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Blood Lipid Profiles of Male Local Bali Ducks Given Noni Fruit (*Morinda citrifolia* L.)

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Abstract

Duck meat production in Indonesia in 2022 reached 41,972.07 tons spread across various provinces (BPS, 2023). These data indicate that public interest in duck meat consumption continues to increase. However, duck meat is known to have a relatively high cholesterol content, requiring efforts to produce healthier meat products. One effort that can be made is feed supplementation with herbal ingredients, such as noni fruit (Morinda citrifolia L.). Noni is a plant that grows abundantly in Indonesia and has long been utilized by the Balinese people as a traditional drink (loloh) due to its antioxidant activity. Purpose: This study aimed to evaluate the effect of supplementing noni fruit crude ethanol extract on total blood cholesterol and triglyceride levels in male Bali ducks. Methodology: A total of 24 male ducks were used as test animals and were randomly divided into four treatment groups: Control (concentrate feed without noni fruit crude extract), P1 (feed supplemented with noni fruit crude extract at 3.7 g/duck/day), P2 (7.4 g/duck/day), and P3 (11.1 g/duck/day). Data on total cholesterol and triglyceride levels were analyzed using the One-Way ANOVA test. Results: Significant differences in blood triglyceride levels ($p < 0.05$) were observed between the control and treatment groups, as well as within the treatment groups before and after treatment. Meanwhile, total blood cholesterol levels showed no significant treatment effect across groups or treatments ($p > 0.05$). Conclusion: Thus, the administration of noni fruit crude ethanol extract (Morinda citrifolia L.) at the dosage used in this study significantly reduced triglyceride levels, but did not significantly affect total blood cholesterol levels in male ducks.

Keywords: Noni, Male Bali Duck, Total Cholesterol, Triglycerides

Introduction

Ducks are poultry whose meat and eggs can be utilized as sources of animal protein. Duck meat is relatively widely favored by the public, resulting in high duck meat production (Moirangthem et al., 2022; Damaziak et al., 2019). Based on statistical data, duck meat production in Indonesia in 2022 reached 41,972.07 tons, spread across various provinces. Although meat is a primary product of ducks, it has a drawback: a higher cholesterol content compared to chicken meat. Local duck meat contains higher cholesterol (ranging from 171–197 mg/100g) compared to chicken meat (100 mg/100g). Nutritional analyses report that duck meat contains approximately 5.71% fat and 0.06% cholesterol. To produce duck meat with lower cholesterol and fat content, dietary modifications through feed formulation are necessary.

Noni fruit (*Morinda citrifolia* L.) is one of Indonesia's native plants that is widely used for its therapeutic properties, including managing hypertension, diabetes, serving as a diuretic, and

treating roundworms. Pre-clinical studies on *Morinda citrifolia* L. extract demonstrated an ability to improve lipid profiles in mice by lowering total blood cholesterol, LDL, and triglyceride levels, while increasing HDL levels. This capability provides a positive impact by improving the aortic vascular histological structure (reducing tunica media thickening) in mice fed a high-fat diet (Indriawati et al., 2011).

However, most existing studies regarding the hypolipidemic potential of *Morinda citrifolia* have primarily focused on rodents or broiler chickens, leaving a lack of evidence regarding its application in male Bali ducks (*Anas* sp.). The hypolipidemic action of *Morinda citrifolia* is mainly attributed to its bioactive compounds, such as flavonoids, iridoids, and saponins (González-Castelazo et al., 2023). Flavonoids lower lipid levels by inhibiting key cholesterol synthesis enzymes like HMG-CoA reductase and enhancing fatty acid oxidation. Iridoids stimulate lipid catabolism and inhibit lipid accumulation via AMPK pathway activation, whereas saponins interfere with intestinal lipid absorption and facilitate bile acid excretion (Su et al., 2021). Clarifying these mechanisms in waterfowl is necessary to validate the natural feed additive's efficacy. Based on this background, this study was conducted to evaluate the effect of noni fruit crude ethanol extract on total blood cholesterol and triglyceride levels in male Bali ducks (*Anas* sp.).

Methods

Extraction

Noni fruit was extracted using 96% ethanol as a solvent via the maceration method for 24 hours. Prior to extraction, the size of the noni fruit was reduced by chopping/grinding.

Chemical Compound Identification

Compound identification was carried out for chemical classes including alkaloids, flavonoids, terpenoids, tannins, and saponins.

Preparation of Noni Fruit (*Morinda citrifolia* L.) Feed

Feed preparation was carried out by thoroughly mixing noni fruit crude extract with commercial duck concentrate feed.

Antihyperlipidemic Activity Assay

The test animals used were 24 male 12-week-old Bali ducks (*Anas* sp), obtained from a duck collector in Gianyar Regency. Acclimatization of the test animals was conducted for 1 week. The cages used were battery colony system cages made of bamboo slats, each measuring 80 cm in length, 60 cm in width, and 70 cm in height. Each cage compartment was equipped with feed and water containers. Each cage housed 1 duck. The experimental design and grouping were arranged as follows:

Table1. Determination of Test Animal Treatment Groups

No	Group	Treatment
1	Control	Given commercial concentrate feed without noni extract
2	Treatment I (P1)	Given feed supplemented with noni extract at a dose of 3.7 g/duck/day and feed ad libitum
3	Treatment II (P2)	Given feed supplemented with noni extract at a dose of 7.4 g/duck/day and feed ad libitum
4	Treatment III (P3)	Given feed supplemented with noni extract at a dose of 11.1 g/duck/day and feed ad libitum

For duck blood sampling, 10 mL of blood was drawn from the axillary vein using a syringe, placed into an Eppendorf tube, and centrifuged at 4000 rpm for 15 minutes to separate the serum. After centrifugation, the serum separated from blood components and formed the top layer (supernatant). The serum layer was harvested and carefully transferred to a new Eppendorf tube for further analysis. This study was approved by the ethics committee under certificate number 295/KE-PH-Lit1/V/2017. Data from lipid level measurements (Total Cholesterol and Triglycerides) were analyzed statistically using SPSS. Data were tested for normal distribution using the Shapiro-Wilk test and for homogeneity using Levene's test. If data distribution was normal and homogeneous ($p > 0.05$), the analysis was continued with parametric statistical tests using One-Way ANOVA. If data were not homogeneous and normal, the Kruskal-Wallis test was used. Further analysis was performed using the LSD post hoc test with a 95% confidence level ($p < 0.05$) to identify groups showing significant differences. A paired t-test was performed to determine differences between pre-test and post-test values within the same groups; differences were considered significant if $p < 0.05$. If data were non-normal, the Wilcoxon test was performed. *Morinda citrifolia* L. was considered to possess significant lipid-lowering activity if a statistically significant reduction ($p < 0.05$) in total cholesterol or triglyceride levels was observed in the treatment groups compared to the control group

Results and Discussion

The administration of noni fruit crude extract resulted in a significant reduction in blood triglyceride levels in male Bali ducks ($p < 0.05$). Significant differences in blood triglyceride levels were observed between the control and treatment groups at baseline, as well as within the treatment groups before and after treatment.

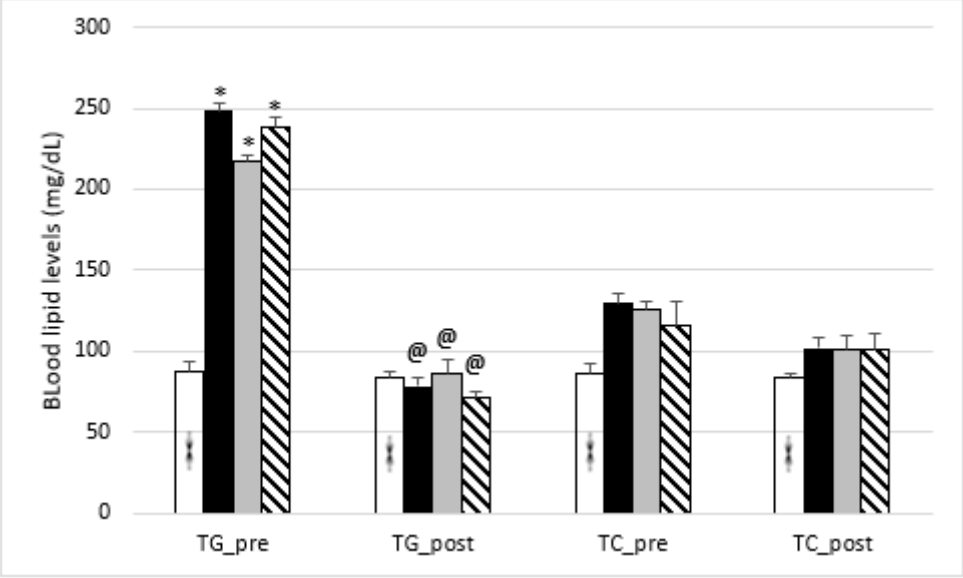

Fig 1. Blood lipid level of local duck, TG_pre: triglyceride before treatement; TG_post: triglyceride after treatement; TC_pre : total cholesterol before treatement; TC_post: total cholesterol after treatement; = control; = treatment I; = Ttreatment II; = treatment III; * = significantly different from the normal group; @= significantly different from the pre-treatment group. Fenita (2010) stated that feeding noni fruit to broiler chickens for 59 days at 0.75% reduced triglyceride levels to 104 mg/dL, at 1.5% to 94.12 mg/dL, at 2.25% to 89.4 mg/dL, and at 3% to 81.05 mg/dL compared to the control at 127.05 mg/dL ($p < 0.05$). The significant reduction in triglyceride levels in the treatment groups demonstrates the efficacy of

noni bioactive compounds. Conversely, for total blood cholesterol levels, there was no significant treatment effect between groups or across treatments ($p > 0.05$). While total cholesterol levels showed a slight downward trend in the treatment groups, the difference was not statistically significant compared to the control group.

In the present study, noni fruit extract exhibited a distinct, dose-dependent impact on lipid profiles. Treatment III (P3) achieved the most pronounced hypolipidemic response, yielding a 3.3-fold (~330%) reduction in blood triglyceride levels compared to the control group ($p < 0.05$). Conversely, total blood cholesterol levels exhibited a much more modest response, with treatments P1 to P3 reducing total cholesterol by only 0.05 to 0.1 times (5%–10%) relative to the control group, which was not statistically significant ($p > 0.05$). Biologically, these findings indicate that the bioactive components in noni fruit crude ethanol extract are particularly potent in suppressing hepatic lipogenesis and facilitating fatty acid clearance via AMPK activation pathways (Li et al., 2025; Zhao et al., 2021) whereas higher doses or prolonged administration may be necessary to elicit a statistically meaningful suppression of systemic cholesterol biosynthesis.

The findings of this study align with various reports demonstrating that noni (Morinda citrifolia) possesses hypolipidemic activity. Marros reported that noni extract administration at a dose of 8 mg/kg BW for 30 days reduced chicken cholesterol levels from 123 mg/dL to 107 mg/dL. Fenita (2010) also showed that noni fruit supplementation in broiler chickens for 59 days reduced blood cholesterol levels in a dose-dependent manner, with the largest decrease occurring at a 3% dose reaching 77.35 mg/dL compared to the control at 177.27 mg/dL. A more recent study by Krismiyanto et al. (2021) demonstrated that adding noni fruit extract to broiler chicken rations at a level of 0.12% significantly ($p < 0.05$) reduced cholesterol, triglyceride, and LDL levels while increasing HDL compared to the control group. Furthermore, Setiyono (2020) reported that supplementing noni leaf shoot meal in free-range local chickens produced meat with lower cholesterol content, accompanied by increased antioxidant status and unsaturated fatty acids. This effect is presumed to be related to the content of flavonoids, iridoids, and phenolic compounds capable of inhibiting lipid synthesis and enhancing cholesterol metabolism.

Based on those previous studies, the absence of a significant decrease in total cholesterol levels in male Bali ducks in this study was likely caused by the relatively low dosage of noni fruit extract, such that the active compound content received by test animals was insufficient to produce optimal hypocholesterolemic effects. Additionally, the shorter treatment duration compared to several previous studies could also influence the cholesterol-lowering response. Factors such as livestock species, lipid metabolism differences, and the preparation form of noni used (simplisia, meal, or extract) also potentially cause variations in treatment responses.

The decrease in total blood cholesterol tendency and triglyceride levels in ducks given ethanol extract of noni fruit (*Morinda citrifolia* L.) is suspected to be related to bioactive compounds in the form of flavonoids, alkaloids, terpenoids, and saponins working synergistically to improve lipid metabolism (Mandukhail et al., 2010; Zhou & Huang, 2024). Flavonoids contained in noni, such as quercetin, kaempferol, rutin, catechin, and hesperidin, are known to inhibit HMG-CoA reductase activity a key enzyme in cholesterol biosynthesis—thereby lowering blood cholesterol levels (Zhou & Huang, 2024). Furthermore, flavonoids can upregulate low-density lipoprotein (LDL) receptor expression, activate the AMP-activated protein kinase (AMPK) pathway, enhance fatty acid oxidation, and decrease hepatic triglyceride synthesis (Hou et al., 2025). The antioxidant activity of flavonoids also plays a role

in preventing lipid peroxidation, ensuring lipid metabolism runs more optimally and lowering dyslipidemia risk (Hou et al., 2025).

Saponin compounds in noni are known to bind cholesterol and bile acids in the intestine, inhibiting cholesterol absorption and increasing its excretion through feces (Mandukhail et al., 2010). Terpenoids, particularly iridoid groups which represent one of the primary bioactive compnents of noni, play a role in suppressing lipogenesis, enhancing fatty acid ß-oxidation, and helping maintain liver function vital for lipid metabolism (Zhou & Huang, 2024; Hou et al., 2025). Meanwhile, alkaloids are known to assist in reducing fat accumulation, inhibiting triglyceride formation, and increasing fatty acid utilization as an energy source, thus contributing to reduced blood lipid levels (Hou et al., 2025; Chen et al., 2022; Song & Jiang, 2017; Amssayef & Eddouks, 2023). Therefore, the combination of flavonoid, saponin, terpenoid, and alkaloid activities in noni ethanol extract is presumed to be the main factor driving reductions in total blood cholesterol and triglycerides in ducks through mechanisms of inhibiting lipid synthesis, reducing cholesterol absorption, and enhancing lipid metabolism and excretion (Mandukhail et al., 2010; Zhou & Huang, 2024).

Reductions in total blood cholesterol and triglycerides in ducks given noni fruit (*Morinda citrifolia* L.) ethanol extract indicate improvements in lipid metabolism that potentially affect fat deposition in body tissues, including meat. Physiologically, circulating triglycerides and cholesterol in the blood serve as primary sources for fat formation and storage in avian adipose and intramuscular tissues. Therefore, if noni extract can lower circulating triglyceride and cholesterol levels, the amount of lipid available for tissue storage also tends to decrease, potentially lowering fat and cholesterol content in duck meat. Flavonoids, saponins, terpenoids, and alkaloids present in noni are thought to play roles in inhibiting lipogenesis, increasing fatty acid oxidation, and reducing digestive tract lipid absorption, thereby suppressing tissue fat accumulation (Mandukhail et al., 2010; Zhou & Huang, 2024).

This assumption is strengthened by research showing that noni leaf supplementation in local chickens produced meat with lower cholesterol levels than control groups, indicating that improvements in blood lipid profiles can be followed by reduced lipid deposition in meat. Additionally, broiler chicken research reported that noni fruit extract administration lowered blood cholesterol, triglyceride, and LDL levels, correlated with overall lipid metabolism improvement (Krismiyanto et al., 2021; Santoso & Fenita, 2017; Ogbuewu & Mbajiorgu, 2024; Widjastuti et al., 2025). Thus, although meat lipid content was not directly measured in this study, the reductions in total blood cholesterol and triglycerides in ducks given noni extract serve as an indicator that the extract has potential to decrease fat deposition and meat lipid content though this assumption still requires confirmation through analysis of fat levels, cholesterol, and fatty acid profiles in duck meat tissues.

Despite these promising outcomes, several study limitations must be acknowledged. First, the parameter scope was limited to total blood cholesterol and triglyceride levels; broader lipid fractions such as high-density lipoprotein (HDL) and low-density lipoprotein (LDL) were not evaluated, nor were direct meat quality characteristics such as intramuscular fat content or fatty acid composition (Indriawati et al., 2011). Second, factors such as a relatively small sample size, the specific treatment duration, and the selected dosage range may have constrained the statistical power needed to detect subtle changes in total cholesterol parameters. Future research incorporating comprehensive lipid profiling, extended treatment durations, and direct tissue quality analyses is recommended to further clarify the physiological mechanism and practical applications of noni extract in poultry production.

Conclusion

In conclusion, the administration of noni fruit crude ethanol extract (*Morinda citrifolia* L.) at the dosage used in this study significantly reduced blood triglyceride levels, but did not significantly affect total blood cholesterol levels in male Bali ducks. Based on the findings, further investigation is suggested incorporating higher dosage levels and longer intervention durations of noni fruit (*Morinda citrifolia* L.) ethanol extract to determine the optimal dose- and time-dependent response on total blood cholesterol levels.

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