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THE EFFECT OF ADDING MICROCAPSULES PRODUCTS OF NONI FRUIT EXTRACT (*MORINDA CITRIFOLIA* LINN) IN THE RATION ON THE PERFORMANCE OF SENTUL CHICKENS AGED 14 TO 24 WEEKS

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Abstract
This study aims to determine the effect of adding microcapsules noni fruit extract (MNFE) to the feed on the feed consumption, body weight gain, feed conversion, and sexual maturity age of Sentul chickens aged 14 to 24 weeks. The study was conducted from July to September 2023 at the Test Farm of the Faculty of Animal Husbandry Padjadjaran University. The study method used a Completely Randomized Design (CRD). There were five types of treatments, namely, P0 = basal ration without the addition of MNFE, 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, with four replications. The measured variables were feed consumption, body weight gain, feed conversion, and sexual maturity age of Sentul chickens aged 14 to 24 weeks. The data were analyzed using analysis of variance (ANOVA). The differences in effects were tested with the Tukey HSD test, with P0 as the negative control and P1 as the positive control. The study's results showed that adding 225 mg MNFE to the rations provided the best result on body weight gain and feed conversion. However, the MNFE addition did not significantly affect feed consumption and the sexual maturity age of Sentul chickens aged 14 to 24 weeks. It can be inferred that adding MNFE up to 225 mg/kg can replace the role of AGP zinc bacitracin as an antibiotic in the ration.
Keywords: microcapsules noni fruit extract, feed consumption, body weight gain, feed conversion, sexual maturity age

PENGARUH PENAMBAHAN PRODUK MIKROKAPSUL EKSTRAK BUAH MENGKUDU (MORINDA CITRIFOLIA LINN) DALAM RANSUM TERHADAP PERFORMA AYAM SENTUL UMUR 14-24 MINGGU

Abstrak
*Penelitian ini bertujuan untuk mengetahui pengaruh penambahan mikrokapsul ekstrak buah mengkudu (MNFE) pada pakan terhadap konsumsi pakan, pertambahan bobot badan, konversi pakan, dan umur matang kelamin ayam Sentul umur 14 sampai 24 minggu. Penelitian dilaksanakan pada bulan Juli sampai dengan September 2023 di Test Farm Fakultas Peternakan Universitas Padjadjaran. Metode penelitian menggunakan Rancangan Acak Lengkap (RAL) dengan lima perlakuan, yaitu: P0 = ransum basal tanpa penambahan MNFE, P1 = ransum basal + 50 mg/kg zink basitrasin, P2 = ransum basal + 75 mg/kg MNFE, P3 = ransum basal + 150 mg/kg MNFE, P4 = ransum basal + 225 mg/kg MNFE, dan diulang sebanyak empat kali. Peubah yang diamati yaitu konsumsi pakan, pertambahan bobot badan, konversi pakan, dan umur dewasa kelamin ayam Sentul umur 14 sampai 24 minggu. Data dianalisis menggunakan analisis sidik ragam (ANOVA) dan perbedaan pengaruh diuji menggunakan uji lanjut Tukey (*Honestly Significant Difference / HSD*) dengan P0 sebagai kontrol negatif dan P1 sebagai kontrol positif. Hasil penelitian menunjukkan bahwa penambahan MNFE sebanyak 225 mg pada ransum memberikan hasil terbaik terhadap pertambahan bobot badan dan konversi ransum. Namun, penambahan MNFE tersebut tidak berpengaruh nyata terhadap konsumsi ransum dan umur dewasa kelamin ayam Sentul umur 14 sampai 24 minggu. Dapat disimpulkan bahwa penambahan MNFE sampai dengan 225 mg/kg pada ransum dapat menggantikan peran AGP zinc bacitracin sebagai antibiotik.*
Kata kunci: mikrokapsul ekstrak buah mengkudu, konsumsi pakan, pertambahan bobot badan, konversi pakan, umur kematangan seksual

INTRODUCTION

Sentul Chicken is a local dual-purpose chicken breed originating from Ciamis Regency, West Java, and it has the potential to meet the demand for animal protein in the form of meat and eggs. Compared to other local chickens, Sentul Chicken has relatively fast growth (Wiradimadja et al., 2018). Adult females weigh between 0.8 – 2.2 kg, produce 118 – 140 eggs annually, and reach sexual maturity at 5–6 months (KEMENTAN, 2013). The developer phase of laying chicken needs attention, as it is a phase of dominant growth in anatomical structure and muscle development (Fadilah, 2013). In Sentul chickens aged 14 to 24 weeks, uniformity is a crucial aspect

influencing productivity. The uniformity of frame size and maturity impacts overall productivity and egg quality (Medion, 2018). Therefore, it is important to monitor the quality and quantity of daily feed consumption (Wiradimadja et al., 2018).

One way to optimize feed usage is through antibiotics, which can stimulate growth and increase productivity (Wahju, 2015). However, antibiotics as growth promoters (AGP) have adverse effects, such as residues in the food chain, antibiotic resistance, and resistance to antibiotic therapy (Mehdi et al., 2018). Therefore, herbal plants are becoming an alternative to AGP, one of which is noni fruit (*Morinda citrifolia* Linn), which can be given as a microencapsulated extract.

Noni fruit extract contains many chemical compounds, such as alkaloids, tannins, flavonoids, triterpenoids/steroids, anthraquinones, and saponins. Those compounds can help in nutrient absorption in the digestive organs and function as antimicrobials. Anthraquinones, in particular, stimulate the growth process of intestinal villi and improve the absorption of feed and digestive activity in the intestine (Widjastuti et al, 2023). A study conducted by Putri et al (2019) showed that adding noni fruit extract into broiler chicken ration increased the length and relative weight of duodenum, jejunum, and ileum, which indicated the expansion of nutrient absorption area and effective absorption of feed essence.

Adding noni fruit extract (MNFE) at 250 mg/kg and supplemented with Cu and Zn can increase the digestibility of dry matter, organic matter, and protein (Azizah et al., 2020). This supplementation also increases weight gain and optimizes feed conversion (Ilyasa, 2019). Adding MNFE at doses of 125-250 mg/kg is recommended as a natural alternative to AGP as a feed additive in Sentul chicken rations until 12 weeks of age, as it can improve chicken's carcass quality and its intestinal histology (Widjastuti et al, 2023). This study aims to determine the effect of adding microcapsules of noni fruit extract in the feed of Sentul chickens on feed consumption, weight gain, feed conversion, and sexual maturity age of Sentul chickens aged 14 to 24 weeks.

MATERIALS AND METHODS

In this experiment, 40 female Sentul chickens aged 14 weeks were selected based on their body weight and then divided into five treatment groups. Each treatment was replicated 4 times (two chickens in each replicate) and raised in a cage system. They were provided with four diet treatments: P0 = Basal diet, P1 = Basal diet + 50 mg/kg AGP zinc bacitracin, P2 = Basal diet + 75 mg/kg MNFE, P3 = Basal diet + 150 mg/kg MNFE, P4 = Basal diet + 225 mg/kg MNFE.

Feed and water were provided for 10 weeks, from 14 weeks until 24 weeks old, following the developer phase feeding recommendations for Sentul chickens as per Widjastuti (1996). The feed was a commercial self-mixed feed composed of rice bran, ground corn, and layer concentrate with a protein content of 15.8% and metabolizable energy of 2777 kcal/kg. The feed was given twice daily, at 07:00 AM and 04:00 PM, with a total of 80 grams per chicken per day, split evenly between morning and evening feedings. Water was provided ad libitum. The housing system used in the study was a cage system made of galvanized wire, consisting of 40 experimental cage units. Each experimental unit measured 40 cm in length, 35 cm in width, and 30 cm in height.

Table 1. Nutrient Content and Metabolic Energy of Feed Ingredients in Rations

Feed Ingredients	Feed content							
	Crude Protein	Crude Fat	Crude Fiber	Calcium	Phosphor	Lysine	Methionine	EM
	----------%----------							(kcal/kg)
Rice bran	12,00	13,00	12,00	0,02	0,10	0,18	0,29	1.630
Yellow corn	8,60	3,90	2,00	0,20	0,12	0,77	0,29	3.370
Layer concentrate	34,00*	2,00*	9,00*	12,00*	0,50*	1,70*	0,80*	2.740*

Sources: Laboratory of Ruminant Animal Nutrition and Animal Feed Chemistry in Faculty of Animal Husbandry, Universitas Padjadjaran (2016). *Cargill's feed labels

Table 2. Composition of Basal Ration

Feed Ingredients	Amount (%)
Rice bran	25,00
Yellow corn	50,00
Laying hen concentrate	25,00
Total	100

Source: Formulation calculations using AFOS software

Table 3. Nutrient Content and Metabolic Energy of Basal Ration

Nutrient content	Amount	Local Chicken Needs
Metabolic energy (kcal/kg)	2.777	2.750
Crude protein (%)	15,8	15
Crude fat (%)	5,7	Max 8*
Crude fiber (%)	6,25	Max 8*
Calcium (%)	3,1	Min 0,9*
Phosphor (%)	0,21	0,3*
Lysine (%)	0.86	0,90*
Methionine (%)	0,42	0,30*

Source: Widjastuti (1996)
*SNI (2008)

Microcapsules noni fruit extract (MNFE) product was mixed into the feed during the mixing process. Variables measured daily included feed consumption by weighing the remaining daily feed, body weight gain by calculating the difference between the initial and final weights, and feed conversion ratio calculated at the end of the study by dividing the total feed consumption by the body weight gain. Sex maturity variables were determined by observing the age at which the chickens first laid eggs. The research method was conducted experimentally using a completely randomized design (CRD). Data were analyzed using analysis of variance and differences in effect with Tukey HSD test.

Formula for each variable:

1. **Feed Consumption Formula:**
   Feed consumption = feed provided subtracted with the feed remaining
2. **Body Weight Gain Formula:**
   Body weight gain = final body weight subtracted with the initial body weight
3. **Feed Conversion Formula:**
   Feed conversion = feed consumption per bird during the study (g) divided with the body weight gain per bird during the study (g)
4. **Sexual Maturity**
   The age at which the chickens lay their first egg.

RESULTS AND DISCUSSION

The result of the performance measurement of Sentul chickens in the aged 14 to 24 weeks treated with AGP zinc bacitracin and microcapsules products of noni fruit extract can be seen in Table 4.

Effect of Treatment on Ration Consumption

Based on the research data shown in Table 4, the average daily ration consumption of Sentul chickens was relatively similar across treatments, with no significant differences observed between groups. Analysis of variance indicated that adding MNFE to the ration did not significantly affect ration consumption ($P>0.05$).

The similarity in ration consumption among treatments was due to the microencapsulation process, which reduced the bitter taste caused by saponin compounds in noni fruit extract. Yuhendra and Darmiwati (2021) found that tannins and saponins in noni fruit have a bitter taste, which reduces its palatability for broiler chickens. Appetite in poultry is also determined by the light or dark colour of the ration (Irianing et al., 2015). Microencapsulation using maltodextrin, which is odorless and has a bland taste, helps neutralize the bitterness without altering the taste or color of the ration. This aligns with Cahyadi's (2017) statement in Santoso et al.

(2020) that maltodextrin is an ideal dressing material because of its neutral aroma and taste.

The ration consumption of chickens receiving MNFE at 75 - 225 mg/kg ration treatment was relatively the same as that of chickens given AGP zinc bacitracin. This suggests that adding MNFE at these levels can replace AGP zinc bacitracin in achieving the normal daily ration consumption for Sentul chickens aged 14 to 24 weeks.

Effect of Treatment on Body Weight Gain

Based on Table 4, the average body weight gain of Sentul chickens per bird per day tends to increase in the treatment of P3 (basal ration + 150mg/kg MNFE) of 5.84 g/head/day and P4 (basal ration + 225mg/kg MNFE) of 6,84 g/head/day compared to treatment P0 (basal ration) at 4.46 g/head/day, P1 (basal ration + 50 mg/kg zinc bacitracin) at 4.88 g/head/day and P2 (basal ration + 75mg/kg MNFE) at 4.52 g/head/day. Based on the results of analysis of variance showed that the addition of MNFE in the ration had a significant effect ($P < 0.05$) on body weight gain. Significant differences were found in treatments P0, P1, and P2 with treatments P3 and P4.

The highest average body weight gain (BWG) was recorded in the P4 treatment (6.84 g/head/day), with the addition of MNFE at 225 mg/kg ration. This is due to the alkaloid compounds in noni fruit, namely xeronin and proxeronin, which makes protein synthesis in the digestive organs more effective. Djauhariya (2006) as cited by Setyoko et al. (2020) states that proxeronin will be converted into xeronin by the enzyme proxeronase contained in the small intestine, and xeronin will modify the structure of protein molecules, leading to better and faster absorption process of food substances. Better and faster nutrient absorption in the small intestine will result in a better BWG.

Aprilianti et al. (2017) states that optimal nutrient absorption will support meat formation, as is reflected in BWG. The average BWG of Sentul chickens in the P3 and P4 treatments was higher than that of the P1 treatment (positive control with the addition of AGP zinc bacitracin). This suggests that adding MNFE at 150 - 225 mg/kg ration level can replace AGP zinc bacitracin's role in achieving optimal BWG of Sentul chickens aged 14 to 24 weeks.

Effect of Treatment on Ration Conversion

According to Table 4, Sentul chicken's average ration conversion value varied between 11.05 and 19.95 for all treatments. The lowest average conversion value was found in P4 treatment with 11.65 and the highest was found in P0 with 18.00. The results showed that adding MNFE to the ration had a significant effect ($P < 0.05$) on ration conversion. Significant differences were found in P3 and P4 treatments with P0, P1 and P2 treatments.

Table 4. Result of average ration consumption, average body weight gain, feed conversion ratio, and sex maturity age of chickens Sentul during the study.

Treatments	Variable			
	Ration Consumption (gram/head/day)	Body Weight Gain (gram/head/day)	Feed Conversion Ratio	Sex Maturity Age (day)
P0	79,86^{a}	4,46^{a}	18,00^{c}	166^{a}
P1	79,30^{a}	4,88^{ab}	16,46^{bc}	165^{a}
P2	79,67^{a}	4,52^{a}	17,72^{c}	167^{a}
P3	79,36^{a}	5,84^{bc}	13,73^{ab}	168^{a}
P4	79,32^{a}	6,84^{c}	11,65^{a}	165^{a}

Notes: Different letters in the significance column indicate significantly different treatment effects ($P<0,05$)
P0 = Basal ration
P1 = Basal ration + 50 mg/kg AGP zinc bacitracin
P2 = Basal ration + 75 mg/kg MNFE
P3 = Basal ration + 150 mg/kg MNFE
P4 = Basal ration + 225 mg/kg MNFE

The average ration conversion value from this study showed that the level of MNFE addition of 225 mg/kg ration in treatment P4 showed the smallest value of 11.65. According to studies conducted by Landari (2023), there are 9 flavonoid compounds in noni fruits which have been dried using direct sunlight, namely Kaempferol-3, 7-glucoside, *Kaempferol-3-gentiobioside, 3-(4'-Hydroxy-benzyl)-5, 7-dihydroxy-6-methyl-8-methoxy-chroman-4-one, Isorhamnetin, Quercetin, Bowdichione. Methyl ophiopogonanone B,* and *Genkwanin* (Landari et al., 2023). The content of flavonoid compounds, namely quercetin contained in MNFE, has a function as an antibacterial, so it can inhibit pathogenic bacteria in the digestive tract and help in the absorption of ration nutrients to be more optimal. Widjastuti et al (2023) states that the active components in noni fruit extract, specifically flavonoids and steroids, can inhibit the activity of pathogenic bacteria in the intestine.

The flavonoid compounds quercetin inhibits pathogenic bacteria by damaging the cell wall and cell membrane of bacteria and inhibiting their process of nucleic acid synthesis. Wang et al. (2018) mentioned that quercetin effectively damages the cell walls and cell membranes of *E. coli* and *S. aureus*. In *E. coli*, quercetin induces cell wall lysis, cell distortion, leakage of cytoplasmic material, cytoplasmic membrane separation from the cell wall, and uneven endocytema density. The study conducted by Plaper et al. (2003) showed that quercetin inhibits nucleic acid synthesis in bacteria by inhibiting the ATPase activity of the DNA gyrase enzyme in *E. coli* by binding the posts of *GyrB*.

In the small intestine, quercetin compounds inhibit pathogenic bacteria that prevent nutrient absorption. Therefore, it contributes to achieving maximum BWG and a low feed conversion (FCR). A low FCR, which results in high body weight, indicates optimal feed utilization, as marked by an increase in body weight and high feed intake. This finding aligns with Muslim's (2022) statement that the FCR is calculated by dividing the total feed consumed by the body weight gain achieved during a given period.

The addition of MNFE in the P4 treatment at a dose of 225 mg/kg in the ration provides the most effective effect on nutrient absorption. According to a study by Putri et al. (2019), adding noni fruit extract into broiler chickens ration increased the area for nutrient absorption and nutrient absorption effectiveness in the small intestine. These results show that the addition of MNFE at the level of 150 - 225 mg/kg in the ration can replace the role of zinc bacitracin as an AGP that deceases ration conversion in Sentul chickens aged 14 to 24 weeks.

Effect of Treatment on Sexual Maturity Age

Table 4 shows that the average sexual maturity age of Sentul chickens in the P2 and P3 treatments was later when compared to P0, P1, and P4. The analysis of variance result indicated that the addition of MNFE to the ration did not significantly affect (P>0.05) the age of sexual maturity. The P3 treatment resulted in the longest average sexual maturity age of 168 days. According to Wihandoyo and Mulyadi (1986) in Hidayati et al (2016), the sexual maturity of intensively raised native chickens is 167 days.

Adriani et al. (2015) mentioned that administering noni fruit extract containing alkaloid active substances can reduce blood cholesterol levels. According to Koshy et al. (2001) in Azizah (2020), alkaloid active compounds lowering cholesterol by increasing bile salt synthesis, which reduced cholesterol levels. Increased bile production and secretion expel cholesterol through feces, causing blood cholesterol and the body to decrease because cholesterol is one of the raw materials for bile (Afifah, 2003; Wiradimadja et al, 2018). Supplementing diets with noni fruit or leaf extract at 5 g/kg diet lowered serum cholesterol in broiler chickens (Fenita, 2010; Diarra et al., 2019). However, the addition of MNFE at a level of 150–225 mg/kg in the diet did not affect blood cholesterol levels, likely due to insufficient alkaloid content to reduce serum cholesterol. As a result, it did not influence the sexual maturity age of Sentul chickens aged 14 to 24 weeks.

CONCLUSIONS

Adding microcapsules of noni fruit extract (*Morinda citrifolia* Linn) positively impacts body weight gain and feed conversion of Sentul chickens aged 14 to 24 weeks. However, it does not significantly affect feed intake or sexual maturity. The most effective level of MNFE was 225 mg/kg in the ration,

which gave the best results for body weight gain and feed conversion of Sentul chickens aged 14 to 24 weeks.

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REFERENCES

Adriani, L., Widjastuti, T., Sudjana, E., Mushawwir, A., & Yulianti, A. A. (2015*). Effect of Combination of Noni (Morinda citrifolia L.) Juice and Palm Sugar (Arenga pinnata) Supplementation in Drinking Water on Lipid Profile of Broiler Chicken*. Pakistan Journal of Nutrition, 14(8), 531-534.

Aprilianti, E., Mangisah, I., & Ismadi, V. D. Y. B. (2017). *Pengaruh Penggunaan Limbah Kecambah Kacang Hijau terhadap Kecernaan Protein Kasar, Kecernaan Serat Kasar dan Pertambahan Bobot Badan Itik Magelang*. AGROMEDIA: Berkala Ilmiah Ilmu-ilmu Pertanian, 35(2).

Azizah, T. R. N., Singgih, D. P., H. Setiyatwan, T. Widjastuti, & I. Y. Asmara. (2020). *Peningkatan Pemanfaatan Ransum pada Ayam Sentul yang Diberi Ekstrak Buah Mengkudu (Morinda citrifolia) dengan Suplementasi Tembaga dan Seng*. Jurnal Nutrisi Ternak Tropis dan Ilmu Pakan, 2:25-34.

Diarra, S. S., Amosa, F., & Lameta, S. (2019). *Potential of Morinda (Morinda citrifolia L.) Products as Alternative to Chemical Additives in Poultry Diets*. Egyptian Journal of Veterinary Sciences, 50(1), 37-45.

Fadilah, R. & Fatkhuroji. (2013). *Memaksimalkan Produksi Ayam Ras Petelur*. Agromedia Pustaka. Jakarta.

Hidayati, H., Saleh, E., & Aulawi, T. (2016). *Identifikasi Keragaman Gen BMPR-1B (Bone Morphogenetic Protein Receptor IB) Pada Ayam Arab, Ayam Kampung dan Ayam Ras Petelur Menggunakan PCR-RFLP*. Jurnal Peternakan, 13(1), 1-11.

Ilyasa, H. M. (2019). Pengaruh Penambahan Ekstrak Buah Mengkudu (Morinda citrifolia) yang Disuplementasi dengan Cu, Zn dalam Ransum terhadap Performa Ayam Sentul. *Disertasi*. UNPAD. Jatinangor.

Irianing, S., Suthama, N., & Mangisah, I. (2015). *Pengaruh Subtitusi Jagung dengan Tepung Biji Alpukat terhadap Konsumsi Ransum, Asupan Protein, dan Retensi Nitrogen pada Ayam Broiler*. Jurnal Pengembangan Penyuluhan Pertanian, 11(22), 19-24.

Kementerian Pertanian. (2013). Keputusan Menteri Pertanian Nomor 698/Kpts/PD.410/2/2013. Kementerian Pertanian. Jakarta

Landari, I. G. A. A. D., Kusumawati, I. G. A. W., Nursini, N. W., & Yogeswara, I. B. A. (2023). *Profil Senyawa Flavonoid Ekstrak Buah Mengkudu (Morinda citrifolia L.) dengan Berbagai Metode Pengeringan*. Jurnal Teknologi Pertanian Andalas, 27(1), 7-16.

Medion. (2018). *Pentingnya Keseragaman untuk Pullet Berkualitas*. https://www.medion.co.id/wp-content/uploads/2019/08/IM_Feb_18.pdf, accessed at 7th January 2025.

Mehdi, Y., Letourneau-Montminy, M.P., Gaucher, M.L., Chorfi, Y., Suresh, G., Rouissi, T., Brar, S.K., Cote, C., Ramirez, A.A. & Godbout, S. (2018). *Use of Antibiotics in Broiler Production: Global Impacts and Alternatives*. Anim. Nutr. 4: 170-178.

Muslim, A. M. (2022). *Performa Ayam Sentul Fase Developer yang Diberi Tingkatan Ekstrak Kulit Manggis (Garcinia Mangostana L.) yang Disuplemenasi dengan Cu dan Zn*. Jurnal Produksi Ternak Terapan, 3(1).

Plaper, A., Golob, M., Hafner, I., Oblak, M., Šolmajer, T., & Jerala, R. (2003). *Characterization of Quercetin Binding Site on DNA Gyrase*. Biochemical and Biophysical Research Communications, 306(2), 530-536.

Putri, S. A., Yunianto, V. D., & Suthama, N. (2019). *Perkembangan Organ Pencernaan dan Persentase Karkas Pada Broiler Diberi Ransum dengan*

Penambahan Ekstrak Buah Mengkudu (Morinda citrifolia L.). Seminar Nasional Sains dan Entrepreneurship, 1(1).

Santoso, B. D., Ananingsih, V. K., Soedarini, B., & Stephanie, J. (2020). *Pengaruh Variasi Maltodekstrin dan Kecepatan Homogenisasi Terhadap Karakteristik Fisikokimia Enkapsulat Butter Pala (Myristica fragrans houtt) dengan Metode Vacuum Drying*. Jurnal Teknologi Hasil Pertanian, 13(2): 94-103.

Setyoko, H., Sukamto, B., Wahyono, F., & Krismiyanto, L. (2020). Kecernaan Lemak Kasar dan Bobot Karkas Ayam Broiler Akibat Penambahan Ekstrak Buah Mengkudu (Morinda Citrifolia L.) dan Lactobacillus acidophilus. *Conference Proceeding Series*, 1: 134-142.

Wahju, J. (2015). *Ilmu Nutrisi Ternak Unggas*. Gadjah Mada University Press: Yogyakarta.

Wang, S., Yao, J., Zhou, B., Yang, J., Chaudry, M. T., Wang, M., & Yin, W. (2018). *Bacteriostatic Effect of Quercetin as an Antibiotic Alternative In Vivo and Its Antibacterial Mechanism In Vitro.* Journal Of Food Protection, 81(1), 68-78.

Widjastuti, T. (1996). Penentuan Efisiensi Penggunaan Protein, Kebutuhan Protein dan Energi untuk Pertumbuhan dan Produksi Telur Ayam Sentul pada Kandang Sistem Cage dan Sistem Litter. *Disertasi*. Universitas Padjadjaran. Bandung.

Widjastuti, T., Nurlaeni, L., Hasbuna, A., Setiawan, I., Yudaasmara, I., & Tanwiriah, W. (2023). *The Microencapsulation of Noni Fruit Extract (Morinda Citrifolia L.) with Maltodextrin and Its Implementation As Feed Additive on Carcass Quality and Histology of Intestinal Sentul Chicken*. International Journal on Advanced Science, Engineering & Information Technology, 13(1).

Wiradimadja, R., T. Widjastuti, & D. Rusmana. (2018). *Performan Ayam Sentul Fase Developer yang Diberi Berbagai Tingkat Tepung Kunyit (Curcuma domestica, Val) sebagai Imbuhan Pakan*. Jurnal Ilmu Ternak. Universitas Padjadjaran, 18(1): 53-59

Yuhendra, Y., & Darmiwati, D. (2021). *Efek Pemberian Tepung Kulit Kayu Manis (Cinnamomum burmanii) Feed Additive Ransum terhadap Performans Ayam Broiler*. Journal of Animal Center (JAC), 3(1), 24-32.