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Research Article
Effect of Chicken Feather Meal on the Feed Conversion Ratio and Blood Lipid Profile of Broiler Chickens

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Abstract

Objective: The goal of this research was to study the effect of chicken feather meal on the feed conversion ratio (FCR) and blood lipid profile consisting of triglyceride, total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) in broiler serum. **Materials and Methods:** This study used broiler chickens of 707 strain bred by PT Charoen Phokphand with varied sex and standard body weight. The broiler chickens were randomly divided into 5 treatment groups: Control (C) group were fed 100% BR-1 commercial broiler feed twice a day, treatment group 1 (P-1) was fed 90% BR-1+10% chicken feather meal, treatment group 2 (P-2) was fed 92.5% BR-1+7.5% chicken feather meal, treatment group 3 (P-3) was fed 95% BR-1+5% chicken feather meal and treatment group 4 (P-4) was fed 97.5% BR-1+2.5% chicken feather meal. Crude protein and total lipid content of the chicken feather meal was determined with Kjeldahl and Gravimetric methods. After 33 days of rearing period, body weight, FCR, triglyceride, total cholesterol, HDL and LDL level in blood sera were quantified and analyzed with ANOVA one way followed by multiple comparison methods. **Results:** The results showed that the quantification of crude protein content in chicken feather meal which was used in this study was 33.98%, while total lipid content quantified was 3.02%. The FCR value showed that only in the P-4 treatment group which was fed 97.5% BR-1+2.5% chicken feather meal showed a significant decrease of FCR value ($p<0.05$), while the treatment groups with higher feeding percentage of chicken feather meal (5, 7.5 and 10%) did not show significant decrease of FCR. Quantification of blood lipid profile including triglyceride, total cholesterol, HDL and LDL levels showed no significant difference ($p>0.05$) between control (C) and treatment group (P-1, P -2, P-3, P-4). **Conclusion:** The broiler feed with 2.5% of chicken feather meal could reduce the FCR value without being followed by the change of blood lipid profile. Therefore, chicken feather meal can be used as an alternative ingredient in broiler feed to reduce the production cost.

Key words: Chicken feather meal, FCR, blood lipid profile, triglyceride, blood sera

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The poultry industry, especially broiler chickens has an important role to fulfil the national needs of meat consumption. Moreover, people are increasingly aware of the importance of consuming animal protein, thus causing an increase in demand for broiler meat. The broiler meat is a kind of food containing animal protein which is cheap and easily obtainable[1].

Chicken feather is one of the waste products of chicken slaughter house with abundant availability, however it has poor digestibility and often considered as solid wastes[2]. In Indonesia, every year, the consumption of duck meat, chicken and other poultry meat tend to increase, in line with the increase of poultry industry sector. The demand growth for poultry product has been positively correlated to population growth. The consumption of chicken meat increase much larger compared to Malaysia and Thailand under the same assumptions. This situation causes an increase in demand of poultry feed[3].

Chicken feathers meal as poultry feed ingredients have not been widely utilized and only a small portion was utilized. In each slaughter house, the feathers obtained was ±6% from the life body weight of a broiler chicken[4]. Before given to poultry as their meal, chicken feathers must firstly be processed into meal. The processing of chicken feathers into meal, was carried out to weaken or break the bonds in keratin with the hydrolysis process[5]. Various processing methods have been studied to improve the digestibility of chicken feather meal. The chicken feather meal is a potential source of poultry feed, because the crude protein content is high around 81.7-85.8%[6]. Chicken feather meal treated can be utilized as feed ingredients protein source in broiler chickens by three types of processing, namely: Steam pressure processing, soaked and cooking vapor pressure, fermented by *Bacillus licheniformis*[7].

Broiler chickens are young male or female chickens that are generally reared until 5-6 weeks in order to produce meat. In relation to relatively short rearing period, the chickens are required to experience fast growth, have wide breasts with thick flesh piles and produce meat with soft fibers and good pile of meat. Broiler chickens are usually reared at a temperature of 18-21°C. Another factor that affects feed consumption is the physical form of broiler chicken feed which was usually in the form of mash, crumble, or pellet. Pellet was more often given because broiler chickens prefer food in the form of granules. Chicken broilers tend to continue eating until they reach the amount of energy or calory they need. Therefore, it was important to feed broiler chicken with food containing high energy content in order to meet their energy needs. Feed has a very important role in the poultry industry. Chicken feed makes up 70% of total production cost. Poultry feed was heavily dependent on the needs of the concentrate as the main ingredient of the protein source in the feed[8].

The advantages of keeping broiler chickens are its rapid growth and effectivity in producing meat induced by genetic factor. With a good broiler breeding system, it takes 5 weeks to have broilers with the average body weight of around 1.3-1.6 kg[6]. Another factor that affects the performance of broiler chickens is protein intake, drinking water quality, temperature and altitude of the hatchery[9].

Chicken feather meal has been reported to be an alternative source of protein in poultry feed[10] and ruminant feed[11]. It was also reported that viral infections may affect feed intake and body weight gain, such as newcastle disease virus[12] and avian encephalomyelitis virus infections[13].

The physiological and hematological data of animals was an important guideline in the handling and treatment of sick animals as well as comparative hematology studies[14]. Therefore, studies on the use of cheap alternative feeds associated with the feed conversion ratio (FCR) and blood profile of broiler chicken is still necessary. The goal of this research was to study the effect of feather meal on the FCR and blood lipid profile consisting of triglyceride, total cholesterol, high density lipoprotein (HDL) and low density lipoprotein (LDL) in broiler sera. So, it can informed that chicken feather meal has high levels of crude protein and lipid total. It can used as one source of alternative feed on broiler chickens to reduce the production cost by reducing of FCR value without being followed by the change of blood lipid profile.

MATERIALS AND METHODS

Chicken preparation: The study was carried out for 6 months (October, 2016-April, 2017). It used 50 days old broiler chicken of 707s strains breed by charoen phokphand (CP) with varied sex and standard body weight. Chickens were raised for 33 days in cages which used an open house system where litters were placed in five smaller cages. The size of each small cage was 1×2 m. The litters were covered with rice husks. Each cage contained one drinking water container, food apparatus and gas heater. During the 33 days rearing period, chickens were fed BR-1 commercial broiler feed (Japfa Comfeed Indonesia Co. *ad libitum* and were vaccinated against newcastle disease (ND), infectious bronchitis (IB) and infectious bursal disease (IBD) according to standard broiler vaccination protocols and schedules recommended by the vaccine manufactures.

Preparation of chicken feather meal: The chicken feathers were collected from chicken slaughter house and then processed into chicken feather meal. Processing chicken feathers into meal can be carried out through the following process: Waste chicken feathers were washed, dried, milled and ready to be sieved with a sieve.

Broiler rearing: Fifty days old chickens were reared for 21 days fed with BR-1 and fresh drinking water *ad libitum*. Starting the 22nd day, the broilers allocated to treatment groups were given a specific amount of chicken feather meal, as described in the study design (below), together with BR-1, whereas those in the control group were continuously feed with 100% BR-1. Cages were cleaned daily. Feed portions were adapted to body weight gain and broiler age.

Study design: Broiler chickens were fed treatment diet for 12 days. Before beginning dietary treatment, each broiler was weighed and randomly divided into five trial groups. Dietary treatments were as follows:

- Control (C) chickens were given 100% commercial BR-1 feed
- Treatment group 1 (P-1) was fed with 90% BR-1 mixed with 10% chicken feather meal
- Treatment group 2 (P-2) was with fed 92.5% BR-1 mixed with 7.5% chicken feather meal
- Treatment group 3 (P-3) was fed with 95% BR-1 mixed with 5% chicken feather meal
- Treatment group 4 (P-4) was fed with 97.5% BR-1 mixed with 2.5% chicken feather meal

All chickens were fed twice a day in the morning and evening along with fresh drinking water *ad libitum*, each feed amount was weighed and recorded. Any residual feed was also weighed and recorded as consideration for quantifying food requirements on following day. All chickens in each group were weighed once a week at the end of the week. On the 33rd day, 2-3 mL blood was taken from the brachialis vein of all the broilers in each group to determine triglyceride level, total cholesterol, HDL and LDL levels from blood sera, a total of 50 broilers were analyzed.

Blood collection: On the 33rd day, 2-3 mL of blood samples were taken from the brachial vein using a syringe then collected to a tube without EDTA. The tubes then centrifuged at 6.000 rpm to separate the serum from another blood component. The serum was then sent to LPPT UGM for quantifying the triglycerides level, total cholesterol, HDL and LDL levels.

Statistical analysis: The data were analyzed with one-way analysis of variance (ANOVA) followed by multiple comparison methods. Statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSION

Quantification of crude protein and total lipid content: The crude protein content of chicken feathers meal which was quantified with Kjeldahl method was 33.98%. It was lower than the crude protein analysis which was reported by Adiati *et al*.[6] of 81.7-85.8%. Meanwhile, the total lipid content in the chicken feather meal used in this study was 3.02% or still within the normal range of 3.0-7.21%[6]. The high content of crude protein was not accompanied by high digestibility. The rate of dry matter digestibility and organic matter of chicken feathers was between 0.7-5.8% *in vitro*. The low digestibility was caused by the amino acid sequence of keratin consists of 40 and 60% hydrophobic chemical groups. Protein molecule of keratin was accumulated in the structure of the α-helix, β-sheet or random, unordered macrostructure. Keratin fibers in feather consist of 41% α-helix, 38% β-sheet and 21% random structure[15,16]. Keratin in the gastrointestinal tract cannot be converted into a digestible protein, so it cannot be utilized by poultry. In order to be used as feed ingredients, chicken feathers should be treated, by breaking the sulfur bonding of the cystine amino acid contained in chicken feathers[6].

Feed conversion ratio: Feed conversion ratio or FCR is the ratio between the amount of feed consumed with the production of meat. Feed conversion is influenced by several factors such as: Age, breed of poultry, feed nutrition, temperature and poultry condition. Feed conversion of broiler chickens obtained from the amount of feed consumed to produce 1 kg of live body weight. Low (small) feed conversion rates indicate the less feed used to produce 1 kg of meat. The feed conversion rate also indicates the level of feed use. The higher of FCR value indicates the more feed needed to increase the broiler's body weight, the lower the FCR value means better and more efficient feed conversion[17]. The statistical analysis of FCR values in the control group (C) and the other four treatment groups (P-1, P-2, P-3, P-4) after 33 days of rearing were presented in Table 1.

Table 1: Feed conversion ratio of broiler after 33 days of rearing period

Sample	Body weight (g)	Feed consumed (g)	FCR mean
C (control)	1.772	2.976	1.68±0.13[a]
P-1 (10%)	1.824	2.954	1.62±0.14[ab]
P-2 (7.5%)	1.822	3.006	1.65±0.14[ab]
P-3 (5%)	1.929	2.970	1.54±0.09[ab]
P-4 (2.5%)	1.970	2.974	1.51±0.10[b]

[a,b,ab]Different superscripts showed significantly different ($p<0.05$)

Table 2: Mean of triglyceride level in broiler blood sera

Samples	Trigliceride Mean (mg dL^{-1})
C (control)	84.78±21.66[a]
P-1 (10%)	54.20±20.90[a]
P-2 (7.5%)	70.80±26.44[a]
P-3 (5%)	64.94±18.64[a]
P-4 (2.5%)	71.28±49.51[a]

[a]The same superscript showed no significant difference ($p>0.05$)

The lowest mean of FCR value was shown in the P-4 group, whereas, the highest mean was found in control group. It indicated that there was a decrease of FCR value in all treatment groups (P-1, P-2, P3, P-4) when compared to control group. The difference between the treatment group and the control group was further analyzed with one-way ANOVA method which then was followed by multiple comparisons showing that there were significant differences in FCR values. The quantification of FCR value also showed that only in the P-4 group which was given 2.5% chicken feather meal mixture gave a significantly different of FCR value ($p<0.05$), when compared with the mean FCR value at control group. While the other treatments group, P-1, P-2 and P-3 groups which were given 5, 7.5 and 10% chicken feather meal did not show significant decrease in FCR value. The FCR value quantification results were in line with a study reported by Haryanto *et al.*[18] in broiler treated with 10% banana peel meal, which showed a significant decrease in FCR value. The higher FCR value was caused by the main protein contained in chicken feather meal which was difficult to digest. The chicken feathers consist in 90% of keratin and they make up 5-7% of the total weight of adult chickens what causes that feathers waste was the main source of keratin[19].

Fibers of chicken feather are composed of a hydrophobic keratin, which was a protein having similar strength to nylon and a smaller diameter than the wood fiber. The feature of the chicken feather fibers are semi-crystallinity and cross-linked structure, which enhances the resistance of composites based on polymers to mechanical stress and causes a relatively high modulus of elasticity. Chicken feather fibers have a high elongation coefficient. These mentioned properties suggest that there are possibilities of successful application of chicken feather fiber as a polymeric reinforcement[15,20].

Triglyceride: Triglyceride is one type of lipid found in the blood. The triglyceride levels rise drastically after eating, especially simple carbohydrates such as sugar, meal and saturated fats. This was because simple carbohydrates cannot be used directly to produce energy, but will be converted into triglycerides and stored in the lipid form. The release of triglyceride stored was regulated by hormones and depends on the body's need for energy. Triglycerides stored in the body will circulate in the blood. Triglycerides are nonhydrated compound. For energy production, triglyceride is oxidized to produce 9 kcal g^{-1}, whereas, carbohydrates produce only 4 kcal g^{-1} [21].

The quantification of triglyceride in broiler sera was presented in Table 2. The mean value of triglycerides in all the groups showed normal results, with the lowest mean values shown in broiler chickens in the P-1 group and the highest mean value in group C. The normal value of triglycerides in broiler chicken is <150 mg[22]. The statistical analysis with one-way ANOVA showed that the mean value of triglyceride was not significant between C and treatment group (P-1, P-2, P-3 and P-4), which means the feeding of chicken feather mixed with commercial broiler feed does not have a significant effect on triglyceride levels in broiler sera ($p>0.05$). This was in contrast to those reported by Haryanto *et al.*[18], who stated that triglyceride levels in broiler chickens fed with banana peel meal mixture will increase significantly. Meanwhile in this study, the administration of chicken feather meal mixture did not affect triglyceride levels in broiler sera. Therefore, related to the levels of triglycerides in the blood, chicken feather meal was more suitable for use as a mixture of broiler chicken feed compared to banana peel meal.

Total cholesterol: Cholesterol is an amphipatic lipid and is an essential structural component that forms the cell membrane and the lipoprotein external layer. In the body, cholesterol is the precursor of all steroidal compounds, such as corticosteroids, sex hormones, bile acids and vitamin D. Lipoproteins transport free cholesterol in the blood circulation in the form of low density lipoprotein (LDL) and high density lipoprotein (HDL). The LDL and HDL also play an important role in the pathological process of atherosclerosis formation in blood vessels[23].

The quantification results of total cholesterol total were presented in Table 3. The normal standard of total cholesterol of broiler chickens is 128-140 mg dL^{-1} [24]. It showed that the total cholesterol levels in control group and all treatment groups were lower than the normal range, with the lowest of total cholesterol mean was found in the P-3 group and the

Table 3: Mean of total cholesterol, HDL and LDL levels in broiler blood sera after treated with chicken feather meal

Sample	Total cholesterol mean (mg dL^{-1})	HDL mean (mg dL^{-1})	LDL mean (mg dL^{-1})
C (control)	87.28±5.16[a]	42.78±6.13[a]	44.50±7.83[a]
P-1 (10%)	105.20±15.23[a]	55.24±11.51[a]	49.96±6.59[a]
P-2 (7,5%)	96.22±7.72[a]	49.18±9.64[a]	47.04±4.44[a]
P-3 (5%)	86.88±19.0[a]	41.0±12.15[a]	45.88±9.33[a]
P-4 (2,5%)	86.80±11.60[a]	41.46±8.59[a]	45.34±6.84[a]

[a]The same superscript showed no significant difference (p>0.05)

highest mean of total cholesterol was in the P-1 group. The statistical analysis with one-way ANOVA showed that there was no significant difference between control group (C) and all treatment groups (P-1, P-2, P-3 and P-4). This indicates that chicken feather meal give significant effect to total cholesterol level in broiler blood (p>0.05). This was in line to the research conducted by Bidura and Partama[25], who reported that administration of 5% fermented chicken feathers meal in broilers feed can decrease abdominal lipid content and total cholesterol levels of 6 weeks broiler chicken.

Low density lipoprotein (LDL): Normal LDL levels in broiler blood is 95-125 mg dL^{-1}. Basmacioglu and Ergul[22] stated that LDL levels in ≤130 mg dL^{-1} is good and safe for poultry condition. The lower level of LDL was then better for the broiler because it was associated with the amount of lipid deposit in the body. If the level of LDL is high, it will lead to cholesterol deposition in the meat.

The quantification of LDL levels in broiler blood is shown in Table 3. It showed that the LDL level in all treatment groups remained within the normal range of ≤130 mg dL^{-1}. The mean of the lowest LDL levels was found in control (C) group, whereas the mean of highest LDL level was in treatment group P-1. One-way ANOVA analysis showed that there was no significant difference between control (C) group and all treatment groups P-1, P-2, P-3 and P-4. This indicates that chicken feather meal did not give significant effect to broiler LDL blood level (p>0.05). It was in line with other researchers who worked with different feed mixtures stated that seaweed meal give no effect on triglyceride, total cholesterol, HDL and LDL levels in broiler blood[26].

High density lipoprotein (LDL): The normal HDL levels in the blood of broiler chickens is 66.5-97.7 mg dL^{-1} [27], whereas, according to Basmacioglu and Ergul[22] is ≥22 mg dL^{-1}. The quantification of HDL levels was presented in Table 3. It showed that all treatment groups (P-1, P-2, P-3, P4) indicated normal HDL levels, with the lowest mean of HDL level was the P-3 group (41±12.15) and the highest mean of HDL level was P-1 group (55.24±11.51). One-way ANOVA analysis of HDL level showed that there was no significant difference between control (C) group and treatment (P-1, P-2, P-3 and P-4) groups. This indicates that chicken feather meal did not give significant effect to HDL level in broiler blood (p>0.05). Table 3 showed that a slight increase in HDL levels was not significant though. Statistical analysis also showed no significant difference between control (C) group and treatment group (P-1, P-2, P-3, P-4). This result was consistent with a research conducted by Ruela *et al.*[28], who states that elevated HDL levels will increase the production of Apo A1 which acts as a cofactor of lecithin cholesterol acyl transferase (LCAT) enzyme and was one of the ingredients to produce HDL[29]. Apo A1 may also act as a ligand to interact with lipoprotein receptors in the tissues and be protective against atherosclerosis[30].

CONCLUSION

The quantification of FCR value showed that only in the P-4 treatment group which was treated with 2.5% of chicken feather meal there was a significant decrease in FCR value (p<0.05), while the higher concentration at 5, 7.5 and 10% of chicken feather meal, did not cause significant FCR decrease. The lipid profile of broilers' blood including triglyceride levels, total cholesterol, HDL and LDL levels showed no significant difference (p>0.05) between control (C) group and treatment group (P-1, P-2, P-3, P-4). Statistical analysis also indicated that administration of 2.5% chicken feather meal in broiler feed can decrease the FCR value without being followed by the change in blood lipid profile.

SIGNIFICANCE STATEMENTS

This study discovers possibility of chicken feather meal as a waste product of poultry slaughter house that can be used as alternative feed mixture for broiler chicken. This study will help researchers to utilize chicken feather meal which still has high levels of crude protein and lipid total, as one source of alternative feed on broiler chickens. Therefore, a new theory to utilize chicken feather meal as an alternative ingredient in broiler feed mixture can reduce FCR value without reducing the quantity and quality of meat produced, thus reducing production cost by minimizing the waste produced.

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