiaradwnkrs@gmail.com

Abstract

This study aimed to evaluate the effects of microencapsulation noni fruit (*Morinda citrifolia* Linn.) extract (MNFE) on the diet of the performance of Sentul laying hens during the production phase. The research employed a sample of 40 Sentul hens aged 24 weeks and was conducted for 12 weeks. The experiment used a completely randomized design (CRD) with five treatment groups: P0 (basal diet), P1 (basal diet supplemented with 50 mg/kg zinc bacitracin), P2 (basal diet supplemented with 75 mg/kg MNFE), P3 (basal diet supplemented with 150 mg/kg MNFE), and P4 (basal diet supplemented with 225 mg/kg MNFE). The study's findings indicate that the P4 treatment statistically increases the average egg weight. Similarly, the P3 treatment significantly influenced hen day production and feed conversion ratio (FCR) on the layer but did not affect feed consumption. Ultimately, adding microencapsulation noni fruit extract to the diet at 150 mg/kg MNFE and 225 mg/kg MNFE concentrations can raise the average egg weight, the number of days hens lay eggs, and the feed conversion ratio in Sentul laying hens.

Keywords: Sentul Chickens, feed, microencapsulation, noni fruit, production

PENGARUH PENAMBAHAN PRODUK MIKROENKAPSUL EKSTRAK BUAH MENGKUDU (MORINDA CITRIFOLIA LINN.) SEBAGAI FEED ADDITIVE TERHADAP PERFORMA AYAM SENTUL FASE LAYER

Abstrak

Penelitian ini dilakukan untuk mengetahui adanya pengaruh dari penambahan produk mikroenkapsulasi ekstrak buah mengkudu (Morinda Citrifolia Linn.) sebagai feed additive dalam ransum terhadap performa ayam Sentul (konsumsi ransum, bobot rata-rata telur, hen day production, dan konversi ransum/FCR Layer) pada fase produksi. Penelitian ini menggunakan 40 ekor ayam Sentul betina umur 24 minggu serta dilakukan pemeliharaan secara intensif selama 12 minggu. Penelitian menggunakan metode eksperimental dengan rancangan percobaan yang digunakan adalah Rancangan Acak Lengkap (RAL). Perlakuan terdiri dari lima macam, yakni P0 (ransum basal), P1 (ransum basal + 50 mg/kg zinc bacitracin), P2 (ransum basal + 75 mg/kg MEBM), P3 (ransum basal + 150 mg/kg MEBM), dan P4 (ransum basal + 225 mg/kg MEBM). Setiap perlakuan dilakukan pengulangan sebanyak empat kali dan setiap pengulangan terdiri dari dua ekor ayam Sentul. Hasil penelitian menunjukkan bahwa perlakuan P4 berpengaruh terhadap rataan bobot telur dan perlakuan P3 berpengaruh pula terhadap hen day production dan konversi ransum (FCR layer), namun tidak berpengaruh terhadap konsumsi ransum. Hasil penelitian menunjukkan bahwa penambahan produk MEBM pada level 150 mg/kg dalam ransum dapat meningkatkan rataan bobot telur, hen day production, dan menurunkan konversi ransum sehingga mampu menggantikan penggunaan antibiotic growth promotor sebagai penunjang produktivitas ayam Sentul.

Kata kunci*: *Ayam Sentul, mikroenkapsulasi, mengkudu, produksi, ransum

INTRODUCTION

Poultry farming, particularly chicken farming, is essential for livestock development in Indonesia. Chickens are readily available animal protein sources widely favoured by the population (Abdillah et al., 2021). The increasing popularity of local chicken varieties, such as free-range chickens, is associated with significant health benefits for consumers. Free-range chicken meat is known for its balanced amino acid profile and tender white meat, which lends itself well to various culinary preparations. As Iskandar (2012) cited in Haryuni (2019), the consumption of free-range chicken is notably high.

Among Indonesia's indigenous chicken breeds, Sentul chicken, originating from Ciamis Regency, has gained attention due to its numerous advantages as a protein source. Sentul chickens can produce high-quality meat and eggs, surpassing several other local dual-purpose breeds (Indra et al., 2015). Farmers typically use Sentul chickens for egg production and breeding, selecting specific roosters for their breeding program while utilizing others for daily consumption (Indra et al., 2015). A critical aspect of raising Sentul chickens is the management of their feed, which is vital for their growth, activity, and egg-laying productivity, especially when they reach 20 weeks of age.

Feed additives are often incorporated into their diets to enhance productivity among laying hens. One commonly used additive is the antibiotic growth promoter (AGP), which is beneficial in low doses. However, prolonged use of AGPs can accumulate residues and contribute to the development of antibiotic-resistant bacteria, posing health risks to humans consuming these animals and their products (Dominguez et al., 2018). As a result, researchers in Indonesia are exploring alternatives to AGPs, including herbal plant extracts known as phyto additives (Gadde et al., 2017).

Morinda citrifolia Linn., commonly known as noni, is recognized for its numerous health benefits, particularly as a probiotic. Its bioactive components include antibacterial, antioxidant, anticancer, antifungal, and antiviral properties, as noted by Sam-Ang et al. (2023). Noni is also rich in essential amino acids, such as histidine, valine, arginine, leucine, threonine, isoleucine, methionine, and tryptophan, as highlighted by Solomon (2001) cited in Kristiana et al. (2020). A unique alkaloid found in noni, known as proxeronine or xeronine, plays a significant role in expanding the small intestine in poultry. This compound facilitates nutrient absorption, activates enzymes, regulates cellular protein functions, and supports the thyroid gland and thymus, which are crucial for immune system functionality (Aniszewski, 2015). Moreover, noni is abundant in polyphenols, vital for gastrointestinal health. These compounds help modulate gut microbiota, reinforce the intestinal barrier, and mitigate oxidative stress. They also regulate immune function, contributing to an environment that fosters optimal digestive health (Jiang et al., 2022). When these mechanisms operate efficiently, nutrient absorption improves, enhancing metabolism and increasing resistance to bacterial diseases, promoting overall health. With its richness in proxeronine and polyphenols, noni fruit stands out as a beneficial feed additive. Utilizing extraction techniques such as maceration and microencapsulation can further optimize its bioactive components, enhancing noni's quality and effectiveness in promoting digestive health.

Microencapsulation is a technique that involves enclosing active ingredients in a protective microlayer made of maltodextrin, which helps preserve their chemical, physical, and biological properties. By reducing moisture content and water activity, maltodextrin significantly enhances the stability of powdered products, thereby maintaining quality and extending shelf life (Liu et al., 2024). This study utilizes spray drying for microencapsulation, a standard industrial method that ensures microbiological stability, lowers water content, and prevents degradation. It also offers cost-effective storage and transportation options, creating products with desirable features like instant solubility (Banožić et al., 2021). This research aims to explore the effects of adding microencapsulation noni fruit extract in the diet on the performance of Sentul chickens.

MATERIALS AND METHODS

This study involved 40 female Sentul chickens (laying hens) obtained from the Poultry Livestock Development and Breeding Center (Balai Pengembangan dan Pembibitan Ternak Unggas / BPPTU) Jatiwangi. The chickens were intensively reared for 12 weeks, starting at 24 weeks of age. The average initial weight of the female Sentul chickens was 1,341.7 grams, with a coefficient of variation of 14%. The chickens were divided into five feeding treatment groups, each with four repetitions, resulting in eight experimental groups, with two chickens in each replication. They were randomly placed in 40 battery cages made of galvanized wire, each measuring 40 cm in length, 35 cm in width, and 30 cm in height. Each cage unit was assigned a feed treatment number and a repetition number.

Materials

The ration for Sentul chickens in the layer phase was formulated based on recommended standards for crude protein content and metabolic energy requirements, precisely 17–18% crude protein and 2850 kcal EM/kg (Widjastuti, 1996). The feed ingredients included rice bran, yellow corn, and layer concentrate, all sourced from the Pagaden Feed Shop (Toko Pakan Pagaden) in Tanjung Sari. These ingredients were mixed thoroughly according to the specified quantities. The ration was fed to the chickens twice daily, at 7:00 a.m. and 4:00 p.m., with drinking water provided ad libitum. Manufacturing Microencapsulation Noni Fruit Extract (MNFE) or *Mikroenkapsulasi Ekstrak Buah Mengkudu*, begins with grinding the washed and dried noni fruit. The fruit was then sliced thinly, macerated in a 96% methanol solvent, and stirred every 12 hours for 48 hours. After maceration, the mixture was filtered using Whatman paper no. 40, and the resulting liquid was evaporated with a Rotary Evaporator Bunchi R-300 at 60°C to obtain a concentrated liquid separating methanol from the noni extract. The thick liquid was then supplemented with Cu (5 ppm) and Zinc (40 ppm) to stabilize the active compounds and mixed with maltodextrin. The resulting mixture was baked at 60°C until it forms a paste. This paste was subsequently dried using spray drying, resulting in MNFE as a dry powder (flour). Finally, the MNFE powder was combined with the basal rations (in mash form) to produce the final treatment ration, ready to be fed to each Sentul chicken.

Methods

The research method used was an experimental method with a completely randomized design (CRD). This research method was carried out based on previous research, specifically the research of Nurlaeni et al. (2024) conducted in previous years. Ration was distributed according to each treatment (basal ration, basal ration + zinc-bacitracin, basal ration + MNFE with different levels). Sentul chickens were randomly divided and placed into 40 battery cages and provided the treated rations, with four replications. Sentul chickens were intensively reared for 12 weeks.

Table 1. Basal Ration Composition

Feed Ingredients	Amount (%)
Rice bran	15.00
Yellow corn	50.00
Layer concentrate	35.00
Amount	100

Table 2. Nutrient Content and Metabolic Energy of Basal Ration

Nutrient Content	Amount	Chicken Needs
Metabolic energy (kcal/kg)	2887.80	2850*
Crude Protein (%)	17.12	17-18*
Ether Extract (%)	5.43	Max 8**
Crude Fiber (%)	8.81	Max 8**
Calcium (%)	3.25	3.25-4.25**
Phosphorus (%)	0.56	0.3**

Source: *Widjastuti (1996)
** NRC (1994)

Table 3. Nutrient Content and Metabolic Energy of Feed Ingredients Composing the Ration

Feed Ingredients	Nutrient Content							
	CP	EE	CF	Ca	P	Lys	Met	EM
	----------------------------------%------------------------------------							(kkal/kg)
Rice bran	8.35	13.00	12.00	0.02	0.10	0.18	0.29	1630
Yellow corn	8.60	3.90	2.00	0.20	0.12	0.77	0.29	3370
Layer concentrate	34.00*	2.00*	9.00*	12.00*	0.50*	1.70*	0.80*	2740*

Source: Laboratorium Nutrisi Ternak Ruminansia dan Kimia Makanan Ternak Fapet Unpad (2016)
*Cargill (2023)

Notes: CP = Crude Protein; EE = Ether Extract; CF = Crude Fiber

Observed Variable

1. Ration Consumption (gram)

   Ration consumption was calculated every day during the maintenance period. To determine ration consumption, the following formula was used:

   $$\textbf{Ration consumption (grams)} = Rations\ fed\ (grams) - Rations\ remaining\ (grams)$$

2. Average Egg Weight (grams)

   The average egg weight was calculated by weighing the eggs one by one to get the weight, then summed up and then divided by the total eggs produced during the study.

3. Henday Production

   Henday production was calculated by dividing the number of eggs produced during the study by the number of hens laying at that time, then multiplying by 100%.

   $$\%\ \textbf{Henday Production} = \frac{Amout\ of\ egg\ production\ (in\ grain)}{The\ number\ of\ live\ laying\ hens\ on\ that\ day}\ x\ 100\%$$

4. Feed Conversion Ratio

   Feed conversion ratio was calculated from the amount consumed and divided by the eggs produced in the same unit.

   $$\boldsymbol{FCR} = \frac{The\ amount\ of\ feed\ comsumed\ (kg)}{Egg\ production\ (Kg)}$$

RESULTS AND DISCUSSION

The results of the performance measurement of Sentul chickens in the layer phase treated with zinc-bacitracin and microencapsulation products of Noni fruit extract is presented in Table 4.

Table 4. Results of Average ration consumption, average egg weight, hen day production, and ration conversion of Sentul chickens during the study

Treatments	Variables			
	Ration Consumption (gram/head/day)	**Average Egg Weight** (gram/grain)	**Hen day production** (%)	**Feed Conversion Ratio**
P0	99.60[a]	42.90[a]	30.75[a]	3.19[c]
P1	99.80[a]	41.91[a]	42.30[b]	2.37[ab]
P2	96.50[a]	41.78[a]	38.00[ab]	2.59[b]
P3	99.20[a]	44.16[ab]	45.50[b]	2.09[a]
P4	98.70[a]	45.50[b]	32.80[a]	2.80[bc]

Notes: Different letters in the significance column indicate significantly different treatment effects (P < 0.05)
P0 = Basal Ration
P1 = Basal Ration + 50 mg/kg Zinc Bacitracin
P2 = Basal Ration + 75 mg/kg MNFE
P3 = Basal Ration + 150 mg/kg MNFE
P4 = Basal Ration + 225 mg/kg MNFE

Effect of Treatments on Ration Consumption

Based on Table 4, the average ration consumption observed in the treatments involving adding MNFE products (P2 and P4) showed fluctuating results. It was lower than the favourable control treatment (P1), which included 50 mg/kg of Zinc-Bacitracin. An analysis of variance was performed to assess the effect of the treatments on ration consumption. The results indicated that adding MNFE products to the feed did not significantly impact consumption levels. This lack of effect can be attributed to the similarity in the constituent feed ingredients, which had consistent amounts, colours, and shapes and were prepared using the same method. According to Zahra et al. (2012), as cited in Huda et al. (2023), various factors such as age, production level, quantity and quality of feed, and palatability influence feed consumption.

One specific factor contributing to decreased palatability in Sentul chickens was the bitter taste of noni fruit. Liu et al. (2018) further state that chickens' sense of taste is crucial in determining nutrient uptake and ration consumption. The active compounds in noni fruit may render the rations less appealing to livestock, particularly because products high in phenolic compounds tend to possess a more intense bitter taste (Syadik et al., 2021). Chickens are susceptible to bitter flavours (Hirose et al., 2015). However, the bitterness can be masked using maltodextrin and microencapsulation techniques, as maltodextrin has a taste and aroma that are generally neutral (Cahyadi, 2017, as cited in Santoso, 2020). Therefore, the addition of MNFE does not significantly affect the palatability of Sentul chickens, resulting in similar average consumption across all treatments.

Effect of Treatment on Average Egg Weight

Table 4 demonstrates that the average egg weights for the P0, P1, and P2 treatments were statistically similar ($P > 0.05$). Similar results were observed on treatment P1, P0, and P3. However, further analysis revealed that P2 and P3 treatments were significantly different ($P < 0.05$). P2 - P4, P1 - P4, and P0 - P4 treatments showed significantly higher results compared to P2 - P3. These findings suggest that the P2 treatment (at 75 mg/kg) was insufficient to replace the antibiotic growth promoter as a feed additive regarding this specific parameter.

Noni fruit has high levels of essential amino acids. Lima et al. (2012), as cited in Medion (2021), demonstrated that essential amino acids increase egg weight, mass, and production in chicken feed, as this amino acid enhances the absorption of lysine within the birds' bodies. Additionally, noni fruit is rich in saponin compounds, which help cleanse the intestinal walls and enhance nutrient absorption due to their soap-like cleansing properties (Francis et al., 2002 cited in Wahyudi et al., 2015). Noni also contains vitamins A, C, and B alongside active compounds such as scopoletin, anthraquinone, coumarin, xeronine, proxeronine, terpenoids, and damnacanthal, all of which contribute to improving cellular function (Winarti, 2005 cited in Hasri et al., 2018).

One critical alkaloid in noni is xeronine, which is essential for activating enzymes and regulating cell protein functions. Although present in limited quantities, proxeronine—a precursor to xeronine—is produced significantly (Solomon, 1999 cited in Fuady, 2020). Xeronine is vital in protecting and repairing cells, particularly liver cells, which are crucial for the chicken's metabolism (Andriyanto et al., 2015). Healthy liver cells enhance nutrient absorption efficiency, optimize energy metabolism, and improve immunity by detoxifying harmful substances, aiding in absorbing vitamins A, D, E, and K, and synthesizing proteins (Andriyanto et al., 2015). This, in turn, contributes to increased egg production (Suganti, 1973 in Alwi, 2015).

Effect of Treatment on Henday Production

Table 4 shows that the average percentage of hen day production of Sentul chickens in treatments P2 to P4 fluctuated, but had a higher average than the control treatment P0. The P0 - P3 treatment showed significantly higher results ($P < 0.05$) than P0 - P1, P4 - P1, and P4 - P3. This means that the P3 treatment can replace P1 (AGP) as a feed supplement to support the daily egg production of Sentul chickens. The P3 treatment yielded a high HDP percentage of 45.5% because the noni plant contains various polyphenolic compounds, including anthraquinone. According to Sinovasahan and Durairaj (2014), anthraquinone compounds have many health benefits, such as being antifungal, antimalarial, antibacterial, antioxidant, anticancer, and increasing metabolism in the body. These compounds can also optimize the digestibility and absorption of nutrients by making the intestinal pH more acidic, thus inhibiting the growth of pathogenic bacteria in the digestive tract. This makes lactic acid bacteria more stable in producing organic acids, and nutrient absorption can run optimally. In addition, saponin compounds found in noni fruit extract (Wulandari et al., 2022) can increase cell wall permeability, increase the effectiveness of feed utilization, and increase the percentage of egg production in Sentul chickens (Asmara et al., 2019). This statement aligns with the opinion of Sinovasahan and Durairaj (2014) that saponins can increase the absorption of feed nutrients due to good cell wall permeability.

Noni fruit is rich in essential amino acids, such as tryptophan ($C_{11}H_{12}N_2O_2$) (Abou Assi et al., 2015). Unfortunately, no research analyzes the exact tryptophan content contained in noni fruit. However, based on research conducted by Abou Assi et al. (2015), noni fruit also contains other amino acids, such as : glutamate, alanine, arginine (range 20-26 mg/100 g); glycine, cysteine, methionine, tyrosine, phenylalanine, lysine (range 9.0-14.5 mg/100 g) and threonine, serine, valine, isoleucine, leucine (range 3-6.5 mg/100 g). It was also found that the highest and lowest amino acid contents were aspartate 34.9 (mg/100 g) and histidine (2.0 mg/100 g). Tryptophan can increase egg production by accelerating the activity of the magnum in producing egg white (albumen) and increasing mucus production from the epithelium of the magnum to accelerate the process of egg release (Medion, 2021). If egg formation occurs more quickly, the average HDP will also be more optimal. According to Heinicke (1999) cited in Widianto et al. (2015), the xeronine content found in noni fruit also has enzyme activity in the digestive tract. This will impact increasing the absorption of nutrients from the feed consumed. Along with this increased absorption, Sentul chickens can absorb more nutrients. The more feed efficiency is improved, the more optimally the livestock's primary living and production needs will be met to maximize the average HDP.

Effect of Treatment on Feed Conversion Ratio

Table 4 shows that the average results of ratio conversion with the addition of MNFE in treatments P2 to P4 fluctuated and ranged between 2.09 and 2.80. Treatments P3 - P4, P3 - P0, and P1 - P0 were significantly higher ($P < 0.05$) than treatments P2 - P0. The fairly low conversion value of treatment P3 (2.09) was closely related to ration consumption and the number of eggs produced. Lower ration conversion indicates good performance because laying hens can produce more eggs with less feed, thus affecting the assessment of egg production efficiency (Putra Perkasa Genetika, 2023). Sari (2015) states that noni fruit has active compounds such as alkaloids, vitamin C, anthraquinones, terpenoids, proxeronine, and xeronine. The active compounds anthraquinone and alkaloid are antibacterial agents that prevent the development of bacteria in the digestive tract, thus improving system performance in poultry. Plant extracts with antibacterial compounds can improve feed utilization efficiency and facilitate nutrient absorption. Meanwhile, the active compound anthraquinone has positive effects on increasing appetite, reducing fat content, and improving immunity (Liamirdi et al., 2016).

Another thing that makes the ratio conversion of Sentul chickens with the addition of MNFE low is the content of essential amino acids (K et al., 2018), which functions as a compound that forms the neurotransmitter serotonin (Medion, 2021). As the number of serotonin increases, the chicken's appetite and ration consumption will also increase. Essential amino acids can increase the efficiency of nutrient digestion in feed by stimulating the expansion of small intestinal villi, therefore increasing the amount of absorbed nutrients. Increased nutrient intake resulted in positive effects on the chicken's performance (Medion, 2021). Essensial amino acid supply could also stimulate the production of niacin, a growth hormone, increase body weight and appetite, and reduce FCR (Lisnahana, 2021). The manufacture of xeronine involving proxeronine, the enzyme proxeronase, and the hormone serotonin will dash due to the large amount of serotonin hormone. According to Abdillah et al. (2021), xeronine can activate proteins and help intestinal absorption, so that later, it will increase egg production and reduce feed conversion values.

CONCLUSIONS

The addition of microencapsulation products of noni fruit extract (*Morinda citrifolia* Linn.) treatments affected average egg weight, hen day production, and ration conversion of Sentul chickens in the layer phase. However, it didn't affect the ration consumption of Sentul chickens in the production phase. The addition of MNFE product P3 treatment with a level of 150 mg/kg in the basal ration can be applied as a feed additive to replace the use of antibiotic growth promoter (AGP) in increasing the average egg weight, hen day production, and reducing ration conversion in Sentul chickens in the production phase.

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