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Effects of Noni Leaf Water Extract on Meat Quality and Blood Lipid Profile in Bali Ducks

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ABSTRACT

Bali duck meat is famous for its distinctive taste and texture, but it has a higher cholesterol content compared to other types of commercial ducks. To improve the quality of Bali duck meat, natural feed additives can be given. Noni water extract (NLE) has the potential as one of the natural feed additives. This study aims to evaluate the effect of NLE in drinking water as a natural feed additive on meat quality and blood lipid profiles in Bali ducks. This research method used a Completely Randomized Design, which was divided into three treatment groups; each treatment was repeated five times, with 10 day-old ducks (DOD) in each replication unit. A total of 150 one-day-old male ducklings with homogeneous body weight were used in this study. The control group (P0) received drinking water without NLE, while groups P1 and P2 were given NLE at doses of 2mL and 4mL in 100mL of drinking water. The variables studied were the physical quality of meat, chemical quality of meat, and the blood lipid profile of Bali ducks. The results showed that the addition of NLE at doses of 2mL and 4mL in 100mL of drinking water affected the physical quality of meat, which could reduce the percentage of cooking loss and improve the blood lipid profile of Bali ducks. This study shows that the addition of noni water extract (NLE) functions as an effective natural feed additive at doses of 2mL and 4mL in 100mL of drinking water because it has a positive effect on meat quality, especially in reducing the percentage of cooking loss and improving the blood lipid profile of Bali ducks.

Key words: Bali duck, Blood lipid profile, Cooking loss, Feed additive, Noni leaf extract.

INTRODUCTION

The demand for Bali duck (*Anas sp.*) meat in Bali, Indonesia, which is an international tourist destination, presents a challenge for duck farming in producing products with lower fat and cholesterol levels (Sedana et al. 2025). Bali duck meat is renowned for its distinctive taste and texture, however, it has a higher cholesterol content compared to other commercial duck breeds (Suhaemi et al. 2023). Reducing the cholesterol levels in Bali duck meat is crucial, given the increasing awareness of the health risks associated with high cholesterol consumption (Bidura et al. 2019). This creates a significant opportunity for farmers to produce healthier duck meat that is preferred by a market that increasingly prioritizes health (Nugmanova et al. 2024). Therefore, efforts to produce quality duck meat are a challenge for researchers. In the maintenance process, meat quality and blood lipid profile in ducks can be influenced by various factors, including feed, environmental management, and the use of natural additives.

Noni (*Morinda citrifolia*) contains various bioactive compounds, such as flavonoids, saponins, and alkaloids, which have the potential to improve animal health and product quality (Widjastuti et al. 2024). Several studies proved that noni extract exhibits anti-inflammatory and antibacterial effects, lowers cholesterol levels, and enhances lipid profiles in the body. Krauze et al. (2019) reported that the phytochemical compounds in noni fruit include polysaccharides, scopoletin, ascorbic acid, β-carotene, L-arginine, and proxeronine. Noni fruit contains active enzymes such as proxeronase and the alkaloid proxeronine, which can form the active compound xeronine in the body of poultry, thereby optimizing enzyme activity (Asiseh et al. 2020). Noni extract also contains bioactive compounds, such as antioxidants and anti-inflammatory agents, which can influence metabolism and animal health (Hou et al. 2025). Antioxidants can prevent the oxidation of lipids (LDL), thereby inhibiting the formation of oxidized LDL (Davies 2015; Ahmadi et al. 2022).

According to multiple prior investigations, noni extract has the potential to affect cholesterol levels, triglycerides, and the balance of other blood lipids, which

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in turn affects fat content and fat distribution in meat. Wardiny et al. (2020) explained that the supplementation of noni shoot leaf meal (*Morinda citrifolia*) in the diet can lower meat cholesterol levels and enhance the unsaturated fatty acid content in the meat of 12-week-old native chickens (Wardiny et al. 2020). The active compounds in noni fruit juice, such as steroids, can inhibit cholesterol absorption, thereby reducing blood cholesterol levels and fat content in meat (Widjastuti et al. 2024). A former study reported that administering noni fruit juice at a concentration of 0.3%, combined with palm sugar (*Arenga pinnata*) at 0.2–0.4% through drinking water, was effective in reducing total cholesterol, LDL, and triglyceride levels in the serum of broiler chickens (Adriani et al. 2015). Although noni leaf extract has been proven to have many benefits, some studies indicate potential side effects or limitations in using this extract in poultry feed. This suggests that there is a limitation to the effectiveness of using noni extract at high doses, which may not provide additional benefits and could even pose health risks to poultry if used in excessive amounts. The use of noni extract at high doses or in improper forms can potentially cause digestive disturbances in poultry, such as diarrhea or reduced appetite (Mohamad Shalan et al. 2017). Additionally, some phytochemical compounds in noni may interact with other components in the feed and affect the absorption of other nutrients (Li et al. 2025).

Although there have been many studies on the effects of noni leaf extract on various poultry species, there has been no study that specifically evaluates the use of noni leaf extract in bali ducks, especially regarding meat quality and blood lipid profiles at the age of 0-8 weeks. Therefore, this study was conducted to evaluate the effect of adding noni leaf water extract to drinking water at different levels on meat quality and blood lipid profiles of bali ducks.

MATERIALS AND METHODS

Ethics approval

All research procedures followed established ethical standards for animal research. The Animal Ethics Committee of the Faculty of Veterinary Medicine, Udayana University, Denpasar, Indonesia, approved this study under approval number B/237/UN.14.2.9/PT.01.04/2024.

Experimental design

Three treatment groups, each with five replicates, were randomly assigned 150 one-day-old male ducks with a uniform body weight of 63.64±2.55g. Ten male DODs of consistent weight were used for each replication. All DODs were placed in wire-floored colony battery cages, allowing droppings to fall directly below the cage. The cages were housed in a single building with a controlled temperature and continuous lighting provided throughout the day. The treatments included: The control group (P0) was provided with drinking water without NLE; the P1 treatment group was provided with drinking water containing 2mL of NLE, and the P2 treatment group was provided with drinking water containing 4mL of NLE.

The basic feed is commercial feed CP 707 produced by a Private Limited Company (Ltd.) Charoen Phokphand Tbk, Mojokerto, East Java, Indonesia, which is intended for broiler chickens aged 0-5 weeks, antibiotic-free, with isoenergetic composition of 2854.3kcal/kg and isoproteic composition of 17.89%, shown in Table 1. The feed was supplied in crumble form ad libitum, and drinking water was likewise available ad libitum and refilled daily.

Table 1: Nutrient content in feed

Nutrient		Treatment			Standards*
		P0	P1	P2	
Metabolizable Energy	(kcal/kg)	2854.3	2854.3	2854.3	min 2700
Crude protein	(%)	17.89	17.89	17.89	min 15.00
Crude fiber	(%)	7.4	7.4	7.4	7.0
Calcium	(%)	9.2	9.2	9.2	0.9-1.2
Phosphorus	(%)	0.62	0.62	0.62	0.6-1.0

*Indonesian National Standard (2018).

Sample collection procedure

Four ducks were randomly selected from each cage for slaughter. Before slaughtering, blood was collected from the pectoral vein (located beneath the wings) using a syringe (approximately 3mL). Blood samples were collected in tubes containing EDTA for blood lipid profile analysis.

Preparation of noni leaf extract

The noni leaves used were obtained from a noni plantation in Baturiti, Tabanan Regency, Bali Province, Indonesia. Before use, the leaves were cleaned to remove dirt, then ground and soaked in clean water. Noni leaf water extract was prepared by squeezing 1kg of noni leaves in 1 liter of clean water at a temperature of 28–31°C and a pH of 6.6–6.9. The extract was left at room temperature (21.8±1.4°C, humidity 61±9%) for 24 hours. The mixture was then filtered through a double layer of satin fabric and stored in a refrigerator. The noni leaf water extract had a shelf life of two days and was administered fresh via drinking water. To confirm the presence of active compounds in the noni leaf extract, spectrometric analysis was performed using UV-Vis Spectroscopy (Ultraviolet-Visible Spectroscopy). Spectrometric analysis of the extract under room conditions confirmed the presence of active compounds, including flavonoids, tannins, beta-carotene, and antioxidants. The concentrations of flavonoids, tannins, beta-carotene, and antioxidants in the extract were 177.71mg/100g, 548.78mg/100g, 2798.42mg/100g, and 31.95mg/L.

Observed parameters

The observed physical meat quality parameters included pH, water holding capacity, weep loss and cooking loss, using the methods described by (Nurussyifa et al. 2024). Chemical meat quality (moisture, ash, protein, and fat) was determined using the methods outlined by AOAC et al. (2012). Blood lipid profiles were analyzed using the methods described by Schumacher et al. (2022). Physical, chemical, and meat quality and blood lipid profile analyses were conducted when the Bali ducks reached eight weeks of age.

Statistical analysis

A one-way ANOVA was used to evaluate the data. To determine particular changes, Duncan's multiple range test was used if there were significant differences ($P<0.05$) among treatments. (Steel et al. 2015).

RESULTS AND DISCUSSION

The pH level of duck meat exhibited no significant difference (P>0.05) across treatments. The study's results indicated that the meat's pH remained within the normal range (Table 2). Feiner (2006) Indicated that the pH value of meat and meat products typically ranges from 4.6 to 6.4. Active compounds in NLE, such as flavonoids, saponins, and alkaloids, act as antioxidants and anti-inflammatories, so that they do not significantly affect the pH of the meat. According to Sanjaya, the addition of *Morinda citrifolia* leaf powder to commercial feed did not significantly affect the pH, tenderness, cooking loss, water content, and water holding capacity of quail meat (Coturnix-coturnix Japonica) (Sanjaya et al. 2019). This is in line with those who found no significant effect of noni extract on the pH of broiler meat (Sukoco et al. 2024).

Table 2: Physical meat quality of bali ducks at 8 weeks given with noni leaf water extract

Variable	Treatment			SEM[2)]
	P0	P1	P2	
pH	6.13[a1)]	6.29[a]	6.17[a]	0.11
Water holding capacity (%)	21.88[a]	21.34[a]	21.74[a]	0.30
Weep loss (%)	11.18[a]	12.98[b]	13.58[b]	0.39
Cooking loss (%)	41.26[a]	38.14[b]	38.72[b]	0.40

1) Different alphabets on the same line were significantly different (P<0.05); 2) Standard error of the treatment means.

The water holding capacity of meat treated with NLE P1 and P2 did not have a significant effect compared to the P0 control. The water holding capacity of bali duck meat ranged from 21.34-21.88%, indicating that the ability of meat to retain water is still within the normal range. Soeparno (2009) Stated that normal meat water holding capacity is around 20-60%. Although the water holding capacity produced in this study was still lower than the previous study, which stated the water holding capacity in commercial ducks was 36.54 (Muhlisin et al. 2013). Postmortem meat pH is known to be one of the important factors affecting water holding capacity (Soeparno 2009). This is in line with water holding capacity (Sukoco et al. 2024) who reported that noni extract did not affect the water holding capacity of broiler meat.

The addition of NLE to treatments P1 and P2 increased duck meat weep loss by 16.10 and 21.4% significantly (P<0.05) higher than the control treatment (P0). Weep loss reflects water loss during post-mortem, which is an important factor in meat quality. Noni leaf extract can cause changes in the structure of muscle cell membranes, which increases membrane permeability (Basar et al. 2010). This increases the release of water from muscle cells, which causes an increase in weep loss. In addition, creatine kinase enzyme activity can increase after slaughter, which can damage muscle structure, causing more water to be lost from muscle fibers (Gunya et al. 2025). Administration of noni leaf extract containing active compounds can affect muscle energy metabolism, potentially worsening the activity of this enzyme. Brossi et al. (2018) Stated that increased creatine kinase activity causes higher WP values in chicken breasts. Kayan et al. (2024) Stated that weep loss is the loss of meat weight for 24 hours post-mortem and is a continuous process involving the movement of water from myofibrils in muscle tissue. The decrease in water content in meat may also be related to the antioxidant compounds in noni leaf extract, which can break down ester bonds and reduce water content in meat (Adriana 2019).

The cooking loss values of bali duck meat treated with P1 and P2 were 7.51 and 6.15%, respectively, significantly (P<0.05) lower than bali duck meat treated with P0 seen in Fig. 1 Cooking loss is related to the loss of nutrients during the meat cooking process. The lower the cooking loss value, the less nutrient loss occurs in the meat. The decrease in cooking loss is influenced by the level of cell membrane damage, the amount of water lost from the meat, protein degradation and the ability of the meat to retain water (Mir et al. 2017). This decrease in cooking loss is related to the content of antioxidant compounds in noni leaf extract, such as flavonoids, saponins, and polyphenols, which can protect muscle fibers from excessive damage during cooking and help reduce oxidative damage. Tannin compounds in noni leaf extract, which are included in the phenolic group, have properties like alcohol and can bind water, so they often damage bacterial cell membranes (Mubarokah et al. 2023). The cooking loss value in this study was within the normal range, ranging from 38.14 to 41.26%. According to Cavalheiro, the cooking loss value of meat generally ranges from 15 to 40% (Cavalheiro et al. 2024).

The chemical quality of bali duck meat was unaffected by the addition of noni leaf water extract to drinking water (P >0.05) (Table 3). However, the fat content of the meat in the duck groups that received treatments P1 and P2, 9.9% and 4.46% respectively, was lower compared to treatment P0, but statistically not significant (P>0.05). This is likely because the feed given to ducks across all treatments was isoenergetic and isoproteic (Table 1). Additionally, the addition of noni leaf water extract did not affect the nutrient composition of the feed, even though the extract contains various phytochemical compounds such as polysaccharides, scopoletin, ascorbic acid, β-carotene, L-arginine, proxeronin, and proxeronine. The concentration of active compounds in the extract used may not have been high enough to significantly impact the chemical composition of bali duck meat. Previous studies stated that meat moisture and fat content are greatly influenced by feed nutrients and livestock age (Sudarmadji et al. 1996; Ding et al. 2024). Gultom found that adding bitter melon flour as a feed additive produced no differences in the physical and chemical quality of broiler meat (Gultom et al. 2023). The blood lipid profile of eight-week-old Bali ducks is shown in Table 4. The total serum cholesterol of Bali ducks in the P1 and P2 treatments was 8.19 and 18.02%, significantly (P<0.05) lower than in the P0 treatment. The triglyceride levels in P1 and P2 were 15.50 and 14.74%, respectively, significantly (P<0.05) lower than in P0. Total cholesterol and triglyceride levels in the serum of 8-week-old Bali ducks given NLE in drinking water in treatments P1 and P2 were lower compared to the control treatment P0. The decrease in total cholesterol and triglyceride levels is attributed to the compounds serotonin, saponins and β-carotene found in noni leaf extract. Serotonin in noni has

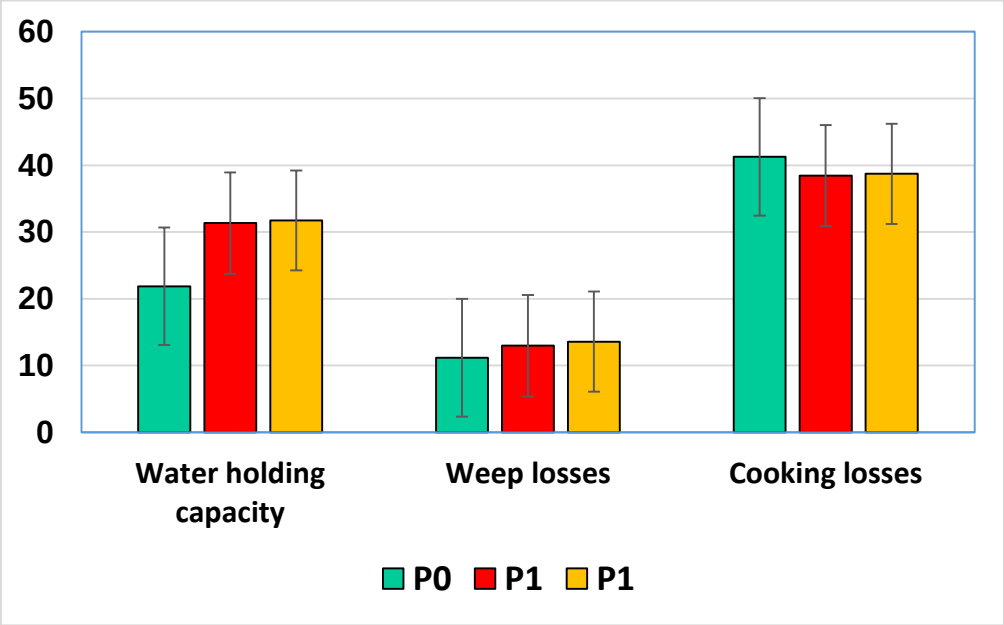

Fig. 1: Graph Physical Meat Quality of Eight-Week-Old Bali Ducks. P0: control group was provided with drinking water without NLE, P1: was provided with drinking water containing 2mL of NLE, P2: treatment group was provided with drinking water containing 4mL of NLE.

Table 3: Chemical meat quality of bali ducks at 8 weeks given noni leaf water extract

Variable	Treatment			SEM[2]
	P0	P1	P2	
Moisture (%)	78.13[a1)]	78.21[a]	78.84[a]	0.50
Ash (%)	1.19[a]	0.98[a]	0.99[a]	0.40
Protein (%)	16.93[a]	17.08[a]	17.25[a]	0.90
Fat (%)	2.02[a]	1.82[a]	1.93[a]	1.07

1) Different alphabets on the same line were significantly different (P<0.05); 2) Standard error of the treatment means.

Table 4: Blood lipid profile of bali ducks at 8 weeks given noni leaf water extract

Variable	Treatment			SEM[2]
	P0	P1	P2	
Total Cholesterol (mg/dl)	153.25[a1)]	140.70[b]	125.63[c]	3.41
Triglycerides (mg/dl)	157.40[a]	133.00[b]	134.20[b]	7.05
HDL (mg/dl)	90.40[a]	108.40[b]	111.50[b]	1.86
LDL (mg/dl)	53.70[a]	46.70[b]	46.20[b]	1.14

1) Different alphabets on the same line were significantly different (P<0.05); 2) Standard error of the treatment means.

antioxidant properties and can influence lipid metabolism by inhibiting cholesterol synthesis in the body. Serotonin can affect the activity of enzymes involved in lipid metabolism, such as HMG-CoA reductase, which plays a role in cholesterol synthesis. By inhibiting the activity of this enzyme, cholesterol production in the liver can decrease, ultimately leading to a reduction in blood cholesterol levels. According to Timilsena et al. (2023), saponins are thought to hinder the small intestine's ability to micellize cholesterol during digestion, which in turn reduces the amount of cholesterol that cells can absorb. Saponins are also thought to inhibit the absorption of cholesterol from the micelles and block the reabsorption of bile acids and cholesterol synthesis, as the interaction of saponins with bile acids forms large, insoluble mixed micelles that cannot be absorbed by the intestine and are excreted in the feces. Kurnia et al. (2021) Stated that the administration of micro-mineral solutions, vitamins, and noni juice can significantly reduce cholesterol and triglyceride levels in quail eggs. The reduction in cholesterol levels may also be due to the high content of beta-carotene and antioxidant compounds in the noni leaf extract (Calislar 2019).

HDL levels in P1 and P2 were 19.91 and 23.34%, significantly (P<0.05) higher than in P0, while LDL levels in P1 and P2 were 13.04 and 13.97%, significantly (P<0.05) lower than in P0. In Fig. 2, it can be seen that the HDL levels of ducks given noni leaf extract increased compared to the control group. Phytochemical compounds in noni leaf extract, such as flavonoids, have strong antioxidant properties. Antioxidants work by reducing LDL oxidation; by preventing LDL oxidation, the body stimulates increased HDL synthesis. According to previous reports (Bidura et al. 2017; Krauze et al. 2019; Bidura et al. 2020). Phytochemical compounds in herbal leaves are effective in increasing serum HDL levels in chickens and pigs.

This reduction in LDL levels is associated with the antioxidant activity of compounds such as saponins, which can prevent lipid oxidation. Saponins can affect the HMG-CoA reductase enzyme involved in cholesterol synthesis in the liver. The decrease in the activity of this enzyme can reduce cholesterol production in the liver and help lower LDL levels in the blood. These findings are in line with a former study, which showed that supplementation of 4.5% noni juice in drinking water for native chickens significantly reduced cholesterol levels and increased HDL levels, although it did not affect growth (Azi et al. 2023). The differences in results obtained may be due to variations in dosage, extract type, and the method of administering the herbal extract (Li et al. 2025).

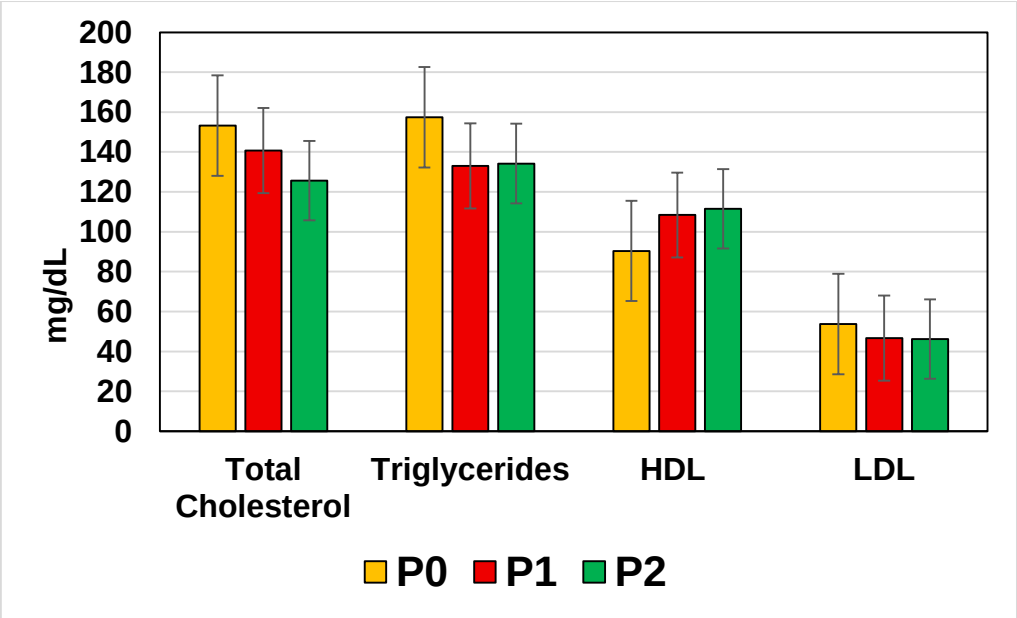

Fig. 2: Graph of Blood Lipid Profiles of Eight-Week-Old Bali Ducks. P0: control group was provided with drinking water without NLE, P1: was provided with drinking water containing 2mL of NLE, P2: treatment group was provided with drinking water containing 4mL of NLE.

Conclusion

The results of the study showed that the addition of noni water extract (NLE) functions as an effective natural feed additive at doses of 2mL and 4mL in 100mL of drinking water because it has a positive effect on meat quality, especially in reducing the percentage of cooking loss (CL) and improving the blood lipid profile of bali ducks. It is recommended to conduct further research by increasing the dose of noni water extract to improve the chemical quality of bali duck meat.

DECLARATIONS

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Data Availability: Data supporting this study are available from the corresponding author upon reasonable request.

Ethics Statement: This study was approved under approval number B/237/UN.14.2.9/PT.01.04/2024 by the Animal Ethics Committee of the Faculty of Veterinary Medicine, Udayana University.

Author's Contribution: DPMAC designed the experiment and prepared the manuscript; NWS performed the statistical analysis; and IGNGB created the illustrations.

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