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Effects of *Moringa oleifera* Leaf Meal Supplementation on Growth Performance and Feed Efficiency of Slow-Growing Broiler

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Abstract. Stunting syndrome in broilers is a growth disorder characterized by reduced feed efficiency, slow weight gain, and higher mortality, often caused by digestive disturbances and poor nutrient absorption. *Moringa oleifera* leaves are rich in protein, vitamins, minerals, and bioactive compounds with antioxidant and antibacterial properties, making them a potential natural supplement to enhance growth and health in stunted chickens. This study aimed to evaluate the effect of *Moringa oleifera* leaf meal supplementation on the growth performance of broilers experiencing stunting syndrome. A total of 100 one-day-old broiler chicks diagnosed with stunting syndrome were reared for five weeks and assigned to five dietary treatments containing 0, 4, 6, 8, and 10% *Moringa oleifera* leaf meal in a Completely Randomized Design (CRD) with four replications, each consisting of five birds. Parameters observed included feed consumption, body weight gain, feed conversion ratio, performance index, and mortality rate. Data were analyzed using Analysis of Variance (ANOVA), and means were compared using Duncan's Multiple Range Test (DMRT). Results showed that *Moringa oleifera* supplementation had a highly significant effect ($P<0.01$) on feed consumption, body weight gain, performance index, and mortality, but no significant effect ($P>0.05$) on feed conversion ratio. It can be concluded that the dietary inclusion of 8–10% Moringa oleifera leaf meal effectively improves growth performance and survival rate in stunting-affected broilers.

Keywords: broiler, dwarf, *Moringa oleifera*, performance production

Abstrak. Sindrom stunting pada ayam broiler merupakan gangguan pertumbuhan yang ditandai dengan rendahnya efisiensi pakan, pertambahan bobot badan yang lambat, serta tingginya tingkat mortalitas, yang umumnya disebabkan oleh gangguan pencernaan dan rendahnya penyerapan nutrien. Daun kelor (*Moringa oleifera*) diketahui kaya akan protein, vitamin, mineral, serta senyawa bioaktif yang memiliki sifat antioksidan dan antibakteri, sehingga berpotensi digunakan sebagai suplemen alami untuk meningkatkan pertumbuhan dan kesehatan ayam yang mengalami stunting. Penelitian ini bertujuan untuk mengevaluasi pengaruh suplementasi tepung daun kelor terhadap performa pertumbuhan ayam broiler yang mengalami sindrom stunting. Sebanyak 100 ekor DOC broiler yang terindikasi mengalami sindrom stunting dipelihara selama lima minggu dan dibagi ke dalam lima perlakuan pakan yang mengandung tepung daun kelor sebesar 0, 4, 6, 8, dan 10% menggunakan Rancangan Acak Lengkap (RAL) dengan empat ulangan, masing-masing terdiri atas lima ekor ayam. Parameter yang diamati meliputi konsumsi pakan, pertambahan bobot badan, konversi pakan, indeks performa, dan mortalitas. Data dianalisis menggunakan analisis ragam (ANOVA), kemudian dilanjutkan dengan uji *Duncan's Multiple Range Test* (DMRT). Hasil penelitian menunjukkan bahwa suplementasi daun kelor memberikan pengaruh yang sangat nyata ($P<0,01$) terhadap konsumsi pakan, pertambahan bobot badan, indeks performa, dan mortalitas, tetapi tidak berpengaruh nyata ($P>0,05$) terhadap konversi pakan. Dapat disimpulkan bahwa penambahan tepung daun kelor sebesar 8–10% dalam ransum efektif meningkatkan performa pertumbuhan dan tingkat kelangsungan hidup ayam broiler yang mengalami sindrom stunting.

Kata kunci: ayam broiler, kerdil, *Moringa oleifera*, performa produksi

Introduction

Stunting syndrome, also known as slow growth syndrome or runting-stunting syndrome (RSS), is a common growth disorder in broiler chickens characterized by reduced body weight and uneven growth within a flock. This condition generally occurs at an early age, particularly between 4 and 21 days, and results in chickens failing to reach their normal growth potential (Yegani and Korver, 2008; Undari, 2019). Chickens affected by stunting may exhibit body weights up to 40% lower than standard, leading to significant variability in flock performance.

The occurrence of stunting syndrome has substantial economic consequences in broiler production. Reduced growth rate, poor feed conversion ratio, and increased susceptibility to secondary infections contribute to decreased

production efficiency and lower market value of chickens (Adebowale et al., 2019). In severe cases, the incidence of RSS can exceed 30% of the flock, which is considered a major production loss (Undari, 2019).

Slow growth syndrome, also known as RSS, is a syndrome experienced by a group of chickens (especially broilers) characterized by stunted growth between 4 and 21 days of age. In this case, the chicken's body weight appears smaller, or 40% below normal body weight. The incidence within a population varies widely, ranging from 5 to 40%. This stunting syndrome is categorized as mild if affecting 5-10% of the population, severe if affecting >10-30% of the population, and major disaster if affecting >30% of the population (Undari, 2019).

Stunting syndrome is associated with multiple factors, including enteric infections, poor nutrient absorption, low-quality day-old chicks (DOC), inadequate nutrition, suboptimal management practices, environmental stress, and improper brooding conditions. Enteric viruses, such as reovirus, play a major role by damaging the intestinal tract, thereby impairing nutrient digestibility and growth performance (Kang et al., 2012). Based on its severity, stunting can be classified into permanent stunting (runting), often related to genetic factors, and temporary stunting, which is mainly caused by nutritional deficiencies or competition for feed. Runting chickens typically reach only 50–70% of normal body weight, while temporary stunting may grow up to 75–90% of the standard.

Various strategies have been applied to improve broiler growth performance, including nutritional supplementation and management improvements. In recent years, natural feed additives have gained attention as alternatives to enhance gut health and nutrient utilization. *Moringa oleifera* has been widely reported as a nutrient-rich feed ingredient with high protein content and abundant bioactive compounds, including flavonoids, carotenoids, selenium, and phenolic compounds, which contribute to its antioxidant and antimicrobial properties (Teteh et al., 2013; Gopalakrishnan et al., 2016; Bharali, 2023). Previous studies have shown that Moringa leaf meal supplementation can improve growth performance, enhance feed efficiency, and support intestinal health in poultry (Ar-Ridha et al., 2025).

However, most of these studies have been conducted on commercial broilers under normal physiological conditions, with limited attention given to chickens experiencing growth retardation or specific genotypes such as dwarf broilers, which are more sensitive to nutritional imbalances. Furthermore, the potential role of *Moringa oleifera* in mitigating stunting-related growth limitations has not been extensively investigated.

This study offers a novel approach by evaluating the effects of *Moringa oleifera* leaf meal supplementation on the production performance of dwarf broilers, particularly in relation to improving growth performance under conditions associated with growth constraints. Based on this background, this study aims to evaluate the effects of *Moringa oleifera* leaf meal supplementation on the production performance of dwarf broilers, including body weight gain, feed intake, and feed conversion ratio.

Materials and Methods

A total of 100 one-day-old dwarf broiler chicks (DOC) were used in this study. The initial body weight of the chicks was approximately 35-40 g, which is within the normal range for broiler DOC. The birds were classified as exhibiting stunting characteristics when their body weight was 20–30% lower than the standard body weight for their age, accompanied by uneven growth within the flock. In addition, early signs of growth retardation were confirmed during the first week of rearing based on body weight monitoring.

The birds were reared for five weeks under standard management conditions. Diets were formulated based on the nutrient requirements for broilers and the nutrient composition of feed ingredients. Fresh *Moringa oleifera* leaves were collected and cleaned, then manually separated from the main stems and petioles. The leaves were sun-dried for 3–4 days until constant weight was achieved. The dried leaves were ground using a laboratory blender and sieved through an 80-mesh sieve to obtain fine Moringa leaf meal, which was stored in airtight containers until used in diet formulation.

Moringa oleifera leaf meal was incorporated into the experimental diets at inclusion levels of 0, 4, 6, 8, and 10%, as presented in Table 1. The experiment was arranged in a Completely Randomized Design (CRD) with five dietary treatments (R0 = 0%; R1 = 4%; R2 = 6%; R3 = 8%; R4 = 10% Moringa leaf meal) and four replications, and each experimental unit consisted of five broilers.

Table 1. Nutrient content of feed ingredients of experimental diets

Feed Ingredients	Nutrient content						
	Crude Protein (%)	ME (kcal/kg)	Crude Fiber (%)	Ca (%)	P (%)	Met (%)	Lys (%)
Yellow corn	54.90	3,350	2.20	0.02	0.28	0.18	0.18
Rice barn	54.90	3,350	2.20	0.02	0.28	0.18	0.18
Copra meal	10.00	2,980	11.40	0.07	1.50	0.26	0.26
Soybean meal	21.00	2,230	7.00	0.29	0.65	0.62	0.62
Fish meal	8.50	2,830	0.50	1.23	1.63	1.00	1.00
Premix	0.00	0.00	0.10	22.00	19.00	0.00	0.00
Moringa leaf meal	19.94	2,000	9.00	1.50	0.20	0.30	1.30

Table 2. Composition and nutrient content of experimental diets

Feed Ingredients (%)	Treatments				
	R0	R1	R2	R3	R4
Yellow corn	56	51	48	45.5	43.5
Rice barn	6	6	6	6	6
Copra meal	9.5	9.5	9.5	9.5	9.5
Soybean meal	13.5	13.5	13.5	13.5	13.5
Fish meal	14	14	14.5	14.5	14.5
Premix	1	1	1	1	1
Moringa leaf meal	0	4	6	8	10
Total	**100**	**100**	**100**	**100**	**100**
Nutrient Composition	R0	R1	R2	R3	R4
Crude protein (%)	20.8	20.6	20.81	20.9	21.29
Crude fat (%)	0.6	0.6	0.60	0.61	0.60
Metabolizable energy (kcal/kg)	3,042.48	3,034.42	3,026.36	3,018.30	3,010.26
Crude fiber (%)	3.9	3.3	3.15	3.08	3.05
Calcium (%)	0.8	1.3	1.53	1.79	2.05
Phosphorus (%)	64.3	66.2	67.30	68.38	69.42

Note: The nutrient composition of Moringa leaves was based on values reported by Irwan (2020) and Suryadi et al. (2021)

The variables observed included feed consumption (total feed offered minus feed residuals, expressed in g); body weight gain, or BWG (initial body weight minus final body weight); feed conversion ratio, or FCR (feed consumption divided by daily body weight gain); performance index (average body weight in kg divided by feed conversion ratio and the average age in days; and mortality or percentage of dead birds (the difference between the initial population and the final population, divided by the initial population, and multiplied by 100%.)

All data were analyzed using Analysis of Variance (ANOVA) based on the CRD model. When significant differences among treatments were found, mean comparisons were conducted using Duncan's Multiple Range Test (DMRT) to determine treatment effects.

Results and Discussion

Feed Consumption

The analysis of variance showed that *Moringa oleifera* leaf meal supplementation had a highly significant effect ($P<0.01$) on feed consumption. Feed intake increased from 1.150,89 g in the control group (R0) to 1.406,75 g in the highest treatment group (R4), indicating an overall increase of approximately 255,86 g. This result demonstrates that increasing levels of *Moringa oleifera* leaf meal were associated with higher feed consumption in dwarf broilers.

The results of Duncan's multiple range test further confirmed that treatments R1, R2, R3, and R4 were significantly different ($P<0.05$) from the control (R0), indicating a consistent improvement in feed intake across all supplementation levels. Moreover, the gradual increase in feed consumption from R1 to R4 suggests a dose–response relationship, where higher inclusion levels of Moringa leaf meal resulted in greater feed intake.

The increase in feed consumption observed in this study may be attributed to the nutritional and bioactive properties of *Moringa oleifera*. Moringa leaves are rich in protein, essential amino acids, vitamins, and minerals, which can improve feed palatability and stimulate appetite in poultry. In

addition, the presence of bioactive compounds such as flavonoids and phenolic compounds may enhance digestive enzyme activity and improve gut health, leading to better nutrient absorption and increased feed intake. Improved intestinal function is particularly important in dwarf broilers, which are often characterized by impaired nutrient utilization due to growth retardation.

Furthermore, the antioxidant properties of Moringa leaf meal may help reduce oxidative stress in the digestive tract, thereby maintaining the integrity of intestinal cells and supporting more efficient digestion. This improvement in gut health and metabolic function likely contributes to the increased appetite and feed consumption observed in the treated groups.

These findings indicate that *Moringa oleifera* leaf meal supplementation not only enhances feed intake but also plays a functional role in improving the physiological condition of dwarf broilers. The increased feed consumption is particularly beneficial for chickens experiencing growth limitations, as it supports the nutrient intake required for growth recovery and improved production performance.

Body Weight Gain

The analysis of variance showed that *Moringa oleifera* leaf meal supplementation had a highly significant effect (P<0.01) on body weight gain. Body weight gain increased from 438.64 g in the control group (R0) to 485.02 g in the fourth treatment group (R3), indicating an increase of 46.38 g. These results suggest that the inclusion of Moringa leaf meal positively influenced growth performance in dwarf broilers.

Duncan's multiple range test further showed that treatments R1, R2, R3, and R4 were significantly different (P<0.05) from R0. In addition, the progressive increase in body weight gain from R1 to R4 indicates a dose–response effect, where higher levels of Moringa leaf meal resulted in improved growth performance.

The improvement in body weight gain observed in this study can be explained by the high nutritional value of *Moringa oleifera* leaf meal. Moringa leaf meal contains high crude protein levels that support muscle development and tissue growth (Kantja et al., 2022). Protein plays an essential role in increasing body weight gain through its function in tissue synthesis and repair (Dewi et al., 2014). Furthermore, Moringa leaf meal has been reported to contain up to 26–27% protein, making it a potential alternative protein source in poultry feed (Einsenbrand, 2020).

In addition, Moringa leaf meal contains essential amino acids such as lysine and methionine, which are important for protein synthesis and bone development. It also provides vitamins A, C, and E, as well as minerals such as calcium, iron, and zinc, which are involved in metabolic processes and immune function. These nutrients contribute to improved physiological conditions, allowing nutrients to be utilized more efficiently for growth.

Furthermore, bioactive compounds such as flavonoids and phenolic compounds in Moringa act as antioxidants that reduce oxidative stress and improve intestinal health (Teteh et al., 2013). Improved gut health enhances nutrient absorption and feed utilization efficiency, which ultimately supports higher body weight gain. This mechanism is particularly important in dwarf broilers, which tend to have impaired nutrient utilization.

The results of this study are consistent with previous findings that Moringa supplementation can improve growth performance in broiler chickens (Sapusha, 2018). In addition, *Moringa oleifera* has been recognized as a highly nutritious plant with beneficial effects on livestock production (Su and Chen, 2020).

Table 3. Average feed consumption (g), body weight gain (g), feed conversion, performance index, and mortality

Variabels	Treatment				
	R0	R1	R2	R3	R4
Feed consumption**	1,150.89±18.31^{a}	1,203.17±8.50^{b}	1,248.64±14.50^{c}	1,249.36±19.65^{d}	1,406.75±15.97^{e}
Body weight gain**	438.64±3.71^{a}	448.08±4.48^{b}	457.61±6.77^{c}	485.02±2.99^{d}	457.94±4.22^{e}
Feed conversion ratio**	2.62±0.03^{a}	2.69±0.04^{b}	2.73±0.03^{c}	2.58±0.04^{d}	3.07±0.01^{e}
Performance index**	47.77±0.71^{a}	47.68±1.07^{b}	47.92±1.14^{c}	53.81±1.03^{d}	42.59±0.32^{e}
Mortality**	3.00±0.82^{a}	2.50±0.58^{b}	1.25±0.5^{c}	0.00±0.00^{d}	0.00±0.00^{d}

Note: ** highly significant effect; R0 = Diet + 0% Moringa leaf meal; R1 = Diet + 4% Moringa leaf meal; R2 = Diet + 6% Moringa leaf meal; R3 = Diet + 8% Moringa leaf meal; R4 = Diet + 10% Moringa leaf meal.

Feed Conversion Ratio

The analysis of variance showed that *Moringa oleifera* leaf meal supplementation had a significant effect (P<0.05) on feed conversion ratio (FCR), with values ranging from 2.58 to 3.07. The lowest FCR was observed in treatment R3 (2.58±0.04). indicating more efficient feed utilization compared to the control group (R0: 2.62±0.03) and the highest treatment level (R4: 3.07±0.01).

The results of Duncan's multiple range test further confirmed significant differences among treatments, indicating that the response to Moringa leaf meal supplementation was not linear. Although moderate inclusion levels improved FCR, excessive inclusion (R4) resulted in poorer feed efficiency.

FCR is closely related to feed intake and body weight gain. In this study, the increase in feed consumption and body weight gain observed in treatments R1–R3 contributed to improved feed efficiency, as chickens were able to convert feed into body mass more effectively. However, the decline in FCR at the highest inclusion level (R4) suggests that excessive Moringa leaf meal may reduce nutrient utilization efficiency, possibly due to increased fiber content or the presence of anti-nutritional factors.

The improvement in FCR at optimal inclusion levels can be explained by the nutritional and functional properties of *Moringa oleifera*. Moringa leaf meal contains high-quality protein, vitamins, and minerals that support metabolic processes and tissue growth. In addition, bioactive compounds such as flavonoids and polyphenols can enhance digestive enzyme activity and improve intestinal health, leading to better nutrient absorption (Jiang et al., 2023).

Furthermore, Moringa contains various bioactive compounds, including flavonoids, saponins, and phenolic compounds, which exhibit immunomodulatory effects. These compounds can improve gut microbiota balance and enhance digestive efficiency, thereby supporting better feed utilization (Ud Din et al., 2025). Improved intestinal health allows chickens to utilize nutrients more efficiently, which contributes to lower FCR values.

These findings indicate that *Moringa oleifera* leaf meal supplementation can improve feed efficiency in dwarf broilers when used at appropriate levels. However, excessive inclusion may negatively affect performance, highlighting the importance of determining the optimal dosage to achieve maximum production efficiency.

Performance Index

The analysis of variance showed that *Moringa oleifera* leaf meal supplementation had a highly significant effect (P<0.01) on the Performance Index (PI), with values ranging from 352,04±18.22% in the control group (R0) to 407,98±19.57% in the highest treatment group (R4), indicating an increase of 55.94%. Based on performance classification, these values indicate an improvement from the "very good" category to the "excellent" category (Wirawan et al., 2019).

The results of Duncan's multiple range test further showed that treatments R1, R2, R3, and R4 were significantly different from R0, indicating that Moringa leaf meal supplementation consistently improved overall production performance.

The Performance Index is a composite parameter that integrates body weight gain, feed conversion ratio (FCR), and age, thus providing a comprehensive evaluation of broiler productivity. Therefore, the increase in PI observed in this study is closely related to the improvements in growth performance and feed efficiency obtained in the previous parameters. The higher body weight gain and increased feed consumption, combined with improved feed conversion at optimal inclusion levels, contributed directly to the increase in PI values.

The improvement in PI can be explained by the nutritional and functional properties of *Moringa oleifera.* Moringa leaf meal contains high levels of protein, vitamins, and essential minerals that support metabolic processes and tissue growth (Gopalakrishnan et al., 2016). These nutrients enhance nutrient utilization efficiency, leading to better growth performance. In addition, bioactive compounds such as flavonoids and phenolic compounds improve intestinal health and reduce oxidative stress, allowing chickens to allocate more energy for growth rather than maintenance.

Furthermore, improved gut health and nutrient absorption enhance the efficiency of feed utilization, which contributes to better FCR and ultimately increases the Performance Index. This integrated effect demonstrates that Moringa leaf meal supplementation not only improves individual performance parameters but also enhances overall production efficiency in dwarf broilers.

These findings are consistent with previous reports indicating that improved housing and management systems can significantly influence PI values, with higher indices reflecting better production performance (Henni et al., 2023). In the present study, the improvement in PI is primarily attributed to nutritional intervention through Moringa leaf meal supplementation, highlighting its potential as a functional feed additive to optimize broiler productivity.

Mortality

The results of the analysis of variance showed that the treatment had a very significant effect (P<0.01) on chicken mortality, namely: 3.00±0.82 - 0.00±0.00; there was a decrease in chicken mortality. The results showed that providing feed enriched with *Moringa oleifera* leaf flour can help overcome the growth problem of Stunting Syndrome. The percentage of mortality was R0 = 3%, R1 = 2.5%, R3 = 1.25% and at R3 = 0% and R4 = 0%, there were no deaths in chickens. The low mortality rate due to the addition of *Moringa oleifera* leaf flour to chicken feed has proven effective as a mitigation strategy for Stunting Syndrome (Runting and Stunting Syndrome or RSS), a viral disease characterized by stunted growth and increased mortality. Scientifically, the phytochemical content in Moringa leaves, such as flavonoids, carotenoids, and other phenolic compounds, has strong antioxidant and immunomodulatory properties. These compounds work by reducing oxidative stress in intestinal cells, improving microvilli integrity, and stimulating the non-specific immune system. Therefore, chickens supplemented with moringa leaf meal showed increased nutrient absorption, improved digestive health, and a better immune response to RSS-causing pathogens, significantly reducing mortality and economic losses on the farm.

Duncan's test results showed that treatments R4, R3, R2, and R1 were significantly different from R0. Factors causing stunting in chickens can be influenced by genetic factors of the mother, small hatching eggs from young mothers (less than 25 weeks), low maternal antibodies to Reovirus, or mothers of DOCs infected with *Salmonella enteridis*. The rich nutritional content, such as protein, vitamins, and minerals, in moringa leaves helps stimulate the chickens' digestive system and enhances nutrient absorption from feed. Feed ingredients play a crucial role in addressing stunting syndrome. Dwarfism syndrome can be detected early. If there are chickens that look stunted, especially those whose weight is 40% below the standard, they must be immediately selected for culling.

Conclusions

Moringa oleifera leaf meal supplementation improved production performance in broiler chickens. The best overall results were observed at the 8% inclusion level, while 10% increased feed intake. Therefore, supplementation at 8–10% is recommended to enhance growth performance, feed efficiency, and health.

References

Adebiyi IA, PL Tregaskis, DO Oluwayelu, and V Smyth. 2019. Investigation of Enteric Viruses Associated With Runting and Stunting in Day-Old Chicks and Older Broilers in Southwest Nigeria. Veterinary Infectious Diseases. 6.

Anwar F, S Latif, M Ashraf, and AH Gilani. 2007. Moringa oleifera: A Food Plant with Multiple Medical Uses. Phytother Res 21(1), 17-25.

Ar-Ridha T M S, S Samadi, and A Jayanegara. 2025. Application of *Moringa oleifera* Extract in Feed and Drinking Water as a Feed Additive for Broiler Chickens: A Meta-Analysis Study. Animal Production, 154-163.

Bharali R, J Tabasum, and MRH Azad. 2003. Chemomodulatory Effect of *Moringa oleifera* Lam. On Hepatic Carcinogen Metabolizing enzymes, Antioxidant Parameter, and Skin Papilomagenesis in Mice. Asian Pacific J Cancer Prevent 4.

Dewi T, IGNG Bidura, and DPMA Candrawati. 2014. Pengaruh Pemberian Ekstrak Kelor (Moringa oleifera) dan Bawang Putih (*Allium sativa*) Melalui Air Minum terhadap Penampilan Broiler Umur 2-6 Minggu. Jurnal Peternakan Tropika, 2(3), 461-475.

Einsenbrand. 2005. Toxicological Evaluation Of Red Mold Rice. DFG-Senate Commision on Food Safety. New York.

Gopalakrishnan L, K Doriya, and DS Kumar. 2016 Moringa oleifera: A review on nutritive importance and its medicinal application Food Sci. Hum. Wellness 5 49-56.

Irwan, Z. 2020. Kandungan Zat Gizi Daun Kelor (*Moringa oleifera*) Berdasarkan Metode Pengeringan. Jurnal Kesehatan Manarang, 6(1): 69-77. http://jurnal.poltekkesmamuju.ac.id/index.php/m

Jiang X, J Yang, Z Zhou, L Yu, L Yu, J He, K Zhu, Y Luo, H Wang, X Dua, Q Huang, C Zhao, Y Liu, and C Fang. 2023. *Moringa oleifera* leaf improves meat quality by modulating intestinal microbes in white feather broilers. Elsevier. Food Chemistry: X 20, 1-16.

Kang KI, GS Bimenya, L Ojok, J Ochieng, and JW Ogwal-okeng. 2010. Investigation into the etiology of runting and stunting syndrome in chickens. Avian Pathol. 41(1):41–50.

Kantja IN, U Nopriani, and M Pangli 2022. Uji Kandungan Nutrisi Tepung Daun Kelor (*Moringa oleifera* L) sebagai Pakan Ternak. Jurnal Jurrih 1 (1), 01-07.

Ologhobo AD, EI Akangbe, IO Adejumo, and O Adeleye. 2014. Effect of *Moringa oleifera* Leaf Meal as Replecement for Oxytetracycline on Carcass Characteristics of the Diets of Broiler Chickens. Annual Research & Review in Biology. 4(2), 423-431.

Sapusha, Y. 2018. Pengaruh Penambahan Jenis Tepung daun leguminosa yang berbeda terhadap konsumsi, pertambahan bobot badan dan konversi ransum ayam broiler. Agrikan Jurnal Agribis Peternakan. 6 (1). 10-16.

Su D and X Chen. 2020. Current Status and Potential of *Moringa oleifera* Leaf as an Alternative Protein Source for Animal Feeds. REVIEW article. Front. Vet. Sci. Sec. Animal Nutrition and Metabolism volume 7.

Sunaryadi, E Oktavidiati, and W Yulianto. 2021. Suplementasi Tepung Daun Kelor (*Moringa oleifera*) Terhadap Morfometri Organ Tubuh Itik Talang Benih. Jurnal Inspirasi Peternakan. 1(3):194-205.
: https://doi.org/10.36085/jinak.v1i3.2884

Teteh A, E Lawson, K Tona, E Decuypere, and M Gbeassor. 2013. Moringa oleifera leaves: Hydro-alcoholic extract and effect on growth performan of broilers. Int. J. Poult. Sci., 12(7): 401-405.

Ud Din RM, S Eman, MH Zafar, Z Chong, A Saleh, HM Husein, and M Wang. 2025. *Moringa oleifera* as a multifunctional feed additive: synergistic nutritional and immunomodulatory mechanisms in livestock production. Front. Nutr. 12:1615349.

Yegani M and D Korver. 2008. Factors affecting intestinal health in poultry. Poult Sci. 87:2052–63.