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Original Article

Providing black soldier fly maggot flour (*Hermetia illucens*) as a substitute for concentrated feed for the low density lipoprotein (LDL) and high density lipoprotein (HDL) content of broiler chickens

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ABSTRACT

This study aims to determine the effect of concentrate substitution with maggot black soldier fly flour in the ration on the percentage of Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) in broilers. This study used 20 broilers strain Cobb 500 aged five weeks. The P0 group was given a basal diet consisting of 30% concentrate, 60% corn, and 10% rice bran. Groups of P1, P2, P3, and P4 were given basal diet with concentrate substitution of 2, 4, 6, 8% with maggot flour, respectively. Data collection was carried out at the end of the study. Analysis of Variance (ANOVA) showed that the substitution of concentrate with maggot flour from black soldier flies had no significant effect ($p>0.05$) on the percentage of Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL).

Keywords: Maggot, low density lipoprotein, high density lipoprotein, broiler

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Introduction

Feed is one of the determining factors for success in livestock farming besides maintenance and genetic factors. In broiler chicken farming, feeding is the largest part of the total production cost, reaching 60-70%. Feed factors, especially in terms of feed quality and price, must receive more attention so that this broiler chicken farming business runs well and optimally and gets maximum profit (Ramukhithi *et al.*, 2023). Broiler chickens can be developed as a meat-producing commodity because they have rapid development and prices that are relatively affordable for people's purchasing power. Broiler chickens have a role in supporting food security, especially to meet the need for animal protein (Suganda *et al.*, 2024).

According to Baghbanzadeh and Decuypere (2008), the rapid growth rate in broilers is always followed by rapid fattening, fat accumulation tends to increase in line with increasing body weight. The high fattening of broilers is caused by broilers having a high appetite, while the nature of broiler chicken movements is slow so that the energy consumed from feed is converted into fat stored in the abdomen and under the skin. Broilers have a blood cholesterol content of 52-248 mg/dL. In the process of transporting cholesterol, there are two types of lipoproteins that play an important role, namely, Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) (Das and Ingole, 2023).

Feed plays an important role in basic needs. Low protein content in feed can interfere with the growth process because it is related to carcass formation (Han *et al*., 2023). Farmers in meeting feed needs for broiler chickens generally use commercial feed that has been prepared to meet standard feed. However, commercial feed has a price that is considered quite expensive and reduces profits for farmers so that other alternative feeds are needed (Alqaisi *et al*., 2017).

Black Soldier Fly (BSF) or Latin *Hermetia illucens* is a type of fly from the order Diptera from the genus Hermetia and the family Stratiomyidae. BSF is a fly native to the United States which then spread almost throughout the world. BSF is also found in Indonesia, especially in the Papua region as one of the natural ecosystems of BSF. The optimum temperature for BSF growth is between 30°C and 36°C. BSF larvae do not survive at temperatures below 7°C and above 45°C. BSF is a type of tropical fly that excels in decomposing organic matter and has been used as a decomposer of organic waste. BSF can extract energy and nutrients from plant waste, food waste, animal carcasses and other waste such as food waste and domestic wastewater. The low economic value of this waste benefits the development of BSF biotechnology (Kim *et al*., 2021).

BSF maggots can be used as a good alternative feed for fish and poultry because they have a high protein content. Chicken is one type of poultry that can be fed maggot worms (Dillak *et al*., 2019). The success of maggot production and quality is largely determined by the growing medium, for example, the type of Hermetia illucens fly likes a distinctive media aroma so that not all media can be used as a place for Hermetia illucens flies to lay eggs. Based on the content contained in Black Soldier Fly maggots, further research is needed to determine the effect of giving Black Soldier Fly maggot flour on Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) levels in broiler serum.

Materials and methods

Research design

This study included laboratory experimental research using a completely randomized design method with five treatment groups. The experimental animals used were broiler chickens to determine the effect of Black Soldier Fly (*Hermetia illucens*) maggot flour on Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) levels in broiler serum. The samples used were 20 Cobb 500 strain broiler chickens. Feed mixing was carried out in the feed laboratory of the Faculty of Veterinary Medicine, Airlangga University. Broiler chickens were maintained in experimental animal cages. Sample examination was carried out at the Healthy Animal Clinic, Malang. The study was conducted in March-April 2022.

Treatment

This study used a Completely Randomized Design (CRD) which was carried out with 5 treatments and each treatment was repeated 4 times. The treatments carried out were as follows:

P_0 = 30% concentrate feed + 60% corn + 10% bran + 0% maggot flour

P_1 = 28% concentrate feed + 60% corn + 10% bran + 2% maggot flour

P_2 = 26% concentrate feed + 60% corn + 10% bran + 4% maggot flour

P_3 = 24% concentrate feed + 60% corn + 10% bran + 6% maggot flour

P_4 = 22% concentrate feed + 60% corn + 10% bran + 8% maggot flour

Data retrieval

Sampling for analysis was carried out when the chicken was 36 days old. Before blood collection, the chicken was fasted for 12 hours. The chicken was held carefully, then the feathers were cleaned and a swab was performed on the wing area using alcohol cotton so that the brachial vein was clearly visible. After being visible, the chicken's blood was taken through the brachial vein using a 3 ml syringe slowly ± 1 ml. The blood was put into a vacutainer tube without

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anticoagulant. The blood was centrifuged for 10 minutes at a speed of 3000 rpm, then 500 µl of serum was pipetted and LDL and HDL were analyzed.

Low Density Lipoprotein and High Density Lipoprotein analysis is performed using the Clinical Chemistry Autoanalyzer. This autoanalyzer is used for clinical chemistry examinations, namely measuring the levels of substances contained in the blood. Examples are glucose, uric acid, triglycerides and cholesterol. The principle of this tool is to carry out chemical examination procedures automatically starting from sample pipetting, adding reagents, incubation, and reading light absorption.

LDL and HDL examination

The first thing to do is to prepare the sample cup and label it according to the sample identity. Insert the sample into the sample cup ± 300 µl, and press the entry button. Enter the sample identity then select the LDL and HDL parameters. Then place the sample cup on the kenza tray at the number corresponding to the sample number to enter the data and examination parameters. Press the exit button until the initial menu appears. Make sure the LDL and HDL reagents are in place. Select the start button then select select test (to select the examination parameters to be examined), namely LDL and HDL. Perform calibration then the tool will start working. Wait until the LDL and HDL levels come out. Record the results on the examination form.

Data analysis

Data analysis in this study used Analysis of Variance (ANOVA) with a Completely Randomized Design (CRD) research design. If a difference is obtained in the treatment, then it is continued with Duncan's Multiple Range Test with a significance level of 5% to determine the treatment group that has the best results.

Result

Low Density Lipoprotein (LDL)

The results of the study showed that the Low Density Lipoprotein (LDL) content of broiler chickens in the substitution of concentrate with Black Soldier Fly maggot flour (*Hermetia illucens*) ranged from 70.425-86.125 mg/dL. The results of the analysis of Low Density Lipoprotein (LDL) of broiler chickens can be seen in table 1.

Table 1. Average and standard deviation of Low Density Lipoprotein (LDL) content in broiler chickens

Treatment	LDL content ± SD (mg/dL)
P0	74.200[a] ± 26.367
P1	70.425[a] ± 19.537
P2	86.125[a] ± 28.653
P3	77.650[a] ± 26.526
P4	71.900[a] ± 17.922

Note: The same superscript in the same column indicates no significant difference (p>0.05)

Based on the calculation results that have been analyzed using Analysis of Variance (ANOVA), it shows that there is no significant difference (p>0.05) in the LDL content of broiler chickens after substituting the concentrate with Black Soldier Fly maggot flour (*Hermetia illucens*).

High Density Lipoprotein (HDL)

The results of the study showed that the content of High Density Lipoprotein (HDL) in chickens in the substitution of concentrate with Black Soldier Fly maggot flour (*Hermetia illucens*) ranged from 54,300-72,600 mg/dL. The results of the analysis of High Density Lipoprotein (HDL) in broiler chickens can be seen in table 2.

Table 2. Mean and standard deviation of High Density Lipoprotein (HDL) content of broiler chickens

Treatment	Mean ± Standard Deviation (grams)
P0	64.100[a] ± 34.168
P1	61.975[a] ± 20.668
P2	54.300[a] ± 23.852
P3	72.600[a] ± 21.696
P4	56.550[a] ± 14.489

Note: The same superscript in the same column indicates no significant difference (p>0.05)

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Based on the calculation results that have been analyzed using Analysis of Variance (ANOVA), it shows that there is no significant difference (p>0.05) in the HDL content of broiler chickens after substituting the concentrate with Black Soldier Fly maggot flour (*Hermetia illucens*).

Discussion

Low Density Lipoprotein (LDL)

Low Density Lipoprotein (LDL) is a type of lipoprotein formed through endogenous pathways and has the function of carrying cholesterol from the liver to peripheral tissues and then stored in these tissues. Low Density Lipoprotein (LDL) is a lipoprotein that has the highest cholesterol content and is the end product of Very Low Density Lipoprotein (VLDL) hydrolysis (Huang and Lee, 2022).

LDL is rich in cholesterol content. This particle contains 10% triglycerides, 40% cholesterol and cholesterol esters, 30% phospholipids and 20% protein (Ndrepepa, 2021). LDL is a fat carrier and contains very high cholesterol, which consists of endogenous fat in the liver. About 50% of LDL is metabolized by peripheral tissues and the remaining 50% is absorbed by the liver (Chen *et al*., 2024).

According to Ivanova *et al*. (2017) Low Density Lipoprotein (LDL) with total cholesterol goes in the same direction because 65% of cholesterol is in the form of LDL. Total cholesterol that decreases is also accompanied by a decrease in LDL. This occurs due to the inhibition of the absorption process of cholesterol in the intestine and increased excretion of bile acids through feces. High excretion of bile acids causes more cholesterol to be converted into bile acids to emulsify fat, so that total cholesterol and LDL decrease. Decreased LDL levels can reduce the risk of atherosclerosis.

According to Drenjančević and Pitha (2022), omega-3 can reduce lipid levels (cholesterol) in blood serum, namely by inhibiting the formation of proteins and triglycerides in VLDL and LDL, so that VLDL and LDL in blood serum become low. The content of Low Density Lipoprotein (LDL) in treatments P0, P1 2%, P2 4%, P3 6%, and P4 with maggot flour substitution of up to 8% did not show any significant difference. The absence of a significant effect of treatment on LDL levels is thought to be due to several factors, namely genetic factors and the feed given is not much different for each treatment. In line with Zhang *et al*. (2010) stated that cholesterol in the blood is influenced by genetics, age and feed consumed. Papotti *et al*. (2021) stated that lipid levels including lipid transport such as LDL in the blood can be influenced by the type of food consumed by humans or animals. Mensink *et al*. (2003) stated that heredity and fatty acid content in the feed consumed can also affect LDL levels in the blood.

Fat in the body can be influenced by the amount of food intake that contains protein and energy (fat) consumed. The saturated fatty acid content in maggots is quite high at 20.00%, this content can cause an increase in LDL in chicken blood (Dal Bosco *et al*., 2022). Shramko *et al*. (2020) stated that saturated fatty acids (SFA) are fatty acids that are not sensitive to oxidation and free radical formation. The dominant effect of saturated fatty acids is an increase in total cholesterol and LDL cholesterol levels. High consumption of saturated fat causes the liver to produce large amounts of LDL cholesterol which triggers heart disease and increases blood cholesterol levels which can cause thrombosis.

Basmacioglu and Ergul (2005) stated that, the safe LDL cholesterol level for livestock health is ≤ 130 mg/dL. The lower the LDL, the better for broilers which is related to the amount of fat stored because if the LDL level is high it causes cholesterol deposits.

High Density Lipoprotein (HDL)

The results of the analysis of variance (ANOVA) showed no significant difference (p>0.05) in the substitution of concentrate with maggot flour up to 8% between the control and treatment groups (P1, P2, P3 and P4) on the percentage of High Density Lipoprotein (HDL) content in broiler chickens. This is thought to be

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because the absorption of food containing unsaturated fatty acids absorbed by the small intestine is almost the same in each treatment. According to Mir *et al*. (2017) stated that lipid metabolism in the blood of broiler chickens can be influenced by several factors such as age, gender, genetic type, environmental conditions and feed.

According to Akinyemi and Adewole (2021) stated that chickens are a type of livestock that is easily stressed. The results of the study obtained a fairly high standard deviation. The high standard deviation results indicate that the HDL test results vary greatly. This is thought to be due to the different levels of stress experienced by chickens. Nanto-Hara *et al*. (2020) stated that comfort in broiler chickens can affect all cells containing nuclei, especially in the liver and intestines which are where HDL synthesis and secretion occur. Comfort in broiler chickens will affect the hypothalamus to reduce the production of the hormone Corticotrophin Releasing Hormone (CRH) so that it will stimulate a reduction in the formation of Adrenocorticotropic Hormone (ACTH) in the anterior pituitary. ACTH production in small amounts will affect the amount of cholesterol, especially HDL because HDL is needed for ACTH production.

The percentage of maggot flour as a substitute for concentrate feed also affects the content of High Density Lipoprotein (HDL). According to research conducted by Nurlaila *et al*. (2023) stated that giving maggot flour up to 15% to female joper chickens can increase the content of High Density Lipoprotein (HDL). The increase in HDL content is caused by a decrease in LDL content in the blood due to increased LDL receptors in the liver (Wang *et al*., 2017). The increase in HDL content is also caused by the intake of omega-3 fatty acids. According to Hartweg *et al*. (2008) several grams of omega-3 PUFA cause an increase in plasma HDL cholesterol concentration. Basmacioglu and Ergul (2005) stated that safe HDL cholesterol levels for health are ≥ 22 mg/dL. According to Weissglas-Volkov and Pajukanta (2010) stated that the increase or decrease in HDL levels in the blood is caused by several factors, namely the inflow of cholesterol from lipoproteins with low cholesterol potential (HDL) to the cell membrane. High or low levels of HDL in the blood are closely related to cholesterol levels and the activity of steroid compound and bile salt synthesis.

Conclusion

Based on the results obtained, it can be concluded that the provision of Black Soldier Fly maggot flour (*Hermetia illucens*) as a substitute for concentrate feed cannot reduce the levels of Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) in broiler serum.

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