

Doi: 10.21059/buletinpeternak.v44i3.52732

Performances of Broiler Chickens Fed the Commercial Diets Partially Substituted with Feeds Containing Fermented and Non Fermented Leubim Fish Meal (*Canthidermis maculata*)

Zulfan, Muhammad Aman Yaman, Allaily*, and Enten Juni Marlina

Animal Husbandry Department, Faculty of Agriculture, Syiah Kuala University, Banda Aceh, 55281, Indonesia

ABSTRACT

The purpose of present study was to evaluate the performance of broilers fed the commercial diet partially substituted with leubim fish (*Canthidermis maculata*) waste meal (LFWM) treated by fermentation and without fermentation. As many as 100 broiler chicks, MB 202 strain, unsex, were reared up to 5 weeks in this study. The research was set up into randomized block design (RBD) consisting of 5 treatments and 4 blocks with 5 birds each. Blocks were as replicate based on the body weights of the birds at the beginning of feeding experimental diets. The experimental diets were commercial diets partially replaced with LFWM administered by either fermentation or not with the level of 6 and 12% each, 6.5% and 13% yellow corn, and 0.5% topmix. The data was analyzed using an Analysis of Variance (AOV) and continued by Duncan's Multiple Range Test (DMRT) only if significant effects were detected among the treatments. The result of recent study indicated that the inclusion of feeds containing LFWM treated by either or not fermented combined with yellow corn and topmix as partially substitution of commercial diets significantly increased ($P<0.05$) FBW, BWG, feed intake, and protein intake compared to those fed full commercial diet. However, FCR and PER were not significantly affected. DMRT indicated there were no significant differences in broiler performances fed the feeds containing LFWM treated by fermentation vs without fermentation.

Keywords: Broiler, Fermentation, Leubim fish (*Canthidermis maculata*), Performance

Article history

Submitted: 20 December 2019

Accepted: 24 August 2020

* Corresponding author:

Telp. +62 853 5907 9042

E-mail: allaily@unsyah.ac.id

Introduction

Broiler chicken is one of the commodities of farms with several advantages since its superior genetic has carried out faster growth and its body weight achieved to market age in earlier time. The growth of broiler chicken is greatly affected by the quality of the diet. Broiler chicken will expose good performance when diet given furnished good nutrition. Unfortunately, the price of commercial diets available in the market was so expensive because some of the feed ingredients (especially fish meal) composed into the diets were still imported.

Fish meal has been known as an excellent protein source for poultry diets (Jassim, 2010) since high protein content within the meal was easily to digest by the chickens. Meanwhile, the protein releases relatively complete amino acids and the taste has been well accepted by the birds. Nevertheless, fish also has several weaknesses due to wide variations in the quality and the price is rather expensive. For this reason, it might be possible to use local fish meal processed from unvaluable raw materials disposed from cutting

fish sites to be included within the diet to reduce commercial diet price.

The by-product of cutting fish which is much found in fish markets in Aceh is leubim (*Canthidermis maculata*) fish waste meal (LFWM). Commonly, this fish is sold in the form of meat that has been separated from other parts like head, bones, gills, fins, tail, and skin. The meat is generally used in making meatball, empek-empek, somai, etc. The number of fish waste is quite a lot and can be processed into fish meal for animal feed.

The result of the analysis in the Examine Laboratory, LIPI was known LFWM contained 49.24% protein, 10.46% Ca, and 6.25% P. The limited factors of exploring LFWM in the diet has been taken into consideration relating to its digestibility since the proportion of fish skin were so abundant. The fish skin was not able to digest by the chickens because most of its content was chitin and keratin. The result of analysis in the Examine Laboratory of Biotechnology, LIPI denoted that LFWM contained high crude fiber (11.33%) suspected chitin.

Chitin is a homopolymer derived from β (1 \rightarrow 4) linked with N-Acetyl-D-glucosamine (Austin

et al., 1981) found normally in fish skin (Kumari and Rath, 2014). Keratins refer to a group of insoluble and filament-forming proteins produced in certain epithelial cells of vertebrates; they belong to the super family of intermediate filament proteins (Wang *et al.*, 2015). Chitin and keratin can be breakdown by employing the enzymes of chitinase and keratinase. The enzymes could be produced by the proper microorganisms provided in inoculants through a mechanism of fermentation.

Feed fermentation is one of the ways to enhance feed digestibility (Winarno, 2000) and the outcome provides better nutrition (Pelczar and Chan, 2007). In this study, broiler chickens were fed commercial diets partially substituted with leubim fish waste meal treated either by fermentation or not combined with yellow corn and top mix. The objective of this study was to evaluate the performance of broilers fed the commercial diet partially substituted with feed ingredients containing fermented or nonfermented leubim fish (*Canthidermis maculata*) waste meal (LFWM). The results of this study was expected to explore local source of by-product of fish cutting which was LFWM to be processed into fish meal for broiler feed ingredients in order that gave adding value to the fish and reduced environmental waste.

Materials and Methods

The research was conducted at the Field Laboratory of Animal Husbandry, Animal Husbandry Department, Syiah Kuala University in July 1 until August 4, 2019.

Materials and equipments

As many as 100 broiler chicks, MB 202 strain, unsex, were reared up to 5 weeks in this study. Broiler commercial diets with the market code of CP 511 and CP 512 manufactured by PT Charoen Pokphand were used as a control diet. Yellow corn, top mix and leubim fish waste meal

(LFWM) either administered by fermentation or without fermentation were included into the commercial diet. Binosil and plastic bags were used to create fermented LFWM. The 20 cages 1 x 1 m with heating bulbs, feeders, and drinkers each were constructed to perform experimental units.

Diets

The experimental diets were commercial diets CP 512 partially replaced with 13% and 25.5% of the feed ingredients consisting of 6 and 12% leubim fish waste meal (LFWM) administered by either fermentation or not, 6.5% and 13% yellow corn, and 0.5% topmix. The protein contents of the experimental diets containing LFWM were increased as many as 1 and 2%. The nutritional contents of the diets were concerned according to the recommendation of NRC (1994). The composition and nutritional contents of the diets based on calculation were given in Table 1. Treatments were as follows:

- D1 = 100% Commercial diets (control)
- D2 = 87% Commercial diets + 6% not fermented LFWM + 6.5% yellow corn + 0.5% top mix
- D3 = 74.5% Commercial diets + 12% not fermented LFWM + 13% yellow corn + 0.5% top mix
- D4 = 87% Commercial diets + 6% fermented LFWM + 6.5% yellow corn + 0.5% top mix
- D5 = 74.5% Commercial diets + 12% fermented LFWM + 13% yellow corn + 0.5% top mix.

Experimental design

The research was set up into randomized block design (RBD) consisting of 5 treatments and 4 blocks. Since the experimental diets were initially fed on the birds in first day of the third weeks, in order to minimize unexpectable effects, various body weights were considered to be blocked into 4 stages. Each block represented a replicate which was an experimental unit placed 5 birds each. The model for this randomized block design according to Ott (1991) was $Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$ where Y_{ij} = the j th sample measurement selected from population i , μ = an overall mean,

Table 1. The composition and nutrient contents of the diet treatments

Feed ingredients	Diets (%)				
	D1	D2	D3	D4	D5
Commercial diet CP 512 Bravo ¹	100	87.0	74.5	87.0	74.5
Yellow corn ²	0	6.5	13.0	6.5	13.0
Not fermented LFWM ³	0	6.0	12.0	0	0.0
Fermented LFWM ⁴	0	0	0	6.0	12.0
Top mix	0	0.5	0.5	0.5	0.5
Totals	100	100	100	100	100
Nutrient contents based on calculations					
Crude protein (%)	21.00	22.00	23.00	22.00	23.00
Crude fiber (%) (max)	4.00	4.34	4.68	4.34	4.68
Ether extract (%) (min)	4.00	3.90	3.80	3.90	3.80
Ca (%) (min)	0.90	1.42	1.93	1.42	1.93
P (%) (min)	0.70	1.00	1.30	1.00	1.30

¹Market label CP 512 Bravo: CP 21%, CF 4%, EE 4%, Ca 0.9%, and P 0.7%; CP 511 Bravo: CP 21–23%, EE 5–8%, CP 3–5%, Ca 0.90–1.20%, and P 0.70–1.00%

²Hartadi *et al.* (2005).

³Proximate analyzed in the Examine Laboratory of Biotechnology, LIPI for CP, CF, and EE contents and Laboratory of Feed Certification and Quality Analysis, Bekasi for Ca and P contents.

⁴Proximate analyzed in the Examine Laboratory of Baristand Banda Aceh

Table 2. Nutrient content of unfermented and fermented leubim fish waste meal

Nutrients	Leubim fish waste meal	
	Unfermented ¹	Fermented ²
		--- (%) ---
Dry matter	92.52	-
Ash	42.82	-
Crude protein	49.24	49.52
Ether extract	1.61	1.82
Crude fiber	11.33	0.34
Ca	10.46	6.75
P	6.25	5.38

¹Analyzed in the Examine Laboratory of Biotechnology, LIPI for CP, CF, and EE contents and the Laboratory of Feed Certification and Quality Analyzing, Bekasi for Ca and P contents.

²Analyzed in the Examine Laboratory of Baristand, Banda Aceh

α_i = an effect due to population i , β_j = an effect due to BW block j , and a random error associated with the response on diet i , BW block j .

Fermentation process

The procedure of making fermentation LFWM was run as following: LFWM was sprayed by 20 ml/l water of binosil per 10 kg feed, then mixed homogenize, and subsequently filled into the plastic bags and held for 7 days. Afterward, plastic bags were opened while feeds were spelt them out and placed to exposure area to aerate for 24 hours. As many as 1 kg of fish sample was sent to the Examine Laboratory of Baristand, Banda Aceh aiming to analysis the LFWM nutritional content. The nutritional content of unfermented and fermented LFWM was given in Table 2.

Experimental procedures

This research was run into several steps: the preparatory step consisted of preparation of cages and diets. As many as 20 cages as an experimental unit each along with the equipments were rinsed and disinfected exploiting detergent and disinfectant agents, then allowed for 7 days. Dry and clean litters were poured into the cages and heating bulbs were set on close to 2 days before placement of chicks. The diet preparation was initially done by making LFWM for which few going to further process i.e. fermentation. Both were included into the commercial diets based on the formulation for each treatment.

Feeding broilers were divided into 2 periods. During the first two weeks, all birds were fed by full commercial diet CP 511 and kept under brooding condition in every cage. At the end of the second weeks, all birds (100 birds) were relocated based on body weight records then split into 4 blocks (as replicates for CRD) ranked from the highest to the lowest. The 20 birds with the highest body weights were taken randomizely one by one in different sequences to occupy in the treatment D1, D2, D3, D4, and D5, respectively so that each treatment had 5 birds to perform block 1 (replicate 1) following the BRD procedure (Ott, 1991). The next blocks were constructed with the same procedures. Therefore, the average initial body weights among the treatments were so close when the birds commenced feeding experimental diets. At this time, the heating bulbs were set off and the birds were fed on experimental diets of

which some replaced with feed ingredients consisting of LFWM without fermentation and fermentation with the level of 6 and 12% each. Diets and drinking water were supplied ad libitum by the additions of the diets twice a day while the latter was replaced by fresh water every day. Vitastress was provided during the second week until the fourth week.

Collecting the data was completed at the end of 5 weeks for which all birds were weighed to record final body weight (FBW). The average weekly body weight gain (BWG) was computed by subtracting FBW with chick weight divided by 5 weeks. Weekly feed intake was obtained by subtracting the number of feed given and the number of rest feed while cumulative feed intake was obtained by adding weekly feed intake. Protein intake was computed by multiplying feed intake and dietary protein level. Feed conversion ratio (FCR) was calculated by dividing cumulative feed intake and BWG. Protein efficiency ratio (PER) was determined by dividing daily BWG and daily protein intake.

Parameters

The parameters observed in this research were broiler performances at 5 weeks of age included final body weight (FBW), body weight gain (BWG), feed intake, protein intake, feed conversion ratio (FCR), and protein efficiency ratio (PER).

Data analysis

The data was analyzed using an Analysis of Variance (AOV) according to Ott (1991). The analysis was continued by Duncan's Multiple Range Test (DMRT) only if significant effects were detected among the treatments.

Results and Discussion

Final body weight and BWG

The average final body weight (FBW) and body weight gain (BWG) of broilers fed the commercial diets partially substituted with feed ingredients consisting of leubim fish waste meal (LFWM) administered by fermenting and without fermenting were given in Table 3.

The results of AOV represented the inclusion of feeds containing LFWM whereas fermented (D2 and D3) or not (D4 and D5) combined with yellow corn and topmix as a partial

Table 3. Average FBW and BWG of the broilers fed the experimental diets

FBW/BWG	Experimental diets				
	D1	D2	D3	D4	D5
Average final body weight, FBW (g/bird)					
Bodyweight at 5 weeks of age	1,874±130.9 ^a	2,119±167.3 ^b	2,001±153.1 ^{ab}	2,029±76.8 ^b	2,060±76.8 ^b
Average weekly body weight gain (BWG) (g/bird/week)					
2–5 weeks	461.6±35.3 ^a	541.7±45.3 ^b	505.3±41.7 ^{ab}	513.9±21.9 ^{ab}	523.0±25.0 ^b
0–5 weeks	366.1±26.2 ^a	415.1±33.5 ^b	391.5±30.6 ^{ab}	397.1±15.4 ^{ab}	403.3±15.4 ^b

^{a,b} The number in the same row with different superscripts were statistically detected in significant differences (P<0.05)

substitution of commercial diets significantly (P<0.05) increased average FBW and BWG during either a period of feeding experimental diets 2–5 weeks or overall period 0–5 weeks. Average FBW of broilers fed the diets some replaced with LFWM without fermenting (with the exception of D2) and fermenting (D2–D5) significantly higher than those fed full commercial diet (control). While average BWG significantly higher than those fed 6% of LFWM without fermenting (D2) and 12% of LFWM with fermenting (D5). Although, collected from the by-products of fish cutting sites, this fish waste was still considered having high nutritional value. Karimi (2006) reported the body weight at 32 and 42 d and daily gain during 0–42 d had significantly increased with the anchovy fish meal inclusion to broiler diets. The LFWM contained relatively high protein (Table 2). The LFWM was also regarded as better amino acids. Among various animal proteins, fish meal is rich protein (amino acids), readily available throughout most of the world (Cho and Kim, 2011).

As LFWM without fermenting was included up to 12% (D3), average FBW and BWG tend to increase but statically no significant differences were detected in comparison to the control diet (D1). Including LFWM in higher level (12%) causing decline in availability of digestible protein derived from its meal within the diet due to the increase of keratin and chitin perhaps highly found in leubim skin. Keratin was structural protein greatly located within the epithelial cells (Coulombe and Omary, 2002) tough digested by the chickens. While chitin is the most important natural polysaccharide after cellulose found in crustaceous shell or in cell walls of fungi (Kumari and Rath, 2014). Rumengan *et al.* (2017) reported that from fish scales of parrotfish (*Chlorurus sordidus*) and red snapper (*Lutjanus argentimaculatus*) were obtained rendered chitin as many as 45% in amide groups at 1627.13 cm⁻¹ and 33% in amide groups at 1648.09 cm⁻¹, respectively identified by the method of FTIR Analysis.

The inclusion of LFWM with high level (12%) with fermented treatment significantly increased average FBW of the birds compared to the control diet (D1). This was in accordance with Winarno *et al.* (1990) feed going through fermentation had nutritional value higher than that without undergoing fermentation. The result of the analysis in the Examine Laboratory of Baristand, Banda Aceh revealed the similar protein content in LFWM after fermented (Table 2). On the other

hand, crude fiber (CF) content extremely declined as the meal was fermented (11.33 vs. 0.34%).

Even though no real increasing in protein content, the digestible protein was expected to rise so as to provide better amino acids. Fermentation released several nutrients especially amino acids that could be absorbed by the chickens for optimal growth (Winarno *et al.*, 1990). The bacillus microbes (*Lactobacillus collinides* and *Lactobacillus delbreckii*) available in binosil were seemed capable of breaking down the keratin releasing the nutrients easily digested by the chickens. Based on Supriyati *et al.* (2000), keratin could be broken down by *Bacillus licheniformis* and *Bacillus sp.* and increased the digestible proteins from 13.09 to 56.43 and 57.05%.

The result of DMRT showed that there were no significant differences in average FBW and BWG between the birds fed feeds containing unfermented and fermented LFWM (D4 and D5 vs. D2 and D3). It means that FBW of broilers fed feeds containing fermented LFWM was not significantly higher than that of broilers fed those containing unfermented LFWM. This result was contrary to Yasar *et al.* (2016), the BWG of birds fed fermented grains was higher (P<0.05) than that of birds fed unfermented grains. In this research, the average FBW of experimental birds fed the diet D2 and D3 had meet to the optimum level at the age of 5 weeks. Basic diet was commercial diet CP 512 though having perfect composition of diet formulation. The feed ingredients of which fermented just included LFWM to replace some of the commercial diets. Fermentation maintained the increase in FBW of broilers fed the commercial diet substituted with high level (12%) of LFWM. Average FBW at the end of 5 week old broilers fed the experimental diets was illustrated in Figure 1.

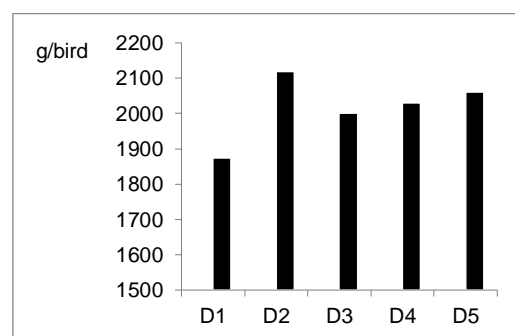


Figure 1. Average final body weight at 5 week old.

There was no indication positive effects of experimental diets on performances were caused by the differences of dietary protein levels. High CP within the LFWM brought to highly raise the CP levels within the diets when used in high levels potentially causing imbalance in energy protein ratio (EPR). For this reason, yellow corn was included at least the similar amount of LFWM to assure the EPR existed in constant ratio close to the control diet. In spite of this, the slightly differences in dietary CP levels could not be kept away from the diets. However, the dietary CP levels kept maintain in the range recommended. The CP requirement for broiler was 23% during 0–3 weeks and 20% during 3–6 weeks with 3200 kcal/kg ME for overall period (NRC, 1994).

The CP levels within the diets containing LFWM indicated D5 > D4 and D3 > D2, the significant differences in broiler performances did not emerge among these treatments. These diets contained CP somewhat higher than D1 (control), then why the birds fed the latter did not show look alike BWG than those fed the formers? Clearly, the CP levels 21–23% in recent study might not affect anything to broiler performances rather than numerous nutrient sources thought mainly originated from LFWM. The diets with lower vs higher CP levels gave related effects as followed by the increasing of ME to appropriate ratio (Anggorodi, 1989). In contrast, Kamran *et al.* (2008^a) found feeding broilers from 1 to 35 d of age on low-CP diets with constant ME:CP ratio had adversely affected the growth performances. In another study, Kamran *et al.* (2008^b) found lowering CP levels from 23 to 20% with isocaloric 2925 kcal/kg ME and maintained digestible lysine at 1.1% within diets did not significantly affect on BWG, feed intake, and FCR of broilers from one to twenty-six-days of age.

Since well known, the corn ME was higher than the usual fish meal ME conversely to the protein content, the inclusions of the comparable numbers of these feedstuffs lead to augment the levels of dietary energy in line with the levels of dietary protein. Unfortunately, the ME content in the diets could not be presented since the ME of LFWM has not been studied yet. Meanwhile, the fabricant for commercial diets CP 511 and CP 512 did not represent the ME content but supposed both nearly 3200 kcal/kg ME with approximately 140 and 150 EPR, respectively. Studied reported by Jackson and Leeson (1982), a significant interaction between protein and energy indicated the importance of balanced ME:CP to achieve optimum performance.

It was not concerned topmix most responsible to positive effects on performances of broilers fed the diets containing LFWM. Commercial diets CP 512 and CP 511 were composed of vitamins and minerals (not mention fabricant merk in the market label). Exclude some amounts of the commercial diets replaced partly with mixture feeds causing lost several these nutrients as well. Study reported by Sayadi *et al.*

(2005) showed that it was possible to remove dietary mineral premix during at least first 2 weeks of grower period but longer with withdraw can negatively affect weight gain and feed conversion of broiler chickens. For this reason, top mix which was 12 vitamins and 6 minerals and 2 essential amino acids, EAA (methionine and lysine) was included 0.5% into the diets containing LFWM. These would not be able to significantly enhance BWG rather than ample EAA served primarily by the LFWM.

The accessible reason could be taken into consideration to suspect the responsibility of LFWM since it was not exclusively used within the replacement feeds. Hence, supplementary effects obtained from the combination of LFWM + yellow corn + top mix + feed ingredients existing in commercial diet were more reasonable to conclude significant effects might occur for BWG. Reported by Borgstrom (2012), certain fish meals having a low biological value when fed to the chickens as the sole source of protein proved to have an excellent supplementary effect when fed at 3% level in a diet containing plant proteins. Fish meals might produce low tryptophan destroyed or make physiologically less available by its processing so they are provided inadequate when feed alone but make efficient supplements for vegetable proteins. In general, cereal proteins are short in lysine, methionine, and to a lesser extent cystine, isoleucine, and threonine of which these are abundantly contained in fish protein. Yellow corn had low protein but with high number composted into the diet furnished more EAA especially tryptophan.

Feed intake and protein intake

The average feed and protein intake of broilers fed the commercial diets partially substituted with feed ingredients consisting of LFWM administered by fermenting and without fermenting was given in Table 4. The results of AOV represented the inclusion of feeds containing LFWM whereas fermented (D2 and D3) or not (D4 and D5) combined with yellow corn and topmix as a partial substitution of commercial diets did not significantly ($P>0.05$) affect on total feed intake. In spite of this, weekly feed intakes were significantly ($P<0.05$) affected during a period of feeding experimental diets 2–5 weeks but insignificantly for overall period 0–5 weeks. Broilers fed the commercial diets partly substituted with feed containing LFWM either fermented (D2 and D3) or not (R4 and R5) were subjected to significantly increase feed intake compared to those fed full commercial diet (D1). It was assumed that LFWM was rather preferred by the birds. Solangi *et al.* (2002) reported that fish meal enhanced feed consumption. Different sources of fish meal affected feed consumption as reported by Raza *et al.* (2015), apparently better feed consumption was observed in gradar fish meal as compared to sindh fish meal. The beneficial effects of fish meal on broiler performance

Table 4. Average feed intake (FI) and protein intake (PI) of broilers fed the experimental diets

Feed intake/protein intake	Experimental diets				
	D1	D2	D3	D4	D5
Feed intake (g/bird)					
Total FI 2–5 weeks	2,333±72.7	2,606±338.6	2,339±147.8	2,471±149.2	2,478±330.8
Total FI 0–5 weeks	2,880±72.7	3,154±338.6	2,886±147.8	3,019±149.2	3,026±330.8
Avg. weekly FI 2–5 weeks	777.6±24.2 ^a	868.7±112.9 ^b	779.6±49.3 ^{ab}	823.8±49.7 ^{ab}	826.1±110.3 ^b
Avg. weekly FI 0–5 weeks	576.1±14.5	630.8±67.7	577.3±29.6	603.8±29.8	605.2±66.2
Protein intake (g/bird/day)					
Avg. Daily PI 2-5 weeks	22.22±0.69 ^a	26.06±3.39 ^b	24.50±1.55 ^{ab}	24.71±1.49 ^{ab}	25.96±3.47 ^b
Avg. Daily PI 0-5 weeks	16.77±0.42 ^a	19.08±2.03 ^b	18.14±0.93 ^{ab}	18.27±0.90 ^{ab}	19.02±2.08 ^b

^{a,b} The number in the same raw with different superscripts were statistically detected in significant differences ($P < 0.05$).

became most evident at higher use levels and during the latter growth periods, primarily via stimulation of feed intake (Karimi, 2006).

However, the presence of yellow corn and topmix within the feeds in recent study could not be obeyed since various feed ingredients formulated into the diet improved palatability (Anggorodi, 1989). Widely known, yellow corn also was so palatable for chickens. As LFWM included up to 12% (D3), feed intake seem to decline but still equal to the control. Increase of keratin and chitin in the diet was though responsible in reducing this feed intake.

Birds lead to increase again their feed intake as LFWM was fermented (D4 and D5) stressing that fermentation could improve palatability of the diet. As reported by Pelczar and Chan (2007), fermentation enhanced flavor and taste to the feed. Increased feed intake of the birds fed LFWM either fermented (D2 and D3) or not (D4 and D5) supported to higher achievement of average FBW and BWG. Agree with Jull (1982), BWG was influenced by the quality of diet given to the birds.

Increase feed intake did not always lead to increase protein intakes depend upon protein levels within the diets as well. Results of AOV indicated protein intakes were significantly ($P < 0.05$) affected by the experimental diets either during a period of feeding experimental diets 2–5 weeks or overall period 0–5 weeks. Feeding the broilers on the diets containing LFWM (D2–D5) significantly increased protein intake relating to feed intake and dietary protein level. Birds fed D2–D5 consumed more proteins and EAA compared to those fed the control diet thus resulting higher FBW and BWG. Broilers have high dietary protein requirement (Beski *et al.*, 2015), protein assists the synthesis of body tissue, for that renovation and growth of the body. At the end of discussions, the positif effects on FBW and BWG in recent study should be emphasize due to the increasing of protein intake.

FCR and PER

The average FCR and PER of broilers fed the commercial diets partially substituted with feeds consisting of LFWM administered by fermenting and without fermenting was given in Table 5. The results of AOV represented the inclusion of feeds containing LFWM whereas fermented (D2 and D3) or not (D4 and D5) combined with yellow corn and top mix as a partial substitution of commercial diets did not significantly ($P < 0.05$) affect on feed conversion (FCR) either during a period of feeding experimental diets 2–5 weeks or overall period 0–5 weeks. The increase in BWG was directly with the increase in feed intake resulting in similar FCR of all treatments. Despite, broilers fed the commercial diets partly substituted with feeds containing LFWM (D2–D5) were susceptible to improve FCR than those fed full commercial diet (D1).

This result indicated that replacements partially commercial diet with feeds containing LFWM either fermented or not improved the quality of the diet. Nutrient content in LFWM was believed excellent. According to Nesheim *et al.* (1990), one of factors influenced feed conversion was sufficient nutrient availability within feed sources. Similarly reported by Amrullah (2006), feed quality affected feed conversion of which the better feed quality the better FCR. Hence, the lower FCR the better feed quality (North and Bell, 1990).

The quality of dietary protein could be determined, for instance, by PER. Results of AOV indicated PER were not significantly ($P < 0.05$) affected by the experimental diets. Feeding broilers on the diets containing LFWM (D2–D5) did not significantly increased PER relating to daily BWG and daily protein intake. Replacement partially protein sources within the commercial diet with the protein sources mostly within the feeds containing LFWM (D2–D5) were capable to maintain the quality of dietary

Table 5. Average FCR and PER of broilers fed the experimental diets

FCR/PER	Experimental diets				
	D1	D2	D3	D4	D5
Feed conversion ratio (g Feed Intake/g BWG)					
2–5 weeks	1.69±0.09	1.60±0.07	1.55±0.08	1.60±0.11	1.58±0.22
0–5 weeks	1.58±0.08	1.52±0.05	1.48±0.07	1.52±0.06	1.50±0.15
Protein efficiency ratio (g BWG/g protein intake)					
2-5 weeks	2.97±0.17	2.98±0.13	2.95±0.16	2.98±0.21	2.92±0.45
0-5 weeks	3.12±0.17	3.11±0.09	3.08±0.14	3.11±0.11	3.05±0.32

protein. The PER determination has been old used in assessment protein quality. It has been criticized on the basis that (1) gain in BW may not be constant in tissue composition the diets containing different proteins, (2) results may vary with protein level, and (3) the determination makes no allowance for the maintenance requirement (Lamb and Harden, 1973).

Conclusions

The results of this research concluded that the inclusion of feeds containing leubim fish waste meal (LFWM) treated by either or not fermented combined with yellow corn and top mix as partially substitution of commercial diets significantly increased final body weight, body weight gain, feed intake, and protein intake compared to those fed full commercial diet. There were no significant differences in feed conversion ratio and protein efficiency ratio between broilers fed the commercial diet partially replaced with the feeds containing either unfermented or fermented LFWM. The best level of LFWM resulting better performances of broilers was recorded at 6% of inclusion as treated without fermenting. However, fermenting meal increased the level of the inclusion of the LFWM up to 12% without adverse effect on broiler performances. Since the LFWM was not the only feed constituted in feed ingredients, it could not be concluded the LFWM solely improved broiler performances. However, the LFWM was thought play important roles rather than merely yellow corn and topmix. So, the benefits of partially replaced commercially diet with the feeds containing LFWM in recent study could possibly carry out the economic advantages. Further studies should be developed to explore the potency of the LFWM as an alternative animal protein source in poultry diets.

References

- Amrullah, I. K. 2006. *Nutrisi Ayam Broiler*. Lembaga Satu Gunung Budi, Bogor.
- Anggorodi, R. 1989. *Kemajuan Mutakhir dalam Ilmu Makanan Ternak Unggas*. Penerbit Universitas Indonesia, Jakarta.
- Austin, P. R., C. J. Brine, and J. E. Castle. 1981. Chitin: New facets of research. *Science* 212: 749–753.
- Beski, S. S. M., R. Swick, and P. Iji. 2015. Specialised protein products in broiler chicken nutrition: A. Review. *Animal Nutrition* XXX: 1–7.
- Borgstrom, G. 2012. *Fish as Food V2: Nutrition, Sanitation, and Utilization*. Vol. II. Elsevier Inc., Amsterdam.
- Cho, J. H. and I. H. Kim. 2011. Fish meal – nutritive value. Review Article. *Journal Physiology and Animal Nutrition* 95: 685–692.
- Coulombe, P. A. and M. B. Omary. 2002. Hard and soft principles defining the structure, function and regulation of keratin intermediate filaments. *Departments of Biological Chemistry and Dermatology, Johns Hopkins University School of Medicine, 725 North Wolfe Street, Baltimore, USA. Current Opinion in Cell Biology* 14: 110–112.
- Hartadi, H., S. Reksohadiprodjo, and A. D. Tillman. 2005. *Komposisi Bahan Pakan untuk Indonesia*. Gadjah Mada University Press, Yogyakarta.
- Jassim, J. M. 2010. Effect of using local fish meal (Liza abu) as protein concentration in broiler diets. *Int. Journal Poul. Sci.* 9: 1097–1099.
- Jackson, S. and S. Leeson. 1982. Effect of dietary protein and energy on broiler performance and production costs. *Poult. Sci.* 61: 2232–2240.
- Jull, M. A. 1982. *Poultry Husbandry*. 3rd ed. Tata McGraw-Hill Publish Co. Ltd., New Delhi.
- Kamran, Z., M. Sarwar, M. Nisaa, M.A. Nadeem, S. Mahmood, M. E. Babar, and S. Ahmed. 2008a. Effect of low-protein diets having constant energy-to-protein ratio on performance and carcass characteristics of broiler chickens from one to thirty-five days of age. *Poult. Sci.* 87: 468–478.
- Kamran, Z., M. Sarwar, M.U. Nisaa, and M. A. Nadeem. 2008b. Effect of low levels of dietary protein on growth, protein utilisation and body composition of broiler chicks from one to twenty-six-days of age. *Avian Biology Research* 1: 19–25.
- Karimi, A. 2006. The effects of varying fish meal inclusion levels (%) on performance of broiler chicks. *Int. J. Poul. Sci.* 5: 255–258.
- Kumari, S. and P. K. Rath. 2014. Extraction and characterization of chitin and chitosan from (Labeo rohita) fish scales. *Procedia Materials Science* 6: 482–489.
- Lamb, M.W. and M.L. Harden. 1973. *The Meaning of Human Nutrition*. Elsevier Inc., Amsterdam.
- Nesheim, M. C., R. E. Austich, and L. E. Card. 1990. *Poultry Production*. Lea and Febiger, Philadelphia.
- North, M. D. and D. D. Bell. 1990. *Commercial Chicken Production Manual*. 4th ed. The Avi Publishing Company Inc., Wesport, Connecticut.
- Ott, R. L. 1991. *An Introduction to Statistical Methods and Data Analysis*. 4th ed. Duxbury Press, Belmont, California.
- NRC. 1994. *Nutrient Requirements of Poultry*. 9th ed. National Research Council (NRC). National Academy Press, Washington DC.
- Pelczar, M. J. and E. C. S. Chan. 2007. *Dasar-Dasar Mikrobiologi*. Jilid ke-1. Penerjemah Hadioetomo, R.S., T. Imas, S.S. Tjitrosomo, dan S.L. Angka. UI Press., Jakarta.
- Raza, S., T. N. Pasha, A. S. Hashmi, M. W. Shoaib, and H. Mubeen. 2015. Effect different levels and sources of fish meal on the performance of broiler chicks. *Int.*

- Journal of Scientific & Engineering 6: 1708–1713.
- Rumengan, I. F. M., P. Suptijah, S. Wullur, and A. Talumepa. 2017. Characterization of chitin extracted from fish scales of marine fish species purchased from local markets in North Sulawesi, Indonesia. *IOP Conf. Series. Earth and Environmental Science* 89: 1–4.
- Sayadi, A. J., B. Navidshad, A. Abolghasemi, M. Royan, and R. Seighalani. 2005. Effects of dietary mineral premix reduction or withdrawal on broilers performance. *Int. J. Poult. Sci.* 4: 896-899.
- Solangi, A. A., A. Memon, T. A. Qureshi, H. H. Leghari, G. M. Baloch, and M. P. Wagan. 2002. Replacement of fish meal by soybean meal in broiler ration. *J. Anim. Vet. Adv.* 1: 28–30.
- Supriyati, T. Purwadaria, and I. P. Kompiang. 2000. Produksi mikroba terseleksi pemecah keratin pada bulu ayam skala laboratorium. *Seminar Nasional Peternakan dan Veteriner*: 349–355.
- Wang, B., W. Yang, J. McKittrick, and M. A. Meyers. 2015. Keratin: Structure, mechanical properties, occurrence in biological organisms, and efforts at bioinspiration. *Progress in Materials Science* 76: 229–318.
- Winarno, F. G. 2000. *Kimia Pangan dan Gizi*. PT Gramedia Pustaka Utama, Jakarta.
- Winarno, F. G., S. Fardiaz, and D. Fardiaz. 1990. *Pengantar Teknologi Pangan*. Gramedia, Jakarta.
- Yasar, S., M. S. Gök, and Y. Gürbüz. 2016. Performance of broilers fed raw or fermented and redried wheat, barley, and oat grains. *Turk. J. Vet. Anim. Sci.* 40: 313–322.