The Effect of *Kaempferia galanga* L. Extract on Blood Profile and Relative Weight of Visceral Organs Indonesian Native Chicken

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Abstract. This study investigated the effects of Kaempferia galanga L. supplementation on blood profiles and the relative weight of visceral organs in Indonesian native chickens. A total of 100 day-old chicks were assigned to a Completely Randomized Design with five dietary treatments: 0% (P0), 0.5% (P1), 1% (P2), 1.5% (P3), and 2% (P4), each with four replications of five birds. The extract was administered through feed from day 22 to 55. Data were analyzed using one-way ANOVA followed by Duncan's multiple range test ($p < 0.05$). The results showed that K. galanga L. significantly decreased blood cholesterol and triglyceride concentrations. Cholesterol levels declined from 191.22 mg/dL (P0) to 125.34 mg/dL (P3) and 128.38 mg/dL (P4), while triglycerides decreased from 97.13 mg/dL (P0) to 79.51 mg/dL (P3). LDL concentrations were also markedly reduced in treated groups (84.95–116.08 mg/dL) compared with the control (149.06 mg/dL). Although hemoglobin slightly decreased at the highest dose, plasma total protein increased at P4 (4.82 g/dL), suggesting enhanced protein metabolism. Relative organ weights indicated significant increases in pancreas and duodenum mass at P3, implying improved digestive capacity. In conclusion, dietary inclusion of K. galanga L. extract enhances lipid metabolism, lowers LDL and cholesterol, and supports digestive organ development, with the optimal effect observed at a 1.5% supplementation level.

1 Introduction

Indonesian native chicken is one of the leading commodities in the livestock industry, gaining increasing popularity among the public. This local chicken is widely favored for its unique meat quality, strong flavor, and consumer preference for traditional poultry products.

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However, the health challenges frequently encountered in its rearing process remain a major obstacle that affects production performance and overall productivity [1–3].

Digestive health is one of the most influential factors in the overall health and productivity of chickens. Efficient gastrointestinal function determines nutrient utilization, immune competence, and metabolic balance [4–6]. One natural ingredient with potential to improve chicken health is *Kaempferia galanga* L. extract, a phytogenic feed additive known for its antibacterial, antioxidant, and immunomodulatory effects. Adding *Kaempferia galanga* L. extract to livestock feed may support the balance of the chicken's digestive system, thereby improving nutrient absorption and strengthening the immune system [7–11].

The beneficial effects of *Kaempferia galanga* L. on blood metabolites and visceral organs can be attributed to its bioactive constituents, mainly flavonoids, phenolic compounds, and essential oils. Muzzazinah *et al.* [7] reported that the essential oils of Kaempferia galanga L. contain ethyl cinnamate and p-methoxycinnamate, compounds with strong antioxidant and lipid-modulating activity. These compounds may influence lipid metabolism by inhibiting cholesterol synthesis and enhancing fat utilization, thereby contributing to reduced blood cholesterol and triglyceride levels. In addition, phytogenic additives are known to improve intestinal morphology and function. Rafeeq *et al.* [8] demonstrated that dietary herbal extracts enhanced ileal histo-morphology and immune responses in broiler chickens, suggesting that such phytogenic compounds stimulate nutrient absorption and gut health.

Moreover, *Kaempferia galanga* L. has also been reported to reduce fat deposition and improve carcass quality in broilers [9]. These biological activities suggest its potential role in modulating blood metabolites and supporting organ development.

Moreover, *Kaempferia galanga* L. extract may also affect visceral organs, particularly the liver and heart, which are crucial for metabolism, detoxification, and overall health. Its bioactive components interact with metabolic and antioxidant pathways, which may lead to changes in the weight and function of these organs. Changes in the relative weight of the liver and heart, serve as physiological indicators of the internal organ response to dietary supplementation [12].

The blood profile of Indonesian native chickens is a reliable indicator of physiological and metabolic status [11]. By measuring hematological parameters such as hemoglobin, plasma protein, cholesterol, triglycerides, High-Density Lipoprotein (HDL), and Low-Density Lipoprotein (LDL), the present study evaluates the effects of *Kaempferia galanga* L. extract supplementation in feed on the health and productivity of Indonesian native chickens. The results are expected to clarify its potential as a natural feed additive to support sustainable native chicken production.

2 Materials and methods

This research has received ethical approval under permit number E.5.a/185/KEPK-UMM/VII/2024. The study used 100 Day-Old Chicks (DOC) of Indonesian native chickens reared for a 56-day experimental period. The equipment used included (120 × 60 × 40 cm), rice husks, lamps, feed containers, water drinkers, analytical scales, hanging scales, large basins, measuring cups, strainers, and freezers. The materials consisted of *Kaempferia galanga* L. extract, Indonesian native chickens, commercial feed (BR1 Wonokoyo), and drinking water.

The design consisted of five group and four replications for each treatment, with each replication consisting of five chickens [13–15]. All birds were reared under uniform management practices to minimize environmental variation. Chicks were housed in floor pens with rice husk litter at a stocking density of five birds per cage. Commercial starter and grower feed (BR1, Wonokoyo, Indonesia) and fresh drinking water were provided ad libitum.

Lighting and temperature followed standard native chicken management guidelines, with brooding temperatures maintained at 28–32 °C. Standard vaccination against Newcastle disease and infectious bursal disease was applied, and birds were routinely monitored.

The treatments consisted of five concentrations of *Kaempferia galanga* L. extract: P0 (0%), P1 (0.5%), P2 (1%), P3 (1.5%), and P4 (2%).

The extract was administered from day 22 to day 55 through feed supplementation. Samples were collected at 55 days by randomly selecting birds from each replication. The measured variables included hemoglobin, plasma protein, triglycerides, cholesterol, HDL, and LDL.

At 55 d of age, blood samples (2–3 mL) were collected from the brachial vein of two randomly selected birds per replication using sterile syringes and stored in EDTA tubes. Hemoglobin concentration was determined by the cyanmethemoglobin method, while plasma total protein was measured using the biuret method. Serum cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were analyzed using commercial enzymatic colorimetric kits (DiaSys, Germany) following the manufacturer's instructions. For visceral organ measurements, the birds were slaughtered, and the pancreas, duodenum, jejunum, and ileum were carefully excised, cleaned of digesta, and weighed using an analytical balance. The relative weight of each organ was calculated as the organ weight divided by live body weight, expressed as a percentage. These procedures provided standardized and reliable data for statistical analysis.

The data were analyzed using ANOVA, followed by Duncan's multiple range test when significant differences were detected [12].

3 Results and discussion

3.1 Relative weight of visceral organs

The following are the results of the relative visceral organ weight measurements for each treatment administered in the study shown in Table 1:

Table 1. Mean Relative Weights of Visceral Organs

Group	Pancreas weight (g)	Duodenum Weight (g)	Jejunum Weight (g)	Ileum Weight (g)
P0	1.68 ± 0.43	3.94 ± 2.44	8.48 ± 3.43	7.09 ± 1.26
P1	1.59 ± 0.38	3.96 ± 1.33	8.18 ± 2.13	6.52 ± 1.07
P2	1.72 ± 0.24	4.32 ± 0.56	7.17 ± 0.65	6.68 ± 1.10
P3	1.90 ± 0.48	5.04 ± 0.82	7.63 ± 1.09	6.94 ± 0.72
P4	1.80 ± 0.17	3.90 ± 0.63	7.15 ± 1.98	6.46 ± 1.03

Note: Values are presented as mean ± standard deviation (n = 10 per treatment). ANOVA results showed no significant differences ($P > 0.05$) among treatments for all variables. ns = not significant.

3.1.1 Pancreas weight

Table 1 showed the pancreas weight for each treatment, which exhibited slight variation. P0 had a mean pancreas weight of 1.68 ± 0.43 g, serving as the baseline value without the

addition of *Kaempferia galanga* L. extract. P1 showed a slight decrease to 1.59 ± 0.38 g. P2, P3, and P4 demonstrated a slight increase, with P3 having the highest pancreas weight at 1.90 ± 0.48 g. The increase in pancreas weight observed in P3, which received *Kaempferia galanga* L. extract, may indicate stimulation of higher digestive enzyme secretion due to the extract, suggesting enhanced digestive activity [22]. However, the differences between treatments were relatively small and did not show significant variation.

3.1.2 Duodenum weight

The duodenum weight in each treatment exhibited more noticeable variations. P0 had a duodenum weight of 3.94 ± 2.44 g, which was relatively high compared to the other treatments. P1 showed a slight increase to 3.96 ± 1.33 g. P2 and P4 recorded slightly lower values compared to P0 and P1, at 4.32 ± 0.56 g and 3.90 ± 0.63 g, respectively. P3 showed the highest duodenum weight, at 5.04 ± 0.82 g, indicating that the inclusion of *Kaempferia galanga* L. extract in the feed for this treatment enhanced the volume or size of the duodenum. This may be associated with increased digestive activity and nutrient absorption. The increase in duodenum weight in P3 could suggest that *Kaempferia galanga* L. extract positively stimulates the growth or enlargement of intestinal structures, potentially contributing to higher digestive efficiency [14].

3.1.3 Jejunum weight

The jejunum weight across the various treatments showed no significant differences. P0 had a jejunum weight of 8.48 ± 3.43 g, the highest among all treatments. P1 showed a decrease to 8.18 ± 2.13 g, while P2 recorded an even lower weight of 7.17 ± 0.65 g. P3 had a jejunum weight of 7.63 ± 1.09 g, slightly higher than P2. P4 showed the lowest value among all treatments, with a jejunum weight of 7.15 ± 1.98 g. The relatively small differences in jejunum weight between treatments suggest that *Kaempferia galanga* L. extract did not have a significant impact on the size or weight of the jejunum. Nevertheless, the reduction in jejunum weight observed in some groups (particularly P2 and P4) may reflect variations in nutrient absorption or digestive processes [28].

The absence of significant differences in jejunum weight among treatments suggests that *Kaempferia galanga* L. extract had a limited effect on this part of the small intestine. The jejunum is primarily responsible for nutrient absorption, particularly amino acids and carbohydrates, and its structural development is more strongly influenced by dietary protein levels rather than phytogenic additives [12]. Nastain et al. [12] demonstrated that protein content and enzyme supplementation exert a more direct effect on jejunal morphology and weight compared to herbal extracts. Similarly, Sutanto et al. [16] found that herbal supplementation in native chickens did not always result in morphological changes in the jejunum, indicating that the jejunum may be less responsive to phytobiotics. Thus, the lack of effect in the present study may be due to the stable role of the jejunum in nutrient absorption, which is not substantially altered by *Kaempferia galanga* L. supplementation.

3.1.4 Ileum weight

The ileum weight across treatments showed a general tendency to decrease. P0 had an ileum weight of 7.09 ± 1.26 g, the highest among all treatments. P1 showed a decrease to 6.52 ± 1.07 g, and P2 recorded an ileum weight of 6.68 ± 1.10 g, which was also slightly lower. P3 and P4 had almost similar ileum weights of 6.94 ± 0.72 g and 6.46 ± 1.03 g, respectively. The reduction in ileum weight observed in P1, P2, P3, and P4 compared to P0 suggests that *Kaempferia galanga* L. extract in the feed may be associated with structural

changes in the small intestine, although the differences were not very pronounced. The decrease in ileum weight may also reflect variations in nutrient absorption efficiency or changes in organ mass formation [16].

The non-significant differences in ileum weight among treatments indicate that *Kaempferia galanga* L. extract did not substantially affect the development of the distal small intestine. The ileum is mainly involved in bile salt and vitamin B12 absorption, and its growth is relatively stable across different dietary treatments [15]. A meta-analysis by Adli et al. [15] reported that herbal fermentation products exerted greater effects on proximal intestinal segments (duodenum and jejunum) than on the ileum. This may explain why significant changes were observed in the duodenum and pancreas in this study, but not in the ileum. Additionally, the antimicrobial properties of *Kaempferia galanga* L. may primarily act in the upper gastrointestinal tract, thereby exerting less influence on the ileum [8]. Therefore, the stable ileum weight across treatments is consistent with previous findings that distal intestinal segments are less responsive to herbal feed additives.

3.2 Blood profile

Several parameters were measured, including hemoglobin levels, total plasma protein, cholesterol, and triglycerides. The data obtained from different treatments revealed interesting variations, providing deeper insights into the effects of *Kaempferia galanga* L. extract on the metabolic health of chickens. The following are the measurement results for each biochemical parameter across the tested treatments (Table 2):

Table 2. Average Blood Profile

Group	Hemoglobin (g/dL)	Plasma Total Protein (g/dL)	Triglycerides (mg/dL)	Cholesterol (mg/dL)	HDL (mg/dL)	LDL (mg/dL)
P0	3.23 ± 0.55	4.90 ± 0.52	97.13 ± 11.23	191.22 ± 42.45 a	42.16 ± 7.34	149.06 ± 35.43b
P1	2.98 ± 0.69	4.22 ± 0.52	81.97 ± 2.99	162.84 ± 19.69ab	48.94 ± 9.94	113.90 ± 12.53 a
P2	3.08 ± 0.66	4.50 ± 0.20	88.52 ± 18.74	155.07 ± 5.09 ab	38.98 ± 5.08	116.08 ± 9.99 a
P3	3.21 ± 0.72	4.48 ± 0.33	79.51 ± 3.90	125.34 ± 13.97b	39.04 ± 9.30	86.35 ± 19.08 a
P4	2.88 ± 1.13	4.82 ± 0.50	81.15 ± 8.52	128.38 ± 20.13 b	43.43 ± 8.65	84.95 ± 19.08 a

Note: Hb = Hemoglobin (g/dL); TP = Total Protein (g/dL); Chol = Cholesterol (mg/dL); Trig = Triglycerides (mg/dL); HDL = High Density Lipoprotein (mg/dL); LDL = Low Density Lipoprotein (mg/dL). Values are presented as mean ± standard deviation (n = 10 per treatment). Different superscripts in the same row indicate significant differences ($P < 0.05$).

3.2.1 Hemoglobin (g/dL)

The hemoglobin values found in this study were within a relatively low range for chickens. The lower hemoglobin value in P4 (2.88 ± 1.13 g/dL) may indicate that the *Kaempferia galanga* L. extract in the feed for treatment P4 potentially had a reducing effect on hemoglobin levels. This decrease could be caused by various factors, such as impaired iron absorption (which plays a role in hemoglobin synthesis) or the effect of the galangal itself, which may influence blood metabolism [16]. The high variation in P4 (SD = 1.13 g/dL) also suggests instability in the animal's response to the treatment. The decrease in hemoglobin levels in P4 may need further analysis. It could be caused by disruptions in iron metabolism

or other factors related to the *Kaempferia galanga* L. extract treatment. Hemoglobin reduction should be closely monitored, as it can affect the oxygen transport capacity in the chicken's body.

3.2.2 Plasma Total protein (g/dL)

The plasma total protein in P4 was higher compared to the other treatments (4.82 ± 0.50 g/dL), which may indicate that *Kaempferia galanga* L. extract in the feed for this treatment has a positive effect on increasing plasma total protein. This increase in total protein may be related to the nutritional content of *Kaempferia galanga* L. extract, which can stimulate protein production in the chicken's body. Conversely, the decrease in P1 (4.22 ± 0.52 g/dL) suggests that this treatment may inhibit protein synthesis, possibly due to other factors such as reduced appetite or decreased feed quality. The increase in plasma total protein in P4 (which received a higher dose of *Kaempferia galanga* L. extract) indicates that the extract could support protein synthesis in the body. This may be related to the effects of *Kaempferia galanga* L. in enhancing digestive efficiency or improving protein absorption from the feed [17].

3.2.3 Triglycerides (mg/dL)

Similar to cholesterol, triglyceride levels were also higher in P0, which did not receive *Kaempferia galanga* L. extract. The decrease in triglycerides in P3 and P4 suggests that *Kaempferia galanga* L. extract may help regulate triglyceride levels in the blood. This supports the hypothesis that *Kaempferia galanga* L. extract has a positive effect on the lipid profile in chickens. The more significant decrease in triglycerides in P3 may indicate that the dose or form of the extract is more effective in reducing triglycerides compared to P4. The reduction in cholesterol and triglyceride levels in the blood in the treatment groups receiving *Kaempferia galanga* L. extract (P3 and P4) suggests that the extract may help regulate fat metabolism, reduce excessive blood lipids, and potentially improve heart health in chickens. This is important in the context of improving the quality of poultry products such as Indonesian native chicken, which may be more appealing to consumers with a better nutritional profile [9].

3.2.4 Cholesterol (mg/dL)

The cholesterol levels in the P0 treatment, which did not receive *Kaempferia galanga* L. extract, appeared higher compared to the other groups. The decrease in cholesterol levels in P3 and P4 (which received *Kaempferia galanga* L. extract) indicates that *Kaempferia galanga* L. extract in the feed may contribute to lowering blood cholesterol levels. This reduction could be caused by the bioactive compounds in *Kaempferia galanga* L., such as flavonoids or essential oils, which may affect lipid metabolism or improve fat digestion [18,17]. The significant difference in P0, which had the highest cholesterol levels (marked with "b"), confirms that *Kaempferia galanga* L. extract has the potential to reduce excessive cholesterol levels.

3.2.5 High-Density Lipoprotein (HDL)

The data showed that *Kaempferia galanga* L. extract in the feed of Indonesian native chickens did not have a significant effect on HDL levels. The HDL level in the control group (P0) was recorded at 42.16 ± 7.34 mg/dL, while in P1, there was a slight increase to 48.94 ±

9.94 mg/dL, although this difference was not significant. In treatments P2, P3, and P4, HDL levels were recorded at 38.98 ± 5.08 mg/dL, 39.04 ± 9.30 mg/dL, and 43.43 ± 8.65 mg/dL, respectively, which were relatively lower or comparable to the control group. Overall, *Kaempferia galanga* L. extract did not cause any significant changes in HDL levels in Indonesian native chicken.

HDL, as the "good" cholesterol, is influenced by various factors such as physical activity, overall diet, and genetic factors, making it difficult to be significantly affected by *Kaempferia galanga* L. extract in the feed alone. Although *Kaempferia galanga* L. is known for its health benefits such as anti-inflammatory, antimicrobial effects, and digestive system improvement, *Kaempferia galanga* L. extract does not directly play a role in lipid metabolism focused on increasing HDL. Furthermore, HDL levels are often influenced by the type of fats in the feed, and if the feed provided to the chickens does not contain healthy fats such as omega-3 fatty acids, *Kaempferia galanga* L. extract may not be sufficient to influence HDL profiles. Additionally, the biological response of chickens to the bioactive compounds in plant extracts may vary, indicating the need for further research to understand the mechanisms of action of *Kaempferia galanga* L. in lipid metabolism in chickens [19,20].

The absence of significant changes in HDL levels suggests that *Kaempferia galanga* L. extract does not directly influence high-density lipoprotein synthesis or transport in Indonesian native chickens. HDL is largely regulated by dietary fat composition—especially unsaturated fatty acids—rather than by phytogenic additives [8]. Previous studies also show that herbal extracts tend to affect LDL and total cholesterol more strongly than HDL. Rafeeq et al. [8] reported improvements in intestinal morphology and immunity without notable HDL changes, while Setyaningrum et al. [20] found phytogenic preparations primarily reduced LDL. Although *K. galanga* contains lipid-modulating compounds [7,9], these act mainly on pathways that lower cholesterol and LDL. Therefore, the stable HDL levels observed here are consistent with earlier findings indicating that phytobiotics predominantly decrease LDL and total cholesterol rather than elevate HDL [8,13,17,20].

3.2.6 Low-Density Lipoprotein (LDL)

The research data shows a significant reduction in LDL levels after the addition of *Kaempferia galanga* L. extract in chicken feed. In the control group (P0), the LDL level was the highest at 149.06±35.43 mg/dL, while P1 showed a decrease to 113.90±12.53 mg/dL. P2 also showed a reduction to 116.08±9.99 mg/dL, while P3 and P4 showed more significant decreases, with LDL levels of 86.35±19.08 mg/dL and 84.95±19.08 mg/dL, respectively. Overall, a significant reduction in LDL levels was observed in all treatments with *Kaempferia galanga* L. extract in the chicken feed.

The significant decrease in LDL levels in chickens fed with *Kaempferia galanga* L. extract can be explained through several mechanisms. *Kaempferia galanga* L. contains active compounds such as flavonoids and essential oils, which have antioxidant and anti-inflammatory effects that may help reduce inflammation in the body, thereby reducing LDL production. Additionally, several studies indicate that *Kaempferia galanga* L. can improve liver function, which plays a key role in cholesterol metabolism. With better liver function, cholesterol excretion through bile can increase, thereby lowering LDL levels in the blood. *Kaempferia galanga* L. may also influence enzymes involved in lipid metabolism, such as lipase, which plays a role in breaking down fats in the body, thus contributing to a reduction in LDL levels [21,17]. Overall, the significant reduction in LDL levels in the treatment groups with *Kaempferia galanga* L. extract demonstrates the potential of *Kaempferia galanga* L. in regulating blood lipid profiles, although it did not affect HDL levels in this study [22].

Based on the Duncan's test results shown in the table, there is a significant difference in LDL levels between the control group (P0) and the treatment groups fed with *Kaempferia galanga* L. extract (P1, P2, P3, P4). The average LDL level in the control group (P0) is 149.0550 mg/dL, which is much higher compared to the other treatment groups, which have lower LDL levels. Specifically, the LDL levels in P4 (84.9460 mg/dL) and P3 (86.3548 mg/dL) show significant reductions compared to P0, and both belong to the same subset, meaning that the difference in LDL levels between P4, P3, P1, and P2 is not significant. Meanwhile, P1 (113.8970 mg/dL) and P2 (116.0848 mg/dL) also show a decrease, but the difference between them is not significant.

These Duncan's test results reinforce the findings that *Kaempferia galanga* L. extract in the feed of Indonesian native chickens can significantly reduce LDL levels, with P4 and P3 providing the largest reductions. Overall, the significant reduction in LDL levels in the treatment groups with *Kaempferia galanga* L. extract demonstrates the potential of *Kaempferia galanga* L. in improving the lipid profile of Indonesian native chickens [23].

Although HDL was not significantly affected, the significant reduction in LDL levels in this study suggests that *Kaempferia galanga* L. could play a role in improving the lipid profile, particularly by reducing the levels of bad cholesterol (LDL). The reduction in LDL levels may be due to the anti-inflammatory and antioxidant effects of *Kaempferia galanga* L., which affect lipid metabolism and improve liver function in managing cholesterol [24].

The Duncan's test results in this study show that the P0 treatment has higher LDL levels compared to the treatments with *Kaempferia galanga* L. extract (P4, P3, P1, P2). This indicates that *Kaempferia galanga* L. extract in the feed of Indonesian native chickens can reduce LDL levels in the chicken's blood. The active compounds in *Kaempferia galanga* L. extract, such as flavonoids and essential oils, are known to have antioxidant and hypolipidemic properties that can help reduce LDL cholesterol levels [25]. Therefore, the reduction in LDL levels in the treatment groups given *Kaempferia galanga* L. extract can be explained by the biochemical effects of *Kaempferia galanga* L. extract that influence fat metabolism in the chickens.

Although LDL levels in the groups given *Kaempferia galanga* L. extract are lower, the Duncan's test did not show significant differences between the P4, P3, P1, and P2 groups. This may be due to differences in the doses or formulations of *Kaempferia galanga* L. extract used in each treatment. Lower doses might not be effective enough to significantly reduce LDL levels, or other factors such as the chickens' biological response or sample variations might influence the results.

4 Conclusion and recommendation

The supplementation of *Kaempferia galanga* L. extract in the diet of Indonesian native chickens significantly affected the relative weight of the pancreas and duodenum, as well as plasma cholesterol and LDL levels ($P < 0.05$). However, no significant differences were observed in the relative weights of the jejunum and ileum or in HDL levels ($P > 0.05$). These findings indicate that *Kaempferia galanga* L. extract has potential as a feed additive to improve lipid metabolism and support digestive organ development, although its effects are specific to certain parameters.

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