ASEAN
Journal of Scientific and Technological Reports
Online ISSN:2773-8752

*Research article*

# Effects of *Trichanthera gigantea* (Ketum Ayam) Leaf Supplementation in Layers Feed on Egg Production and Quality

**Jarunee Noolaong[1], Bukhoree Matukae[1*], Sulfal Hayeelateh[1], Furkorn Baraheng[1], and Arraya Jeanmas[2]**

[1] Faculty of Science Technology and Agriculture, Yala Rajabhat University, Yala, 95000, Thailand
[2] Faculty of Science and Technology, Prince of Songkla University, Pattani, 94000, Thailand
* Correspondence: Bukhoree.m@yru.ac.th

**Citation:**
Noolaong, J.; Matukae, B.; Hayeelateh, S.; Baraheng, F.; Jeanmas, A. Effects of *Trichantera gigantea* (Ketum Ayam) leaf supplementation in layers feed on egg production and quality. *ASEAN J. Sci. Tech. Report.* **2026**, *29*(10), e263685. https://doi.org/10.55164/ajstr.v29i10.263685

**Article history:**
Received: February 13, 2026
Revised: May 3, 2026
Accepted: May 16, 2026
Available online: September 20, 2026

**Publisher's Note:**
This article is published and distributed under the terms of the Thaksin University.

**Abstract:** This research aimed to study the effect of *Trichanthera gigantea* leaf powder in layer feed on production performance and egg quality. Chopped *T. gigantea* leaves were dried and powdered. One hundred and twenty layers, aged 6 months, were allotted in a completely randomized design. Birds were divided into four groups according to the level of *T. gigantea* leaf powder, with 3 replicates per group (10 birds per replicate). Group 1 received feed without T. gigantea leaf powder (control group), while groups 2, 3, and 4 received feed complemented with 1, 2, and 3% of *T. gigantea* leaf powder, respectively. The layers received feed *ad libitum*. Feed intake, egg count, and egg weight were recorded. Twenty eggs per group were randomly sampled for egg quality evaluation. The results showed that feed supplementation of *T. gigantea* leaf powder could significantly improve egg weight, egg percentage, feed conversion ratio, feed per dozen eggs, and egg quality ($P<0.01$). The study suggests a maximum supplementation of 3%, though 2% is identified as the optimal level for enhancing performance.

**Keywords:** *Trichanthera gigantea*; egg production; egg quality; feed supplementation; layer hens

## 1. Introduction

Layer hen farming plays a crucial role in the agricultural sector, as eggs serve as an affordable and widely consumed protein source worldwide. However, feed costs remain a major factor directly impacting farmers' profitability. High-quality layer feed is often expensive, leading farmers to rely on synthetic additives to enhance productivity and product quality-an approach widely accepted in the poultry industry. Recently, interest in organic and cost-effective poultry production has grown, emphasizing the use of natural, locally available feed ingredients. Plant-based proteins, which are abundant in nature, offer a high-potential, environmentally friendly alternative and are prompting further research into low-cost, efficient feed sources.

*T. gigantea* (Figure 1), also known as Madre de Agua, has gained attention among researchers and farmers due to its high crude protein content (13-22%) and rich mineral profile, which are essential for animal growth. This plant is easily cultivable in diverse environments, particularly tropical and humid regions [1]. Nutritionally, T. gigantea leaves contain 2.8% crude fat, 4.4% crude fiber, 19.7% ash, and 37.0% carbohydrates. Additionally, its protein

composition includes essential amino acids that animals can easily absorb [2, 3, 4]. Incorporating *T. gigantea* leaves into layer hen diets may help reduce feed costs while enhancing the nutritional value of poultry feed. Several studies have demonstrated the potential of *T. gigantea* as an alternative protein source in various poultry diets, including layer hens [5, 6], mallard duck [7], quail [8], broiler [2], and native chicken [9]. However, research specifically focusing on layer hens remains limited, and some findings may be outdated. *T. gigantea* contains high crude protein (approximately 22%) with essential amino acids and yields substantial biomass across diverse environments. Its leaves contain antinutritional factors such as tannins and saponins, which may limit digestibility and direct use in chicken diets [10]. Fermentation has been shown as an effective strategy to reduce antinutritional factors and improve the nutritional utilization of tropical plant leaf meals; for example, fermented mulberry leaves at 2% inclusion significantly improved growth performance, muscle composition, and innate immune responses in Nile tilapia [11], and yeast-fermented Acacia mangium leaf meal at 5% enhanced feed utilization and growth in climbing perch (*Anabas testudineus*) without adverse effects on carcass quality [12]. Prior studies showed that supplementing 2-6% *T. gigantea* leaf in layer hen diets maintained egg production rates (74-75%) and egg quality, while reducing feed costs [7]. In mallard ducks, replacing feed with fresh *T. gigantea* leaves yielded no differences in egg production or quality, though intake varied by texture and aroma [7]. These findings from alternative plant-based additives underscore the potential for similar rigorous investigation of *T. gigantea* in layer hens, particularly given its comparable nutritional profile and tropical adaptability [13].

Despite the promising nutritional composition of *T. gigantea* and encouraging cross-species evidence from broilers, ducks, and quail, critical knowledge gaps remain that limit its practical application in commercial layer production. Specifically for layer hens, optimal inclusion rates remain empirically unestablished [14]. In contrast, recent studies of alternative plant-based supplements have systematically addressed these outcome domains. For example, Ardiarini and Lase (2021) demonstrated that herbal supplementation can improve both production performance and gastrointestinal health in layers, providing a methodological framework for evaluating botanical additives [13]. Nasarudin et al. (2024) explored the feasibility of T. gigantea as broiler feed but did not extend their analysis to layers or egg quality outcomes [14]. Therefore, this study aims to evaluate the effects of *T. gigantea* supplementation on egg production performance and egg quality in commercial layer hens. Multiple supplementation levels will be tested to identify optimal inclusion rates that preserve yield while cutting costs and environmental impact. Data from this research will provide essential references for developing and applying *T. gigantea* as a viable alternative feed in the layer hen industry, particularly in tropical regions like Thailand. Nutritional profiles confirm its viability, with antinutrients mitigated for better palatability.



**Figure 1.** *T. gigantea* leaf cultivated in Yaha District, Yala Province, Thailand.

## 2. Materials and Methods

### 2.1 Animals, Experimental Design and Diets

This experiment was approved for the use of animals for scientific purposes under approval document number AG080/2024 by the Institutional Animal Care and Use Committee (IACUC) of Prince of

Songkla University. One hundred twenty commercial crossbred ISA Brown laying hens, 6 months old, with an average body weight of 2.5 ± 0.54 kg in individual cages, were randomly assigned to four treatment groups in a Completely Randomized Design (CRD). Each treatment consisted of three replicates with 10 hens per replicate. The birds were housed in a single-tier gable-roof poultry house with cage dimensions of 40 × 45 cm, elevated 0.3 meters above the ground. A commercial basal diet (BD) met or exceeded the nutrient requirements for laying hens with the following nutrient specifications: minimum 22% crude protein, minimum 3% crude fat, maximum 5% crude fiber, maximum 11% ash content, and maximum 13% moisture content. The hens were fed the basal diet supplemented with different levels of *T. gigantea* leaf powder across four treatment groups: Treatment 1 (Control) received commercial feed without supplementation, while Treatments 2, 3, and 4 received commercial feed supplemented with 1%, 2%, and 3% *T. gigantea* leaf powder, respectively. (Table 1) Throughout the 4-week experimental period, all hens had free access to clean drinking water and sufficient feed to maintain production.

**2.2 Productive Performance and Egg Quality**

Egg production data, including egg quantity, egg weight, and feed intake, were recorded daily to calculate egg production percentage, feed conversion ratio (FCR), and feed per dozen eggs (FDE). During the final 3 days of the experiment, a total of 180 eggs (5 eggs per day from each replicate) were randomly collected for quality analysis. Egg quality parameters were measured using a DET 6500 machine, which assessed egg weight, yolk weight, shell weight, freshness, Haugh unit, albumen height, yolk height, shell strength, shell thickness, yolk width, yolk index, and yolk color.

**Table 1.** Feed composition and nutrient content of basal diets and supplementation with *T. gigantea* sources (% as fed basis)

| Ingredients | Treatments | | | | |
|---|---|---|---|---|---|
| | ***T. gigantea* Leaf** | **control** | ***T. gigantea* 1 %** | ***T. gigantea* 2 %** | ***T. gigantea* 3 %** |
| Corn | - | 63.49 | 63.49 | 63.49 | 63.49 |
| Rice bran | - | 4.2 | 4.2 | 4.2 | 4.2 |
| Soybean meal | - | 25.35 | 25.35 | 25.35 | 25.35 |
| Fish meal | - | 4 | 3 | 2 | 1 |
| Oyster shell | - | 0.3 | 0.3 | 0.3 | 0.3 |
| Dicalcium phosphate | - | 1.45 | 1.45 | 1.45 | 1.45 |
| Premix | - | 0.5 | 0.5 | 0.5 | 0.5 |
| Salt | - | 0.3 | 0.3 | 0.3 | 0.3 |
| Lysine | - | 0.34 | 0.34 | 0.34 | 0.34 |
| Methionine | - | 0.079 | 0.079 | 0.079 | 0.079 |
| Additives | - | 0 | 1 | 2 | 3 |
| **Total** | | **100** | **100** | **100** | **100** |
| **Analyzed composition** | | | | | |
| Crude protein | 22.63 | 20.15 | 22.20 | 22.47 | 22.63 |
| Crude fiber | 10.33 | 5.26 | 4.52 | 4.48 | 5.26 |
| Ether extract | 3.48 | 2.45 | 2.59 | 2.36 | 3.48 |
| Gross energy (GE, kcal/kg) | 3,485 | 2,800 | 3,475 | 3,480 | 3,505 |
| **Calculated composition** | | | | | |
| Calcium | - | 0.80 | 0.80 | 0.80 | 0.80 |
| Available Phosphorus | - | 0.40 | 0.40 | 0.40 | 0.40 |
| Methionine | - | 0.36 | 0.36 | 0.36 | 0.36 |
| Lysine | - | 1.20 | 1.20 | 1.20 | 1.20 |

### 2.3 Statistical Analysis

The averages were calculated from the data using Microsoft Excel, and analysis of variance (ANOVA) was used to assess statistical differences among treatments. Mean differences were compared using Duncan's new multiple range test (DMRT) with SAS® OnDemand for Academics [15].

## 3. Results and Discussion

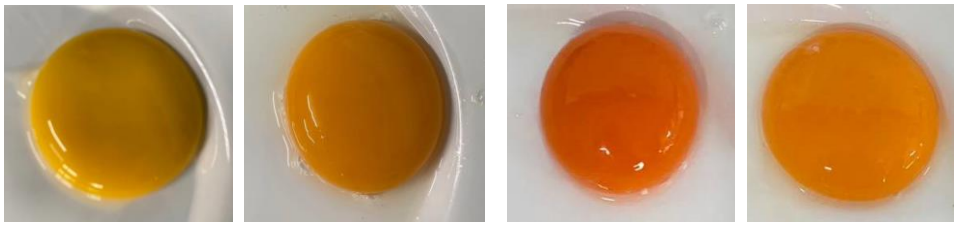
From the experimental results in Table 1, supplementation of *T. gigantea* in the diet of laying hens significantly improved egg production efficiency ($p$<0.05) in all parameters studied. *T. gigantea* supplementation reduced feed consumption compared with the control group, with hens in the experimental group receiving 2% supplementation and showing the lowest feed intake. Meanwhile, all groups supplemented with *T. gigantea* had significantly higher egg weight and production percentage than the control group. Interestingly, *T. gigantea* supplementation improved feed utilization efficiency, as observed by a better feed conversion ratio (FCR) and lower feed amount used per dozen eggs produced in all experimental groups, especially in the group receiving 2% supplementation.

**Table 2.** The effect of supplementing ketum ayam leaves in layer hen feed on egg production performance.

| Parameters | *T. gigantea* leaf | | | | SEM |
|---|---|---|---|---|---|
| | Control | 1 % | 2 % | 3 % | |
| Feed intake (g) | 110.80$^{A}$ | 104.76$^{B}$ | 99.86$^{C}$ | 106.63$^{B}$ | 0.0912 |
| Average egg weight (g) | 59.48$^{C}$ | 68.58$^{A}$ | 69.83$^{A}$ | 64.67$^{B}$ | 1.2137 |
| Egg production (%) | 64.75$^{C}$ | 67.69$^{B}$ | 70.23$^{A}$ | 65.67$^{B}$ | 0.7525 |
| Feed conversion ratio | 5.84$^{A}$ | 5.03$^{C}$ | 4.86$^{C}$ | 5.41$^{B}$ | 0.1098 |
| Feed per dozen eggs (g) | 2,459$^{A}$ | 2,114$^{C}$ | 1,679$^{C}$ | 2,313$^{B}$ | 78.0973 |

$^{A, B, C}$ = The averages in the same row within the same list, marked with different letters, are significantly different (P<0.01).
SEM = Standard error of the mean

In Table 2, it was found that supplementation of *T. gigantea* leaves in laying hen diets had statistically significant effects ($p$<0.05) on several egg quality parameters. All experimental groups receiving *T. gigantea* leaf supplementation showed improved egg quality compared to the control group. The key parameters showing improvement across all supplementation levels included egg weight, yolk weight, shell weight, Haugh unit (an indicator of egg freshness), albumin height, eggshell strength and thickness, yolk height, yolk width, yolk index, and yolk color (Figure 2). Interestingly, the 2% supplementation group emerged as the most effective level for enhancing both production performance and egg quality. In comparison, the 3% supplementation level did not differ significantly from the control group in some parameters, particularly shell weight, albumen height, and yolk color.



T1 (control) T2 (1%) T3 (2%) T4 (3%)

**Figure 2.** Egg yolk color characteristics supplemented with *T. gigantea* leaf.

Egg production in this study ranged from 57.92-70.77%, consistent with the findings of [16] for laying hens fed pandan and lead tree leaves. In contrast, our egg production was lower than the range reported by [17] (75.1–93.4%). Interestingly, our production rates were also considerably lower than those observed by [18], who observed remarkably high hen-day production values of 83.86% in control groups and up to 94.29% in hens supplemented with Nutricell Eggstra (vitamin $D_3$ enriched with canthaxanthin). This disparity might

be attributed to differences in hen genetics, age, management conditions, or the potent effects of concentrated vitamin $D_3$ and canthaxanthin supplementation compared to our plant-based approach. Regarding yolk color, the values observed in this study were similar to those reported by [16] (13.96-14.65) and higher than those reported by [19] (6.30-7.40) and [17] (10.10-11.20). This indicates that *T. gigantea* serves as an effective natural pigment source, enhancing yolk visual quality without the need for synthetic supplementation.

**Table 3.** The effect of supplementing ketum ayam leaves in layer hen feed on egg quality.

| Parameters | *T. gigantea* leaf | | | | SEM |
|---|---|---|---|---|---|
| | (Control) | 1 % | 2 % | 3 % | |
| Egg weight (g) | 56.74$^{C}$ | 64.55$^{A}$ | 67.25$^{A}$ | 61.09$^{B}$ | 1.288 |
| Yolk weight (g) | 15.62$^{C}$ | 17.53$^{A}$ | 17.90$^{A}$ | 16.43$^{B}$ | 0.271 |
| Shell weight (g) | 7.95$^{B}$ | 9.29$^{A}$ | 9.67$^{A}$ | 8.52$^{B}$ | 0.225 |
| Haugh unit | 82.20$^{C}$ | 95.86$^{B}$ | 104.38$^{A}$ | 89.46$^{B}$ | 2.338 |
| Albumin height (mm) | 7.36$^{C}$ | 9.48$^{B}$ | 10.93$^{A}$ | 8.59$^{C}$ | 0.519 |
| Strength of the eggshell (N) | 35.10$^{C}$ | 46.87$^{B}$ | 56.07$^{A}$ | 42.08$^{B}$ | 2.973 |
| Thickness of the eggshell (mm) | 0.435$^{C}$ | 0.463$^{B}$ | 0.493$^{A}$ | 0.443$^{B}$ | 0.008 |
| Yolk height (mm) | 17.69$^{C}$ | 19.10$^{B}$ | 20.15$^{A}$ | 18.68$^{B}$ | 0.214 |
| Yolk width | 38.92$^{C}$ | 41.39$^{A}$ | 42.54$^{A}$ | 39.86$^{B}$ | 0.9706 |
| Yolk index | 0.4425$^{D}$ | 0.4904$^{B}$ | 0.5079$^{A}$ | 0.4624$^{C}$ | 0.006 |
| Yolk color | 12.99$^{B}$ | 14.28$^{A}$ | 14.67$^{A}$ | 13.59$^{B}$ | 0.255 |

$^{A, B, C}$ = The averages in the same row within the same list, marked with different letters, are significantly different ($P<0.01$). SEM = Standard error of the mean

The improvement in egg production and yolk color in hens supplemented with *T. gigantea* leaf powder may be attributed to the presence of various bioactive compounds in *T. gigantea* leaves, such as saponins and phenolic compounds, which have beneficial biological properties [20]. Phenolic compounds carvacrol and thymol are known for their strong antioxidant properties and antimicrobial activity against pathogens such as *Salmonella typhimurium, Escherichia coli, Staphylococcus aureus*, and *Staphylococcus epidermidis* [19]. Additionally, essential oils derived from plants have been reported to stimulate digestive enzyme activity and enhance immune responses in poultry [21], and the reduction in the prevalence of pathogenic bacteria such as *Salmonella typhimurium, Escherichia coli, and Staphylococcus spp*. in poultry production systems leads to improved gut health and more efficient nutrient utilization [22]. However, this evidence is based on general findings across various plant species, and such effects have not been specifically confirmed in *T. gigantea*. Moreover, *T. gigantea* leaves contain lutein and zeaxanthin, which are key carotenoids responsible for yolk pigmentation [23]. These compounds are likely the primary contributors to the enhanced yolk color in hens fed with *T. gigantea* leaf supplements.

Supplementation of *T. gigantea* leaf powder in laying hen diets has demonstrated positive effects on both production performance and egg quality, with the 2% supplementation level yielding optimal results across almost all parameters studied. The observed reduction in feed intake coupled with increased egg production reflects enhanced feed utilization efficiency, as evidenced by improved feed conversion ratio (FCR) and reduced feed per dozen eggs (FDE). In quail, a 15% inclusion of leaf meal optimized growth and peak egg production without compromising feed conversion efficiency. [24]

Nutritional Composition and Bioactive Compounds

The leaves of *T. gigantea*, also known as "Madre de Agua," contain essential nutritional components, specifically ash (18.07%), crude protein (15.80%), crude fat (1.15%), crude fiber (15.42%), calcium (4.70%), and total phosphorus (0.32%) [25]. Additionally, *T. gigantea* leaves contain total phenolic compounds of approximately 50.312 mg gallic acid equivalent per gram of extract (mg GAE/g extract) [26]. *T. gigantea* is rich in antioxidants, particularly phenolic compounds and flavonoids, which play a crucial role in preventing oxidative stress and promoting the overall health of poultry. These compounds also help improve the quality of meat and eggs by reducing lipid oxidation and extending shelf life [20]. Besides antioxidants, *T. gigantea*

contains other bioactive compounds including terpenoids, polypeptides, lectins, and essential oils, which play roles in stimulating digestion and promoting animal growth [27]. The increase in Haugh unit values in experimental groups receiving *T. gigantea* leaf powder supplementation aligns with the antioxidant properties of this plant. Obianwuna et al. (2022) reported that plant-derived antioxidants can be absorbed into eggs and help extend shelf life [28]. The phytochemicals in *T. gigantea* leaves may help prevent the denaturation of proteins in egg albumen, particularly ovomucin, a primary glycoprotein responsible for the structural integrity of egg white. When ovomucin remains stable, it increases egg-white viscosity and height, reflected in higher Haugh unit values.

Several research studies support that phenolic compounds can bind to proteins through non-covalent interactions, such as hydrogen bonds, hydrophobic interactions, and van der Waals forces, thereby maintaining protein integrity and enhancing stability under various conditions [29]. This is consistent with research by [30], which demonstrated that hydrogen bonds between phenolic compounds and proteins can help preserve protein structure; the strength of these interactions depends on pH, temperature, and the structure of both the protein and phenolic compounds. Although this study did not directly measure immune parameters, the improved production efficiency and egg quality may be linked to the overall health status of laying hens. Abd El-Hack et al (2020) reported that plants containing phytochemicals can stimulate the immune system of poultry and reduce inflammation in the digestive tract, leading to improved nutrient absorption and increased productivity [31]. This may be another factor explaining the positive effects of *T. gigantea* leaf powder supplementation in laying hen diets.

## 4. Conclusions

Supplementation of *T. gigantea* leaf powder in laying hen diets demonstrated positive effects on both production performance and egg quality. Among the tested levels, 2% supplementation yielded the most consistent improvements across parameters, indicating it as the optimal inclusion level. However, the results also suggest that supplementation levels up to 3% can be applied without adverse effects, representing a practical upper limit for dietary inclusion. The observed reduction in feed intake coupled with increased egg production reflects enhanced feed utilization efficiency, as evidenced by improved feed conversion ratio (FCR) and reduced feed per dozen eggs (FDE).

## 5. Acknowledgments

The researcher would like to express sincere gratitude to the Animal Science and Livestock Business Program, Faculty of Science, Technology, and Agriculture, Yala Rajabhat University, and the Faculty of Science and Technology, Prince of Songkla University, Pattani Campus, for providing the facilities and support for conducting this experiment.

**Author Contributions:** Conceptualization, J.N. and B.M.; methodology, J.N. and B.M.; validation, S.H. and F.B.; formal analysis, J.N. and B.M.; investigation, S.H. and F.B.; resources, B.M.; data curation, J.N. and B.M.; writing—original draft preparation, J.N., B.M. and A.J.; writing—review and editing, A.J. and B.M.; visualization, S.H. and F.B.; supervision, B.M.; project administration, B.M. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

[1] Abuan, A. G.; Balba, C. M.; Nonan, L. G., Jr.; Gripo, C. U.; Paguia, H. M.; Rodis, G. J.; Balba, J. M. Agronomic performance of Madre de Agua (*T. gigantea* Nees) under upland area in Abucay, Bataan. *Agric. Sci.* **2022**, *4*, 24–28. https://doi.org/10.30560/as.v4n2p24

[2] Libatique, F. O. R. Growth performance, blood dynamics and sensory characteristics of broilers fed with Madre de Agua (*Trichanthera gigantea*) leaf meal. *J. Emerg. Res. Agric. Fish. For.* **2021**, *2*, 1–12. https://www.researchgate.net/profile/Freddie-Libatique/publication/353973141

[3] Alagawany, M.; Elnesr, S. S.; Farag, M. R.; Tiwari, R.; Yatoo, M. I.; Karthik, K.; Michalak, I.; Dhama, K. Nutritional significance of amino acids, vitamins and minerals as nutraceuticals in poultry production and health—A comprehensive review. *Vet. Q.* **2021**, *41*, 1–29. https://doi.org/10.1080/01652176.2020.1857887

[4] Li, J.; Chang, X.; Chen, X.; Ma, R.; Qi, R.; Liu, W.; Li, Y.; Wan, Y.; Qiu, Q.; Shao, Q.; Liu, A.; Zhan, K. Effects of green tea powder on production performance, egg quality, and blood biochemical parameters in laying hens. *Poult. Sci.* **2023**, *102*, 102924. https://doi.org/10.1016/j.psj.2023.102924

[5] Roberts, J. R. Factors affecting egg internal quality and egg shell quality in laying hens. *J. Poult. Sci.* **2004**, *41*, 161–177. https://doi.org/10.2141/jpsa.41.161

[6] Nhan, N. T. H.; Preston, T. R.; Dolberg, F. Use of *T. gigantea* leaf meal and fresh leaves as livestock feed. In *Proceedings of the National Seminar-Workshop on Sustainable Livestock Production Using Local Feed Resources*, 10–14 September 1996. https://www.fao.org/4/ac151e/AC151E09.htm.

[7] Lacayanga, C. D. Effects of different levels of Madre de agua, lead tree and horseradish fresh leaf as partial replacement of feeds on egg production performance of mallard duck. *Int. J. Sci. Basic Appl. Res.* **2015**, *24*, 71–85.

[8] Bejar, F. R. Effects of *T. gigantea* leaf meal on the growth and production of quails supplemented with Aloe vera extract and acid cheese whey. *Online J. Anim. Feed Res.* **2017**, *7*, 138–144.

[9] Paguia, H. M.; Paguia, R. Q.; Peralta, R. A.; Esaga, T.; Balba, C. M.; Corpuz, M. N. C. Effects of fermented Madre de Agua leaf meal (*Trichanthera gigantea*) on growth performance of heritage free-range chicken (*Gallus domesticus* Linn.). *GPH-Int. J. Agric. Res.* **2024**, *7*, 43–50. https://doi.org/10.5281/zenodo.10892139

[10] Prasertsan, S.; Sajjakulnukit, B. Biomass and biogas energy in Thailand: Potential, opportunity and barriers. *Renewable Energy* **2006**, *31*, 599–610. https://doi.org/10.1016/j.renene.2005.08.006

[11] Punjam, T.; Tongsiri, S.; Promya, J.; Kongsombat, W.; Chitmanat, C. Effects of dietary fermented mulberry leaves on growth performance, carcass traits, muscle composition, and innate immune responses of juvenile Nile tilapia (*Oreochromis niloticus*). *ASEAN J. Sci. Technol. Rep.* **2026**, *29*(2). https://doi.org/10.55164/ajstr.v29i2.260518

[12] Nalinanon, W.; Lerdsuwan, S.; Pisuttharachai, D. Effects of yeast-fermented *Acacia mangium* leaf meal on growth performance of climbing perch (*Anabas testudineus*). *ASEAN J. Sci. Technol. Rep.* **2022**, *25*(4). https://doi.org/10.55164/ajstr.v25i4.247547

[13] Ardiarini, N. R.; Lase, Y. A. Supplementation of herbals on the production performance and gastrointestinal health of layer hens. *BIO Web Conf.* **2021**, *33*, 04002. https://doi.org/10.1051/bioconf/20213304002

[14] Nasarudin, N. A.; Hasan, S.; Foo, D. C. Y. The utilisation and feasibility study of solid waste, palm kernel cake, and *Trichantera gigantea* (Ketum Ayam) as animal feed for broiler. *J. Constr. Dev. Ctries.* **2024**, *4* (2). https://doi.org/10.15282/construction.v4i2.10677

[15] SAS Institute Inc. *SAS*; SAS Institute Inc.: Cary, NC, USA, 2025.

[16] Tongdonkham, S.; Chedeng, S.; Morlor, A. Supplementation of *Leucaena leucocephala* and *Pandanus amaryllifolius* Roxb. in laying diet on performance and egg quality. *J. Agric. Res. Ext.* **2018**, *35*, 538–544.

[17] Gül, M.; Yörük, M. A.; Hayirli, A.; Turgut, L.; Karaoğlu, M. Effects of additives on laying performance and egg quality of hens fed a high level of common vetch seed (*Vicia sativa*) during the peak period. *J. Appl. Poult. Res.* **2005**, *14*, 217–225. https://doi.org/10.1093/japr/14.2.217

[18] Yusuf, G. M.; Sumiati; Mutia, R.; Wardani, W. W.; Akbar, I.; Putri, N. D. S. Performance, egg quality, bone health, and immunity assessments of Lohmann laying hens supplemented with vitamin $D_3$ in the diet. *Trop. Anim. Sci. J.* **2023**, *46*, 461–470. https://doi.org/10.5398/tasj.2023.46.4.461

[19] Radwan, N. L.; Hassan, R. A.; Qota, E. M.; Fayek, H. M. Effect of natural antioxidant on oxidative stability of eggs and productive and reproductive performance of laying hens. *Int. J. Poult. Sci.* **2008**, *7*, 134–150. https://doi.org/10.3923/ijps.2008.134.150

[20] Rosales, M. *T. gigantea* (Humboldt and Bonpland.) Nees: Review. *Livest. Res. Rural Dev.* **1997**, *9*, 1–15. https://www.lrrd.org/lrrd9/4/mauro942.htm.

[21] Brenes, A.; Roura, E. Essential Oils in Poultry Nutrition: Main Effects and Modes of Action. *Anim. Feed Sci. Technol.* **2010**, *158*, 1–14. https://doi.org/10.1016/j.anifeedsci.2010.03.007

[22] Suresh, G.; Das, R. K.; Kaur Brar, S.; Rouissi, T.; Avalos Ramirez, A.; Chorfi, Y.; Godbout, S. Alternatives to Antibiotics in Poultry Feed: Molecular Perspectives. *Crit. Rev. Microbiol.* **2018**, *44*, 318–335. https://doi.org/10.1080/1040841X.2017.1373062

[23] Aguillón-Páez, Y. J.; Díaz, G. J. Lutein and Zeaxanthin Content in 21 Plant Species from a Very Humid Premontane Forest in Colombia Palatable for Free-Range Laying Hens. *Plants* **2023**, *12*, 3484. https://doi.org/10.3390/plants12193484

[24] Nasarudin, M. A. S.; Abd Razak, A. S.; Mohamad Termizi, A. Z. A.; Hairolnizam, N. F. A.; Amalina, F.; Sulaiman, S.; Ab Hamid, M. R.; Samat, N. Alternative Plant Protein Sources *T. gigantea* (Ketum Ayam) for Poultry Feed: A Review. *Construction* **2024**, *4*(2), 238–243. https://doi.org/10.15282/construction.v4i2.1067

[25] Corpuz, M. G. N. Madre de Agua (*Trichanthera gigantea*) Leaves and Rice (*Oryza sativa* L.) Bran as Organic Feeds for Duck (*Anas platyrhynchos*). *Int. J. Sci. Acad. Res.* **2025**, *6*, 9220–9231.

[26] Mahazir, N. N. B. *Deciphering the Immunomodulatory and Growth Performance Effects of T. gigantea Extract Adjuvanted Chitosan in Broiler Chicken*; Ph.D. Dissertation, Universiti Malaysia Kelantan, 2023.

[27] Marcos, M. J. L.; Sumalbag, J. G.; Cauilan, J. D. Histological Profile of Jejunum and Liver of Mallard Duck Fed with Madre de Agua (*Trichanthera gigantea*) Leaf Meal. *Int. J. Biosci.* **2024**, *25*, 249–258. https://doi.org/10.12692/ijb/25.2.249-258

[28] Obianwuna, U. E.; Oleforuh-Okoleh, V. U.; Wang, J.; Zhang, H. J.; Qi, G. H.; Qiu, K.; Wu, S. G. Potential Implications of Natural Antioxidants of Plant Origin on Oxidative Stability of Chicken Albumen during Storage: A Review. *Antioxidants* **2022**, *11*, 630. https://doi.org/10.3390/antiox11040630

[29] Yilmaz, H.; Gultekin Subasi, B.; Celebioglu, H. U.; Ozdal, T.; Capanoglu, E. Chemistry of Protein–Phenolic Interactions toward the Microbiota and Microbial Infections. *Front. Nutr.* **2022**, *9*, 914118. https://doi.org/10.3389/fnut.2022.914118

[30] Xiao, Y.; Ahmad, T.; Belwal, T.; Aadil, R. M.; Siddique, M. A Review on Protein-Based Nanocarriers for Polyphenols: Interaction and Stabilization Mechanisms. *Food Innov. Adv.* **2023**, *2*, 193–202. https://doi.org/10.48130/FIA-2023-0021

[31] Abd El-Hack, M. E.; Alagawany, M.; Abdel-Moneim, A. E.; Mohammed, N. G.; Khafaga, A. F.; Bin-Jumah, M.; Othman, S. I.; Allam, A. A.; Elnesr, S. S. Cinnamon (*Cinnamomum zeylanicum*) Oil as a Potential Alternative to Antibiotics in Poultry. *Antibiotics* **2020**, *9*, 210. https://doi.org/10.3390/antibiotics9050210