

Research article

Effects of Fresh Ivy Gourd Leaves (*Coccinia grandis* (L.) Voigt) Added to Concentrate Diets on Production and Egg Quality of Kabinburi Egg Duck of 21–32 Weeks Old

Wiwat Waramit and Tipwadee Prapaiwong*

Department of Animal Production Technology, Faculty of Agro – Industrial Technology, Rajamangala University of Technology Tawan – ok, Chanthaburi Campus, Chanthaburi, Thailand

Received: 22 March 2024, Revised: 6 February 2025, Accepted: 10 March 2025, Published: 2 September 2025

Abstract

This study aimed to investigate the effects of the addition of fresh ivy gourd leaves in the diet on the production and egg quality of Kabinburi egg ducks that were 21-32 weeks old and weighed $1,476.30 \pm 25.80$ g. A total of 120 female Kabinburi egg ducks were maintained in litter cages; each measuring 1×1 duck. The treatment included the addition of fresh ivy gourd leaves at 0, 5 and 10% in concentrate diets. A completely randomized design was used in this study. The production performance and egg quality of the Kabinburi egg ducks of 21-32 weeks old were evaluated. The addition of fresh ivy gourd leaves to the diet had no significant impact on the production performance and quality of the eggs ($p > 0.05$), except for the egg mass (g) and yolk color. The egg mass (g) tended to show significant differences ($p = 0.08$) between the treatment groups when compared with the control group, while a significant increase ($p < 0.05$) in yolk color was observed when 10% fresh ivy gourd leaves were added. An increase in the level of the fresh ivy gourd leaves resulted in a linear increase in egg mass (g) and yolk color ($p < 0.05$). The addition of 10% of fresh ivy gourd leaves increased the egg mass (g) and yolk color but did not improve the production performance, production, physical appearance, and quality of Kabinburi egg duck.

Keywords: fresh ivy gourd leaves; production; egg quality; Kabinburi egg duck

1. Introduction

Ducks are one of the most widely domesticated economic animals worldwide, and the objective is to make them readily available for consumption as meat and eggs. Currently, duck farming has become more commercial, and certain meat duck breeds have become more popular than in the past as they have been developed and are in demand by consumers (Chumpawadee et al., 2018). The main area of duck meat production is in Asia such as Myanmar, China, Bangladesh, Vietnam, India, and Indonesia, produce more than 80% of worldwide duck meat (FAO, 2021), followed by Europe, primarily France, Germany,

*Corresponding author: E-mail: tipwadee_pr@rmutto.ac.th
<https://doi.org/10.55003/cast.2025.262609>

Copyright © 2024 by King Mongkut's Institute of Technology Ladkrabang, Thailand. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Hungary, and the UK, and followed by North America (FAO, 2021). Duck production has received enormous interest because it produces a higher income than other poultry species due to their higher feed conversion ratios (FCR) (El-Soukkary et al., 2005). Ducks can be reared under various climatic and nutritional conditions, and they are resistant to common diseases. They can be fed on a wide variety of foods (Al-Obaidi & Al-Shadeedi, 2016). Moreover, ducks can provide palatable and quality meat while producing a large number of eggs in a short time despite receiving low quality ingredients (Basha et al., 2016).

The demand for duck meat, duck eggs, and related products is increasing yearly (Fouad et al., 2018). Especially, the Kabinburi egg duck, one of the modern meat type ducks that is very popular in Thailand. According to the Department of Livestock Development (2007) reported that the Kabinburi egg duck has a scientific name *Anas platyrhynchos* which is an outlandish purebred duck that has been researched, developed, and bred from Barbary ducks from France since 1991. At present, Thai farmers are very interested in raising this duck breed because it is easy to raise, fast growing, and can be sold in a short period of 10-12 weeks. It has thin skin and is muscular. Its red muscle, are low in fat and low in cholesterol, making its meat healthy to consume. In addition, the adult weight of the male is between 5,000-6,000 g. The female weight when mature is between 2,600-2,800 g. Eggs start at 5-7 months of age, producing yields of 150-180 eggs per year. The egg laying age is 1-2 years.

Currently, animal feed raw materials are more expensive. As a result, the cost of animal production increases while animal farmers suffer losses and lower profits. Pawariya & Jheeba (2015) reported that the main duck production costs were feed costs, accounting for 68.4% of farmer outlays. At the same time, animal product prices have not kept up with the higher feed costs. Whether small or large producers, animal farmers must find ways to reduce the cost of producing the animals. The principle of reducing feed costs is to reduce the price of feed formula while maintaining the nutritional value of the feed formula (Chumpawadee et al., 2018). To minimize feed costs, alternative feed ingredients should be sought to replace conventional feed sources (Abro et al., 2020). Therefore, feed raw materials that are readily available and locally available should be sourced to enable farmers to reduce the costs of animal production.

Ivy gourd (*Coccinea grandis* Voigt), also known as Tamlueng, is a plant in the ivy family that is common in Thailand. Ivy gourds, which are considered a potent natural medicine, grows in tropical areas from Africa to Australia (Van Breugel, 2020). In addition, Khatun et al. (2012) indicated that chemical composition of ivy gourd was crude protein 15%, water soluble protein 11.25%, lipid 4.0%, carbohydrates 12.62%, potassium 3.38 mg/100 g, sodium 0.95 mg/100 g, calcium 3.79 mg/100 g, phosphorous 1.15 mg/100 g, iron 2.23 mg/100 g, β - carotene 70.05 mg/100 g, and total phenol 61.92 mg/100 g. Moreover, Hussain et al. (2010) reported that the ivy gourd had antioxidant, anti-diabetic, anti-bacterial, hepatoprotective, anti-inflammatory, hypolipidemic, anti-tussive activities, and antinociceptive properties. The ivy gourd plant was revealed to contain phytochemicals or herbal medicinal compounds such as saponins, terpenoids, glycosides, tannins, and flavonoids (Sargunam, 2017). While, it contains a high amount of β -carotene and a good quantity of complex carbohydrates, vitamins B, minerals, and fiber, it is a valuable source of nutrition (Gunjan et al., 2010). Interestingly, small-scale farmers use fresh ivy gourd plants as indigenous poultry feed. However, there have been no trials of using ivy gourd plant as an animal feed. Therefore, the objective of this study was to investigate the effect of adding fresh ivy gourd leaves in diet on the production and egg quality of Kabinburi egg duck at 21-32 weeks of age.

2. Materials and Methods

2.1 Location of the research

The study was conducted at the poultry farm in the Department of Animal Production Technology, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan – ok, Chanthaburi Campus, Thailand.

2.2 Animals and treatments

One hundred and twenty young stage Kabinburi egg ducks, weighing $1,476.30 \pm 25.80$ g were used in the study with adaptation period of 14 days and a study period of 84 days. The study comprised three treatments and four replications (ten ducks per replication). The treatment included the adding fresh ivy gourd leaves at 0, 5, and 10% in concentrate diets.

2.3 Preparation of feed and feeding

Fresh ivy gourd leaves from local natural area, which were about 3 months of age, were received from farmers. Additionally, preparation fresh ivy gourd leaves, including both sprouts and stems, were picked. Then, contaminants, e.g., grass, leaves of other plants, dry ivy gourd leaves, very old leaves, or leaves infected by insects were removed from the good quality leaves. After that, they were cleaned with water and dried in the air. Next, the leaves were ground and fresh weight of the ground leaves were mixed with the duck at the required amount for each treatment during the egg production stage. Mixing of the feeds was done once every week to avoid the use of additional preservatives and to increase the feed palatability. As for the feeding method, the ducks were fed the same amount as small farmers usually feed their ducks, and the ducks receive the fresh gourds in the amount specified in each treatment of concentrated feed in the morning and the afternoon, while the experimental ducks received *ad libitum* water. The feed ingredients and nutritional content are presented in Table 1.

2.4 Data collections

At the start of the experiment, Kabinburi egg ducks were weighed every week to measure average daily gain. Feed intake was measured daily, and the feed conversion ratio was calculated by dividing feed consumption/individual/day by egg mass. Survival rates (%) were calculated as: number of ducks surviving x 100/initial number of ducks. The feed cost per dozen eggs (Baht) was calculated by feed cost (Baht/kg) x (feed intake/dozen eggs).

Egg production data were collected every day from week twenty-one to thirty-two for egg production (%), which was calculated based on the number of eggs produced per day divided by the number of ducks multiplied by 100%. Egg quality was determined from egg samples collected every week of the experiment.

Egg quality, expressed as eggshell weight, yolk weight, and albumen weight were measured by weighing the eggs (g) using digital scales, while the Haugh unit (HU) was measured (Silversides & Villeneuve, 1994) using the mathematical model $HU = 100 \log (H - 1.7W^{0.37} + 7.57)$ where H is the albumen width, and W is the egg weight. Yolk color was measured using a yolk color fan with a scale of 1-15. Finally, the eggshell weight ratio (%), yolk weight ratio (%), and albumen weight ratio (%) were calculated as follows:

Eggshell weight ratio (%) = (eggshell weight / egg weight) x 100

Yolk weight ratio (%) = (yolk weight / egg weight) x100

Albumen weight ratio (%) = (albumen weight / egg weight) x100

2.5 Data analysis

All data were analyzed using a Completely Randomized Design (CRD). Data were analyzed using the model $Y_{ij} = \mu + M_i + \epsilon_{ij}$, where Y_{ij} = observation from animal j , receiving diet i ; μ , the overall mean, M_i , the mean effect of treatment ($i = 1,2,3,4,5,6$), A_j , the effect of animal ($j = 1,2,3,4,5$), and ϵ_{ij} , the residual effect. Duncan's new multiple range test (Steel & Torrie, 1980) and orthogonal polynomial contrasts were used to determine the effects of fresh ivy gourd leaf levels. All analyses were done with the statistical analysis system (SAS, 2012). Differences were significant at $p < 0.05$ and trends were declared at $p > 0.05 - p < 0.10$.

3. Results and Discussion

The effect of adding fresh ivy gourd leaves on the production and egg quality of Kabinburi egg duck at 21-32 weeks of age showed that the feed ingredients and nutritional content of the concentrate and fresh ivy gourd leaves can be seen in Table 1.

The feed nutritional content, presented in Table 1, is similar to the findings of Susanti et al. (2025) who reported that protein and metabolizable energy in feed had a balance around $24.19 \pm 4.11\%$ and 2,500 - 2,700 kcal calories, respectively. Moreover, Fouad et al. (2018) indicated that optimal crude protein and metabolizable energy levels for egg type ducks were 17% and 2,500 kcal/kg of the diet, respectively. In our study, the three feeds contained more than enough metabolism energy value, with all of them above the minimum requirements (3,522.46-3,612.73 kcal/kg), while the protein, crude fat, and crude fiber were 23.79-24.65, 3.11-3.72 and 2.62-3.68%, respectively. The three feeds were close to the dietary requirements for laying ducks. Therefore, this study showed that the laying ducks were fed with an appropriately nutritious diet.

The addition of fresh ivy gourd leave had no significant effect on production performance, including average daily gain (g/d), average daily feed intake (g/head/d), feed conversion ratio, survival rates (%), egg production (%) and feed cost per dozen eggs (Baht) ($p > 0.05$) (Table 2). The production performance of Kabinburi egg ducks of 21-32 weeks of age is presented in Table 2. The results showed that the addition of fresh ivy gourd leaves had no significant effect on average daily gain, feed consumption, feed conversion, and egg production ($p > 0.05$). Therefore, the added fresh ivy gourd leaves did not increase the nutrient digestibility and egg production performance.

The feed intake of the control group was the highest, but there were no differences between the treatment groups. However, it can be seen that the feed intake increased when the ducks were on a formula high protein diet. This was consistent with Roy et al. (1994), who conducted an experiment on Peking ducks aged 4-8, and found that ducks in the low protein group had lower feed intake than the high protein group. An animal's growth rate is influenced by many factors including feed intake and digestive efficiency. The results showed that the growth rate of the control group was higher than that of the treatment group; however, no statistical difference ($p > 0.05$) was observed. This was consistent with the findings of Wang et al. (2022) on the Cherry Valley duck, who found that the ducks fed

Table 1. Composition of feed ingredient and fresh ivy gourd leaves in Kabinburi egg duck concentration diet

Feed Ingredient	Level of Fresh Ivy Gourd Leaves (%)			Nutritional Content of Fresh Ivy Gourd Leaves
	0	5	10	
Yellow maize	40	40	40	
Broken-milled rice	20.5	15.5	10.5	
Rice bran	9	9	9	
Soybean oil	1.5	1.5	1.5	
Soybean meal	10	10	10	
Fish meal	10	10	10	
Oyster shell	4	4	4	
Di-calcium phosphate	2	2	2	
Vitamin premix	0.5	0.5	0.5	
L-Lysine	2	2	2	
Salt	0.5	0.5	0.5	
Total	100	100	100	
Nutrient contents (dry matter):				
Dry matter	93.45	94.23	94.80	91.07
Ash	3.15	3.32	3.87	13.25
Crude protein	24.65	23.99	23.79	19.56
Crude fiber	2.62	2.97	3.68	10.78
Crude fat	3.72	3.40	3.11	2.15
Nitrogen free extract	65.86	66.32	65.55	-
Metabolizable energy (kcal/kg) ¹	3,612.73	3,580.07	3,522.46	-

¹Metabolizable energy was calculated according to formula by Bolton (1967) as follows $40.81 \times \{0.87 \times [\text{crude protein} + 2.25 \text{ crude fat} + \text{nitrogen-free extract}] + 2.5\}$.

Table 2. Production performance of Kabinburi egg duck of 21-32 weeks of age when added fresh ivy gourd leaves (%)

Items	Level of Fresh Ivy Gourd Leaves (%)			SEM ¹	P - value	Control vs Treatment	Treatment	
	0	5	10				L ²	Q ³
Initial weight (g)	1,474.40	1,466.10	1,488.50					
Final weight (g)	1,632.70	1,624.80	1,645.40					
Average daily gain (g/d)	2.06	2.05	2.04	0.23	0.99	0.95	0.91	0.94
Average daily feed intake, ADFI (g/head/d)	149.75	147.88	149.24	1.46	0.66	0.81	0.81	0.39
Feed conversion ratio	1.87	1.88	1.89	0.01	0.54	0.31	0.29	0.83
Survival rates (%)	97.5	100	97.5	2.04	0.62	0.63	1.00	0.34
Egg production (%)	88.14	87.67	87.17	0.53	0.46	0.29	0.22	0.98
Feed cost per dozen eggs (Baht)	26.82	26.46	26.35	0.35	0.64	0.52	0.83	0.36

¹SEM = Standard error mean

²L= linear

³Q= quadratic

higher protein diets had higher growth rates than those provided with low protein diets. The feed conversion ratio is an index indicating the efficiency of farming and management. The experiment was to investigate the effect of the addition of fresh ivy gourd leaves on the production and egg quality of Kabinburi egg duck at 21-32 weeks of age and included the study of the feed conversion ratio. The results suggested that giving different levels of fresh ivy gourd leaves had no statistical differences in the feed conversion ratios of the three treatment groups ($p>0.05$).

In addition, there were no significant differences among treatments when compared with the control group for the egg quality parameters of eggshell weight, egg weight, yolk weight, albumen weight, and Haugh unit ($p>0.05$) (Table 3). However, the addition of fresh ivy gourd leaves affected the egg mass (g) and yolk color. The egg mass (g) tended to show significant differences ($p=0.08$) between treatments when compared to the control group, while a significant increase ($p<0.05$) in yolk color was observed when adding 10% of fresh ivy gourd leaves. This was because fresh ivy gourd leaves contain high amounts of polyphenols and flavonoids, which had antioxidant properties (Aryal et al., 2019; Bisognin et al., 2019; Namchaw et al., 2021) and antimicrobial properties that affected various systems such as the immune system and reproductive system. As a result, the poultry was healthy, and egg production increased. The supplementation of laying hen diets with natural antioxidants was also found to improve egg quality and the antioxidant capacity of laying hens (Alagawany et al., 2015; Surai, 2016). Moreover, increasing the levels of the fresh ivy gourd leaves resulted in a linear increase in egg mass (g) and yolk color ($p<0.05$), as shown in Table 3.

Table 3. Eggs quality of Kabinburi egg duck of 21-32 weeks of age with fresh Ivy gourd leaves (%)

Items	Level of Fresh Ivy Gourd Leaves (%)			SEM ¹	P-value	Control vs Treatment	Treatment	
	0	5	10				L ²	Q ³
Eggshell weight (g)	11.56	10.91	10.95	0.56	0.67	0.38	0.46	0.63
Eggshell weight ratio (%)	18.01	16.99	16.90	0.79	0.57	0.31	0.35	0.65
Egg weight (g)	64.18	64.24	64.77	0.36	0.48	0.61	0.33	0.48
Egg mass (g)	52.67	53.26	53.81	0.36	0.13	0.08	0.05	0.96
Yolk weight (g)	34.02	34.25	34.74	0.32	0.32	0.26	0.15	0.75
Yolk weight ratio (%)	52.96	53.39	53.65	0.61	0.72	0.47	0.44	0.91
Albumen weight (g)	23.59	23.69	24.89	0.51	0.19	0.29	0.10	0.40
Albumen weight ratio (%)	36.72	36.92	38.43	0.81	0.31	0.36	0.17	0.52
Yolk color (from Roche yolk color fan)	10.49 ^b	12.04 ^a	12.36 ^a	0.44	<0.05	<0.05	<0.05	0.28
Haugh unit (HU)	89.71	89.29	88.50	0.75	0.53	0.39	0.28	0.84

¹/SEM = Standard error mean

²/L= linear

³/Q= quadratic

The results of egg production in this study were 87.17-88.14%, which was higher than that reported by Henrik & Marhayani (2020), who indicated that on average a female duck had an ability of egg production in the range of 26-74%. Nurjannah et al. (2017) stated that high egg production efficiency was due to the feed intake at an optimal level according to nutritional requirement standards. The survival rate in the three feeds was high (97.5-100%), this may be because, in this experiment, the ducks were already mature and ready to produce eggs at 21 weeks of age. Moreover, the high survival rate was also likely due to plant antioxidants in the feed from the leaves. The antioxidants have the potential to prevent cell degeneration, which affects the maintenance of the health and performance of the poultry. A robust immune system is essential for poultry to be resistant to disease and growth in different environmental conditions (Kabir, 2025). The cost of egg production during the experimental period (weeks 21-32) showed that the feed cost for producing twelve eggs was not statistically different ($p>0.05$).

The statistical results in Table 3 showed that feeding fresh ivy gourd leaves had no significant effect on egg quality except for egg mass (g) and yolk color. The range of eggshell weights produced was between 10.91-11.56 g. This value was greater than the eggshell weight range reported by Simanjuntak et al. (2013), which was 7.05-7.40 g. Generally, eggshell weights were 5-6 g (Lokaewmanee, 2014). While the eggshell weight ratio in this study was higher than that of Lokaewmanee (2014), who reported that eggshells were found to be 10-11% of the egg's weight. Egg weight averaged 64.40 g, which was small according to Thai Agricultural Standard (2012) where small duck eggs weighed between 60-65 g. Similarly, Abraham & Ravindran (2009) mentioned that the average weight of duck eggs that are maintained in semi-intensive management system ranged between 68.74-72.74 g. Therefore, the weight of duck eggs in this study was slightly lower than that range. In addition, egg weight is affected by the size of the egg, albumen weight, egg yolk weight, physiological state, climate, feed, nutrients, and other factors (Wolc et al., 2012; Al-Obaidi & Al-Shadeedi, 2016). However, Gonzalez et al. (1999) reported that high weight eggs tended to have the lowest hatchability. Besides, modulation of the cholesterol content in eggs and egg quality as a result of improving productive performance was reported (Abdel-Wareth & Lohakare, 2020; Vlaicu & Panaite, 2022). This corresponds to the possibility of enhancing the egg quality of laying hens by means of utilizing products that exhibit antioxidant properties and are able to contribute to maintenance of the oxido-redox balance, thereby reducing the effect of oxidation on egg quality and degradation of eggs (Oueslati et al., 2020).

The treatments did not affect the yolk weight, albumen weight, albumen weight ratio, and Haugh unit (HU) in this study. The yolk weight, yolk weight ratio, albumen weight, and albumen weight ratio were 34.02-34.74 g, 52.96-53.65%, 23.59-24.89 g, and 36.72-38.43%, respectively. In addition, Mori et al. (2020) reported that genetic factors had more effect on yolk weight. However, North & Bell (1990) found that the albumen weight and yolk weight were affected by the quality of the seeds and ration given. In addition, Purwantini (2013) indicated that factor that affects egg yolk weight is the nutrients in the feed. The feed nutrients being at an optimal level for the needs of ducks produce a standard egg weight. The Haugh unit (HU) in our results (Table 3) ranged from 88.50-89.71. Haugh unit values are calculated from the egg white height and weight, and the values represent the freshness of the eggs. Therefore, a good quality egg should have a Haugh unit in the range of 72-100 (Keener et al., 2006). The HU values in this study included the eggs were of good quality. These HU values were similar to the results of Stadelman & Cotteril (1995), who reported that the HU values for duck eggs of good quality were greater than 75, and eggs that were damaged had Haugh units lower than 50. According to Purnamaningsih (2010) and Rahayu et al. (2020), the HU is influenced by the protein in feed. The

concentrates in this study were of high protein content. Therefore, it seemed that higher protein in the feed increased HU values. However, the HU value was also influenced by the strain of poultry, storage temperature, age of poultry, and egg age. Stadelman & Cotterilo (1995) reported that Haugh units and albumen height were decreased with the extended storage periods and high storage temperature.

The results of this study indicated that the higher levels of fresh ivy gourd leaves improved egg mass and egg yolk color. Increasing the levels of the fresh ivy gourd leaves resulted in a linear increase in egg mass (g) and yolk color ($p < 0.05$). The addition of 10% of fresh ivy gourd leaves increased the egg mass (g) and egg yolk color. The egg mass in the treatment that received fresh ivy gourd leaves had the highest protein levels. When ducks are fed a diet higher in protein than their nutritional requirements for sustenance, they produce higher quality eggs. Therefore, the egg mass of the treatment was higher than the control group.

Moreover, the yolk color in this experiment was between 10.49-12.36. Similarly, Sun et al. (2019) reported that yolk color had a normal range of 11.75-12.45. In addition, supplementing fresh ivy gourd leaves at the 10% level with concentrated feed resulted in the highest egg yolk color (linear; $p < 0.05$). Based on the results of Marusich & Bauernfeind (1970), pigments received could be accumulated in different parts of a poultry's body, producing a color (pigment) from yellow to red-orange. When poultry receives pigments, it accumulates as a pigment on the skin or egg yolk. Hence, the duck eggs with orange yolk were probably due to the yolk being high in carotenoids and xanthophyll (Salawati, 2020). The use of dietary carotenoids as additives in poultry feed increases the yellow-orange color of poultry skin and egg yolk (Moreno et al., 2020). According to Karadas et al. (2006), carotenoids, which are in the form of carotene and xanthophyll, can affect yolk color. This carotenoid pigment is beneficial for health because it has antioxidant activity (Rohaeni et al., 2021). Fresh ivy gourd leaves, which have a high level of β -carotene was 70.05 mg/100 g (Hussain et al., 2010), can influence egg yolk color.

4. Conclusions

The fresh ivy gourd leaves, a local plant of Thailand, were used in this study. The leaves displayed the ability to affect eggs quality. However, the leaves did not affect the production of Kabinburi egg ducks at 21-32 weeks of age. Supplementation with fresh ivy gourd leaves at 10% with concentrated feed was the best feed mix because it produced the highest egg mass and yolk color.

5. Acknowledgements

The authors thank the Rajamangala University of Technology Tawan – ok, for funding. Special thanks to the Department of Animal Production Technology, Faculty of Agro-Industrial Technology, for providing the place and necessary facilities.

6. Conflicts of Interest

The authors declare no conflict of interest with respect to the research, authorships, and/or publication of this article.

ORCID

Tipwadee Prapaiwong  <https://orcid.org/0000-0002-4001-3493>

References

- Abdel-Wareth, A. A. A., & Lohakare, J. D. (2020). Productive performance, egg quality, nutrients digestibility, and physiological response of bovans brown hens fed various dietary inclusion levels of peppermint oil. *Animal Feed Science and Technology*, 267, Article 114554. <https://doi.org/10.1016/j.anifeedsci.2020.114554>
- Abraham, J., & Ravindran, R. (2009). Studies on the Aroor system of sustainable duck rearing in Kerala, India. *International Journal of Poultry Science*, 8(8), 804-807.
- Abro, Z., Kassie, M., Tanga, C., Beesigamukama, D., & Diiro, G. (2020). Socio-economic and environmental implications of replacing conventional poultry feed with insect-based feed in Kenya. *Journal of Cleaner Production*, 265, Article 121871. <https://doi.org/10.1016/j.jclepro.2020.121871>
- Al-Obaidi, F. A., & Al-Shadeedi, S. M. J. (2016). Comparison study of egg morphology, component and chemical composition of Mallard duck and domestic Peking duck. *Journal of Bio Innovation*, 5(4), 555-562.
- Alagawany, M. M., Farag, M. R., Dhama, K., Abd El-Hack, M. E., Tiwari, R., & Alam, G. M. (2015). Mechanisms and beneficial applications of resveratrol as feed additive in animal and poultry nutrition: A review. *International Journal of Pharmacology*, 11(3), 213-221. <https://doi.org/10.3923/ijp.2015.213.221>
- Aryal, S., Baniya, M. K., Danekhu, K., Kunwar, P., Gurung, R., & Koirala, N. (2019). Total phenolic content, flavonoid content and antioxidant potential of wild vegetables from western Nepal. *Plants*, 8(4), Article 96. <https://doi.org/10.3390/plants8040096>
- Basha, H. A., Abd el Naby, W. S. H., & Heikal, H. S. M. (2016). Genetic diversity and phylogenetic relationship among three duck breeds and geese using RAPD markers. *Advances in Animal and Veterinary Sciences*, 4(4), 462-467. <https://doi.org/10.14737/journal.aavs/2016/4.9.462.467>
- Bisognin, M. B., Pias, O. H. D. C., Vian, A. L., Basso, C. J., & Santi, A. L. (2019). Variabilidade no espaçamento de sementes reduz a produtividade de feijão-comum. [Seed spacing variability reduces common bean yield]. *Pesquisa Agropecuária Tropical*, 49, Article e55134. <https://doi.org/10.1590/1983-40632019v49n55134.2>
- Bolton, W. (1967). *Poultry nutrition*. MAFF Bulletin No.174. HMSO.
- Chumpawadee, S., Saenthaweesuk, N., Prasertwit, S., & Thaseengam, S. (2018). Effect of protein levels in fermented complete feed on growth performance and carcass characteristic in barbery duck. *Prawarun Agricultural Journal*, 15(1), 123-129.
- Department of Livestock Development. (2007) *Raising Kabinburi Exotic Ducks*. 5th ed. Agricultural Cooperative Society of Thailand Co., Ltd. Printing House. (in Thai)
- El-Soukkary, F. A, Mohamed, H. M., Dawood, A. A., & Abd-El Sayed, S. Y. (2005). Physico-chemical, microbiological and lipid characteristics of duck meat. *Minufiya Journal of Agricultural Research*, 30, 527-548.
- FAO. (2021). *Crops and livestock products: Ducks and meat, ducks*. <http://www.fao.org/faostat/en/#data/QCL>
- Fouad, A. M., Ruan, D., Wang, S., Chen, W., Xia, W., & Zheng, C. (2018). Nutritional requirements of meat-type and egg-type ducks: what do we know. *Journal of Animal Science and Biotechnology*, 9, Article 1. <https://doi.org/10.1186/s40104-017-0217-x>
- Gonzalez, A., Satterlee, D. G., Moharer, F., & Cadd, G. G. (1999). Factors affecting ostrich egg hatchability. *Poultry Science*, 78(9), 1257-1262. <https://doi.org/10.1093/ps/78.9.1257>
- Gunjan, M., Jana, G. K., Jha, A. K., & Mishra, U. (2010). Pharmacognostic and antihyperglycemic study of *Coccinia indica*. *International Journal of Phytomedicine*, 2(1), 36-40.

- Henrik, & Marhayani. (2020). Egg production and quality of Magelang duck, Mojosari duck, and their reciprocal crosses. *Indonesian Journal of Animal Science*, 30(3), 180-183. <https://doi.org/10.21776/ub.jiip.2020.030.03.01>
- Hussain, A., Wahab, S., Zarin, I., & Hussain, S. (2010). Antibacterial activity of the leaves of *Coccinia indica* (W. and A) Wof India. *Advances in Biological Research*, 4(5), 241-248.
- Kabir, S. M. L. (2025). Dietary probiotics in poultry: a game-changer for growth, immunity, and microbiota balance. *Asian Journal of Medical and Biological Research*, 11(1), 1-4. <https://doi.org/10.3329/ajmbr.v11i1.79146>
- Karadas, F., Grammenidis, E., Surai, P. F., Acamovic, T., & Sparks, N. H. C. (2006). Effects of carotenoids from lucerne, marigold and tomato on egg yolk pigmentation and carotenoid composition. *British Poultry Science*, 47(5), 561-566. <https://doi.org/10.1080/00071660600962976>
- Keener, K. M., McAvoy, K. C., Foegeding, J. B., Curtis, P. A., Anderson, K. E., Osborne, J. A., & Bush, D. J. (2006). Effect of testing temperature on internal egg quality measurements. *Poultry Science*, 85(3), 550-555. <https://doi.org/10.1093/ps/85.3.550>
- Khatun, S., Pervin, F., Karim, M. R., Ashraduzzaman, M., & Rosma, A. (2012). Phytochemical screening and antimicrobial activity of *Coccinia cordifolia* L. plant. *Pakistan Journal of Pharmaceutical Sciences*, 25(4), 757-761.
- Lokaewmanee, K. (2014). Factors influencing egg quality. *Kasetsart Extension Journal*, 60(2), 1-8.
- Marusich, W. L., & Bauernfeind, J. C. (1970). Oxycarotenoids in poultry pigmentation: 2 broiler studies. *Poultry Science*, 49(6), 1566-1579. <https://doi.org/10.3382/ps.0491566>
- Moreno, J. A., Díaz-Gómez, J., Fuentes-Font, L., Angulo, E., Gosálvez, L. F., Sandmann, G., Portero-Otin, M., Capell, T., Zhu, C., Christou, P., & Nogareda, C. (2020). Poultry diets containing (keto) carotenoid-enriched maize improve egg yolk color and maintain quality. *Animal Feed Science and Technology*, 260, Article 114334. <https://doi.org/10.1016/j.anifeedsci.2019.114334>
- Mori, H., Takaya, M., Nishimura, K., & Goto, T. (2020). Breed and feed affect amino acid contents of egg yolk and eggshell color in chickens. *Poultry Science*, 99(1), 172-178. <https://doi.org/10.3382/ps/pez557>
- Namchaiw, P., Jaisin, Y., Niwaspragrit, C., Malaniyom, K., Auvuchanon, A., & Ratanachamngong, P. (2021). The leaf extract of *Coccinia grandis* (L.) Voigt accelerated *in vitro* wound healing by reducing oxidative stress injury. *Oxidative Medicine and Cellular Longevity*, Article 3963510. <https://doi.org/10.1155/2021/3963510>
- North, M. O., & Bell, D. D. (1990). *Commercial chicken production manual*. The Van Nostrand Reinhold Publishing.
- Nurjannah, Yanto, S., & Patang. (2017). Utilization of golden snail (*Pomacea canaliculate* L.) and waste crab shell (*Portunus pelagicus*) to animal feed for increase the production of egg's duck. *Jurnal Pendidikan Teknologi Pertanian*, 3, 137-147.
- Oueslati, K., Ribeiro, B., Chavatte, D., Alleno, C., & Bouvet, R. (2020). Positive impact of prebiotics and antioxidants on egg quality at the end of the laying hen production cycle. In: *26th world's poultry congress, abstracts selected in 2020* (p. 145). <https://hal.science/hal-04213764v1>
- Pawariya, V., & Jheeba, S. S. (2015). Economic analysis of costs-return, income and employment in poultry enterprise in Jaipur District of Rajasthan State. *International Journal of Agricultural Science and Research*, 5(1), 73-80.
- Purnamaningsih, A. (2010). Effects of golden snail (*Pomacea canaliculate* L.) inclusion in the ration on the duck egg quality. Faculty of Agriculture, Universitas Sebelas Maret.

- Purwantini, I. D. D. (2013). Produksi dan kualitas telur itik lokal di daerah sentra peternakan itik. [Production and quality of local ducks in ducks farming center area]. *Jurnal Pembangunan Pedesaan*, 13(1), 11-16.
- Rahayu, A., Ratnawati, S., Idayanti, R. W., Santoso, B., & Luthfiana, D. N. A. (2020). Bobot telur (Bt), haugh unit (Hu), indeks kuning telur (Ikt), dan kekentalan telur (Kt) padaitik magelang di dusun sempu, desa ngadirojo, kecamatan secang, kabupaten magelang. [Egg weight (EW), haugh unit (HU), egg yolk index (EYI), and egg consistency of Magelang ducks in Sempu Hamlet, Ngadirojo Village, Secang District, Magelang Regency]. *Conference of Applied Animal Science Proceeding Series*, 1(1), 172-177. <https://doi.org/10.25047/proc.anim.sci.2020.24>
- Rohaeni, E. S., Subhan, A., Hanifah, V. W., Bakrie, B., & Sumantri, I. (2021). Effects of feeding Alabio ducks with fresh golden snail on egg production and quality. *Journal of Hunan University Natural Sciences*, 48(10), 305-313.
- Roy, D. R., Ali, M. A., & Chowdhury, S. D. (1994). Effects of varying levels of dietary protein on the performance and production cost of white Peking ducklings. *Asian-Australasian Journal of Animal Sciences*, 7(2), 249-254.
- Salawati, E. (2020). Effects of seaweed in duck diet on yolk colour. *Agro Sain*, 8(1), 71-76.
- Sargunam, J. (2017). Ivy gourd – Medicinal and nutritional values. *International Journal of Current Research*, 9(3), 47604-47607.
- SAS. (2012). *Statistical analysis system, user's guide. Statistical version 9.0*. SAS Institute.
- Silversides, F. G., & Villeneuve, P. (1994). Is the haugh unit correction for egg weight valid for eggs stored at room temperature. *Poultry Science*, 73(1), 50-55. <https://doi.org/10.3382/ps.0730050>
- Simanjuntak, R., Santoso, U., & Akbarillah, T. (2013). Pengaruh pemberian tepung daun katuk (*Sauropus androgynus*) dalam ransum terhadap kualitas telur itik mojosar (*Anas javanica*). [Effect of leaf flour cinnamon (*Sauropus androgynus*) on the quality of duck egg rations Kirkcaldy (*Anas javanica*)]. *Jurnal Sain Peternakan Indonesia*, 8(1), 65-76.
- Stadelman, W. J., & Cotteril, O. J. (1995). *Egg Science and Technology*. 4th ed. The AVI Publishing Co. Inc.
- Steel, R. G. D., & Torrie, J. H. (1980). *Principles and procedures of statistics: A biometrical approach*. 2nd ed. McGraw-Hill.
- Sun, C., Liu, J., Yang, N., & Xu, G. (2019). Egg quality and egg albumen property of domestic chicken, duck, goose, turkey, quail, and pigeon. *Poultry Science*, 98(10), 4516-4521. <https://doi.org/10.3382/ps/pez259>
- Surai, P. F. (2016). Antioxidant systems in poultry biology: Superoxide dismutase. *Journal of Animal Research and Nutrition*, 1(1), Article 8. <https://doi.org/10.21767/2572-5459.100008>
- Susanti, R., Yuliana, E., & Dafip, M. (2025). Feed composition and nutrition affecting duck egg quality in central java intensive farming, Indonesia. *Jurnal Biodjati*, 10(1), 158-170. <https://doi.org/10.15575/biodjati.v10i1.34039>
- Thai Agricultural Standard. (2012). *Duck egg*. <https://faolex.fao.org/docs/pdf/tha166332.pdf>
- Van Breugel, M. (2020). *Pak tamlueng or ivy gourd: Natural medicine that literally grows like a weed*. <https://expatlifeinthailand.com/pak-tamlueng-or-ivy-gourd-natural-medicine-that-literally-grows-like-a-weed/>
- Vlaicu, P. A., & Panaite, T. D. (2022). Effect of dietary pumpkin (*Cucurbita moschata*) seed meal on layer performance and egg quality characteristics. *Animal Bioscience*, 35(2), 236-246. <https://doi.org/10.5713/ab.21.0044>
- Wang, C. K., Huang, Y. W., Chen, W. R., Xu, L. H., Xie, L. Q., Chen, Q. D., & He, G. J. (2022). Effects of different protein levels on growth performance, carcass

characteristics and blood parameters of cherry valley ducks. *Journal of Animal Veterinary Advances*, 12, 1605-1609.

Wolc, A., Arango, J., Settar, P., O'Sullivan, N. P., Olori, V. E., White, I. M. S., Hill, W. G., & Dekkers, J. C. M. (2012). Genetic parameters of egg defects and egg quality in layer chickens. *Poultry Science*, 91(6), 1292-1298. <https://doi.org/10.3382/ps.2011-02130>