Livestock and Animal Research
Accredited by Directorate General of Strengthening for Research and Development No. 10/E/KPT/2019

Open Access
Livest. Anim. Res., November 2022, 20(3): 220-230
p-ISSN 2721-5326 e-ISSN 2721-7086
https://doi.org/10.20961/lar.v20i3.55172

Original Article

Effect of feeding broilers with the diets containing *leubim* fish waste meals processed with including and without its skin on the weights and percentages of carcasses and internal organs of broilers

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Received: September 17th, 2021; Accepted: July 1st, 2022; Published online: November 1st, 2022

Abstrak

Tujuan: Penelitian ini bertujuan untuk mengamati pengaruh penggunaan tepung limbah ikan *leubim* (LFW) yang dibuat tiga macam, yaitu tepung limbah ikan *leubim* keseluruhan (LFW_W), tepung kulit limbah ikan *leubim* (LFW_S), dan tepung limbah ikan *leubim* tanpa kulitnya (LFW_{-S}),untuk mengganti sebagian pakan komersil (CCP) terhadap berat dan persentase karkas dan potongan-potongan karkas serta beberapa organ internal ayam broiler.
Metode: Penelitian ini menggunakan 100 ekor DOC broiler strain CP 707, jagung kuning (YC), tepung ikan lokal komersil (CFM), dan top mix (TM). Rancangan yang digunakan adalah Rancangan Acak Lengkap subsampel dengan 5 perlakuan, 4 ulangan, 2 subsampel. Perlakuan adalah CCP= 100% CP511 (kontrol+), CFM (kontrol-), LFW_W, LFW_S, dan LFW_{-S}, masing-masing 8% ditambah 8% YC + 0,5% TM sebagai pengganti 83,5% CCP. Data dianalisis dengan *Analysis of Variance* (ANOVA).
Hasil: Secara statistik tidak berbeda nyata (P>0,05), namun ayam-ayam dengan perlakuan ransum komersil yang sebagian disubstitusi dengan semua LFW *meal* baik LFW_W, LFW_S, and LFW_{-S}, memiliki berat karkas dan potongan karkas relatif lebih tinggi dan persentase karkas tidak jauh berbeda. Ayam dengan pelakuan LFW nyata (P<0,05) memiliki persentase dada lebih tinggi daripada kontrol. Semua organ internal yang diamati tidak menunjukkan perbedaan nyata (P>0,05), namun ayam-ayam dari perlakuan LFW cenderung memiliki persentase ampela lebih tinggi.
Kesimpulan: Penggunaan tepung limbah ikan *leubim* baik diolah secara keseluruhan, tanpa kulit, ataupun kulitnya saja meningkatkan persentase dada ayam broiler tanpa berpengaruh pada organ-organ internal ayam broiler.

Kata Kunci: Broiler; *Canthidermis maculata;* Internal organ; Karkas; Kulit ikan

Abstract

Objective: This study aimed to evaluate the weights and percentages of carcasses and internal organs of broilers fed the partial substituted commercial ration (CCP) with *leubim* fish waste meal (LFW) made up of whole *leubim* fish waste meal (LFW_W), *leubim* fish waste skin meal (LFW_S), and skinless *leubim* fish meal (LFM_{-S}), each combined with yellow corn (YC) + top mix (TM).
Methods: 100 broiler chicks strain CP 707 and commercial local fish meal (CFM) were employed in this study. The study was performed into a Completely Randomized Design with subsampling

comprising 5 treatments, 4 replications, and 2 subsamples. The treatment was 100% CCP (control+) and 16.5% of substituted feeds composted of the CFM (control-), the LFW$_W$, the LFW$_S$, the LFM$_{-S}$, with the same level of 8% each + 8% YC + 0.5% TM each. The data were analyzed by Analysis of Variance.
Results: Statistically, no significant differences (P>0.05) but substitute partial commercial diet with the mixture feeds constituted of LFW meals in the forms of LFW$_W$, LFW$_S$, LFW$_{-S}$, each added with YC + TM had relatively higher weights of whole carcasses and cut-ups of broilers. Relatively to life weight, the carcass percentages were equal but the percentages of breasts significantly higher (P<0.05) in the broilers fed the LFW-based rations. There were no significant effects (P>0.05) on the weights and percentages of all internal organs.
Conclusions: Substitute partial commercial ration with the *leubim* fish waste meal increased breast percentage without adverse effect on internal organs of broilers.

Keywords: Broiler; *Canthidermis maculata;* Internal organs; Carcass; Fish skin

INTRODUCTION

Broiler meat has been contributing to the need for animal protein for human. The demand for meat increases every year due to the world population growth. For this reason, broiler producers have been encouraged to heighten their broiler meat production. In attempting to respect this, feed cost has become the major barrier predominantly faced by the lower-middle industries. Commercial diets are frequently so expensive causing a low margin earned by small-middle scales of broiler farms. Formulating the broiler diet own selves may not result in better income in several regions in which feedstuffs are not available adequately. Hence, an easier way was to explore the local feed sources willingly originated from disposals potentially to substitute fractionally the commercial diets. Among other things was *leubim* fish (*Canthidermis maculata*) waste.

Leubim fish waste is a by-product of *leubim* fish cutting widely found in the fish markets in Aceh. Based on our survey in Pasar Ikan Lampulo Banda Aceh, we have recorded that approximately 60% of whole *leubim* fish is discarded composts of head, skin/scales, fin, meat attached to bone, and viscera. This waste can be treated into the meal for poultry feedstuffs. A study reported by [1] showed that utilizing *leubim* fish waste meal (LFW) in the diet increased broiler performances. Similarly reported by [2], mixing LFW meal + yellow corn + top mix to replace some of the commercial diets increased broiler performances compared to using a full commercial diet (control). Despite this, the final target of producing broilers, therefore, is the carcass yields. A good performance of broilers should also reflect their economic value. The effects of inclusion of LFW meal in the diet on carcass and cut-up commercials as well as internal organs of broilers are still not well exposed yet.

Recently, the waste originated from fish processing has been collected by several local farmers to make use of it in poultry feed thus assisting in lowering removal. Unfortunately, just the skinless waste was desired, while the *leubim* skin was neglected and imaged as a horrible creature. Therefore, the *leubim* waste has still left the dumping which was its skin. Previous studies [1] have shown that the whole LFW meal including its skin/scales could be introduced into the diets with the results in better performances but its skin/scales was not concerned capable to employ. The rigid and hard skin of *leubim* was suspected to upset the works of internal organs of the birds mostly causing enlargements of several of these organs. In this case, the birds are probably alive but well performance may not be achieved. The growth of broilers is strictly associated with their internal organ development [3]. Therefore, feeding the broilers an alternative fish meal which was a *leubim* fish waste meal to incorporate into the diet should also include measuring their internal organs.

The increased sizes of internal organs may occur not only because of tough feed digestion but feed toxicity as well. Ideally, whatever feed ingredients are formulated into the diet must not be harmful to the organ systems of the broiler that could suffer the birds' health or increase mortality. Extra attention should be notable when the feedstuffs were processed from the by-products or waste materials gathered from highly thinkable contaminated sources. The assessment of unusual feedstuffs should not be careless about their safety. An initial indication of a feed whether safe or not to feed on the birds can be inspected by measuring the volumes of their internal organs mainly liver, heart, spleen, and pancreas. Severely enlarged the majority of internal organs over a normal size strongly designate those birds have swallowed poison feeds causing both high morbidity and mortality [4]. According to Dórea [5], animals mainly fish fed a diet containing fish meal could deposit monomethyl mercury in protein substances and organohalogen toxins could infiltrate into the fat fractions of descended foods. Then, an appraisal of impurity in a fish meal may specify that food safety has to contemplate the people's health impression of foods produced from animals eating a polluted feed. Since LFW has originated from discardings, it is necessary to examine the internal organs of broilers fed the diet containing this administered meal.

The aim of the present study was to evaluate the carcass and cut-up yields, as well as internal organs of the broilers, fed the commercial feed fractionally replaced with *leubim* fish waste meal (LFW) made up of three meals: whole *leubim* fish waste meal (LFW_W), *leubim* fish waste skin meal (LFW_S), and skinless *leubim* fish meal (LFM_{-S}), with the addition of yellow corn (YC) and top mix (TM), each. The effect of those on broiler growth and its economic impacts had been discussed in [6]. The results of the present study were expected to utilize wholly *leubim* fish waste comprising its skin/scales in poultry diets with no adverse effect to the birds and expectantly developing in highly carcass weight. Another benefit was presumed to succeed *leubim* fish waste to zero waste.

MATERIALS AND METHODS

Place and time

Recent study was done at the Laboratorium Lapangan Peternakan (LLP), Syiah Kuala University for 5 weeks starting from March 17 to April 21, 2021.

Materials and equipment

This study used 100 chicks strain CP 707 growing for up to 5 weeks. The materials consisted of commercial feed CP511, commercial local fish meal obtained from Medan, top mix, yellow corn, whole *leubim* fish waste meal, *leubim* fish waste skin meal, skinless *leubim* fish waste meal, vita stress, medicine, and the vaccines of Infectious Bursal Disease (IBD) and New Castle Disease (ND). The equipment was defined into (a) rearing boilers: 20 cages 1 x 1 m each completed by a 40-watt heating light bulb, feeder, and drinker. (b) meal processing: disk mills, stoves, boilers, and drainers, and (c) yield processing: scalder, defeathering machine, scales, and processing knives.

Experimental rations

This study used the commercial feed of CP511 as a positive control ration at 100% usage (CCP). Then, 16.5% of this feed was substituted with mixture feeds composted of 8% fish meal + yellow corn (YC) + 0.5 top mix (TM). A negative control diet was constituted based on using the commercial local fish meal (CFM). The *leubim* fish waste meals were made up of whole LFW_W, LFW_S, and LFW_{-S}. The dietary nutrients were subjected to broiler requirement refers to National Research Council [7]. The fomation and the dietary nutrients of the experimental rations and the chemical composition of fish meal were presented in Table 1 and 2. The experimental rations were:

CCP = 100% CP511 (control +)
CFM = 8% YC+ 0.5% TM + 8% CFM + 83.5% CP511 (control-)
LFW_W = 8% YC+ 0.5% TM + 8% LFW_W + 83.5% CP511
LFW_S = 8% YC+ 0.5% TM + 8% LFW_S + 83.5% CP511
LFW_{-S} = 8% YC+ 0.5% TM + 8% LFW_{-S} + 83.5% CP511

Table 1. Composition and dietary nutrients of the trial rations

Feed ingredients	Experimental rations (%)				
	CCP	CFM	LFWW	LFWS	LFW-S
CP511 bravo (CCP)[1]	100	83.5	83.5	83.5	83.5
Yellow corn (YC)[2]	0	8	8	8	8
Top mix (TM)	0	0.5	0.5	0.5	0.5
Fish meal					
CFM[3]	0	8	0	0	0
LFWW[4]	0	0	8	0	0
LFWS[5]	0	0	0	8	0
LFW-S[5]	0	0	0	0	8
Total	100	100	100	100	100
Dietary nutrients based on calculation:					
Crude protein (%)	21–23	22.76–24.43	22.30–24.08	22.10–23.77	22.83–24.50
Crude fiber (%)	5.0	4.59	5.28	4.43	4.48
Crude fat (%)	5.0	5.26	4.65	4.57	4.79
Calcium (%)	0.9	0.95	1.60	0.78	0.78
Phosphorus (%)	0.6	0.89	1.02	1.86	1.36

1 Labeling product of CP511 Bravo: CP 21-23%, CF 5%, crude fat 5%, Calcium, 0,9%, and Phosphorus 0,6%

2 [8]

3 Dian Aquatic, [9, 10]

4 [1]

5 Determined at the Examine Laboratory of Baristand, Banda Aceh

The procedures of producing *leubim* fish waste meals

All-inclusive by-products of *leubim* fish cuttings originated from Pasar Ikan Lampulo, Banda Aceh was gathered, then grouped into three components; the whole *leubim* fish waste with its skin, the only *leubim* fish skin waste, and the *leubim* fish waste excluded skin. Every substance was heated in separated boiling water for 45 minutes, subsequently transferred into a drainer, and then dried at sunrise for three days. Afterward, these by-products were grounded using a disc mill resulting in 3 fishmeal products: whole *leubim* fish waste meal (LFWW), *leubim* fish waste skin meal (LFWS), and *leubim* fish waste meal excluded skin (LFW-S). As much as 200 g of LFWS and LFW-S samples were weighed each and then posted to the Examine Laboratory of Baristand, Banda Aceh to determine the chemical compositions.

Research procedures

Research was run in three stages; (a) preparation, (b) feeding broilers on experimental diets, and (c) slaughtering the birds. The preparation comprised of installing the cages and formulating diets. The cages, feeder, and drinker were cleaned and disinfected using formades. The 20 pens were sized 1 x 1 m per pen, and each pen was completed by brooder, feeder, and drinker. Next, the cages were left empty for two weeks. A day before the placement of the chicks, the litter was spread into each cage and the brooders were set on. The diet preparation

Table 2. Chemical composition of commercial local fish meal and *leubim* fish waste meals

Nutrients	CFM[1]	LFWW[2]	LFWS[3]	LFW-S[3]
Moisture (%)	15.04[1b]	7.50	6.07	5.00
Crude protein (%)	55.00[1a]	49.24	46.72	55.84
Crude fat (%)	6.54[1b]	1.61	0.95	3.64
Crude fiber (%)	2.98[1b]	11.33	1.01	1.67
Calcium (%)	2.46[1c]	10.46	0.34	0.27
Phosphorus (%)	4.60[1c]	6.21	16.78	10.5

1a Dian Aquatic; 1b [8]; 1c [11]

2 [1]

3 Determined at the Examine Laboratory of Baristand, Banda Aceh

was initialized by making three kinds of *leubim* fish waste meals and then composting those into the diet mixture based on the formulation of experimental diets and mixed weekly.

Soon after completing the cages and the diets, the chicks were randomly transferred into the cages and then fed the experimental diets *ad libitum* for up to 5 weeks. Drinking water was supplied *ad libitum* by adding vita stress for the first fourth week. The ND vaccine was offered by eye drop on the 3rd day repeated via intramuscular injection on the 21st day. The IBD vaccine was delivered by oral drop on the 12th day.

On the last day of the 5th week, all broilers were weighed individually and then sampled two birds from each cage with their average body weights close to those in their experimental unit. The selected birds were fasted for 6 hours but allowed access to drinking water to reduce feed content in the digestive tract to prevent contamination during processing. The birds were placed into a bleeding cone and then killed and allowed the blood flows down to a container. The bleeding birds were moved into a scalder for 60 seconds and then transferred into a dresser. The viscera were pulled out of the body cavity through an opening made in the abdominal region. The internal organs such as crop, gizzard, liver, heart, pancreas spleen, and intestine were collected by removing attached tissues. The heads + necks and shanks were cut off the birds resulting in a whole carcass. A whole carcass was cut up into commercial parts i.e., breast, wings, thighs, and back.

Experimental design

The study was performed into a completely randomized design with subsampling consisting of 5 treatments, 4 replicates which were experimental units (cages) containing 5 birds each, and 2 subsamples per cage. The mathematical model for this experimental design was: $Y_{ijk} = \mu + \tau_i + \varepsilon_{ij} + d_{ijk}$ where Y_{ijk} = observation value, μ= an overall mean, τ_i = an effect due to diet, ε_{ij} = a sampling error and d_{ijk} = a subsampling error [12].

Variables

Variables examined in this study were: weight and percentage of the whole carcass, cut-ups, abdominal fat, and internal organs. All organs were weighed individually. The percentage of the carcass was found by dividing carcass weight by live weight while the percentages of cut-ups were obtained by dividing every part by whole carcass weight. The percentage of each organ (crop, gizzard, intestine, liver, heart, blood, pancreas, and spleen) was determined by dividing individually each organ by live weight (LW).

Data analyses

The data were analyzed using Analysis of Variance (ANOVA) and continued by a Duncan's Multiple Range Test (DMRT) if $F_{observation} < F_{\alpha 0.05}$ or $_{\alpha 0.05}$ [12].

RESULTS

Weights and percentages of the whole carcass

Weights and percentages of the whole carcasses of broilers observed from all groups were shown in Table 3. ANOVA indicated that substituting a partially commercial diet with the mixture feeds constituted of LFW meals in the forms of whole LFW_W, LFW_S, and LFW_{-S} each added with yellow corn and top mix did not significantly affect (P>0.05) the weights and percentages of the whole carcasses of broilers.

Table 3. Weights and percentages of whole carcasses

LW, whole carcass, Non-carcass		Experimental rations				
		CCP	CFM	LFW_W	LFW_S	LFW_{-S}
FBW	(g bird^{-1})	1,887±112	1,991±149	2,062±45	1,996 ±103	2,029 ±85
Sampling LW	(g bird^{-1})	1,901±177	1,961±311	2,079±171	2,009±270	2,012±223
Whole carcass	(g bird^{-1})	1,354±123	1,375±275	1,487±153	1,450±237	1,437±173
	(% bird^{-1})	71.26±1.59	69.73±3.53	71.41±2.30	71.94±2.83	71.35±1.83
Non-carcass	(g bird^{-1})	547±65	589±54	592±43	559±52	575±64
	(% bird^{-1})	28.74±1.59	30.27±3,53	28.59±2.30	28.06±2.83	28.65±1.83

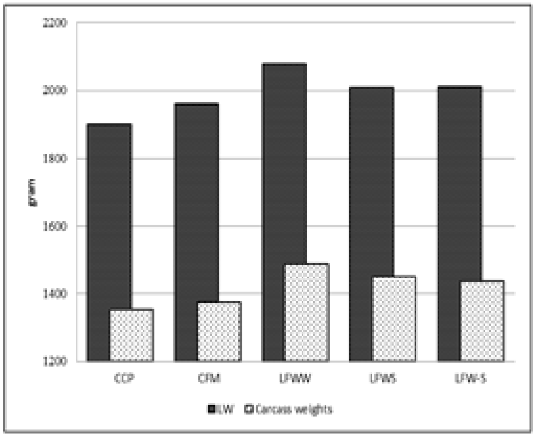

Figure 1. LW and carcass weights of broilers fed the diets containing LFW (CCP= Commercial diet CP 511; CFM= Commercial fish meal; LFW$_{W}$ = Whole *leubim* fish waste meal; LFW$_{-S}$= Skinless *leubim* fish waste meal; LFW$_{S}$= *Leubim* fish skin waste meal)

Even though statistically no significant differences were found, the broilers fed the LFW-based diets (LFW$_{W}$, LFW$_{S}$, and LFW$_{-S}$) seemed to have the whole carcass weights quite higher than those fed the CCP and the CFM diet. Relatively to life weight, the broiler carcasses from all treatments appeared in very close percentages with the range of 69.73–71.94% and were in normal sizes. The LW and carcass weights of the broilers from all groups were illustrated in Figure 1.

Weights and percentages of the cut-ups

Weights and percentages of cut-ups of broilers observed from all groups were shown in Table 4. ANOVA indicated that substituting the partial commercial diet with the mixture feeds constituted of all kinds of LFW diets each added with yellow corn and top mix did not significantly (P>0.05) change the weight and percentage of the cut-ups of broilers. Statistically, no significant differences among the groups, but those fed the fish meal based on the diets either with the addition of the LFW or the CFM meals tended to have greater all cut-ups than those fed the CCP diet. Nevertheless, the latter was quite higher than the former. It meant replacing a partially commercial diet with the LFW meals + yellow corn + top mix resulted in better cut-ups of the broilers. This could be achieved since the broilers fed the LFW-based diets had body weights higher than those fed the control diets.

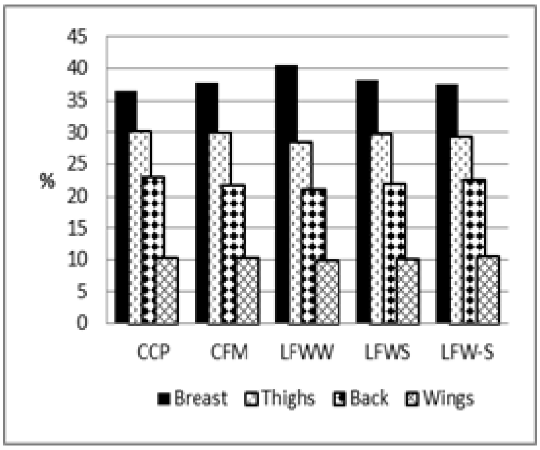

Figure 2. The percentages of cut-up parts of broilers fed the diets containing LFW (CCP= Commercial diet CP 511; CFM= Commercial fish meal; LFW$_{W}$= Whole *leubim* fish waste meal; LFW$_{-S}$= Skinless *leubim* fish waste meal; LFW$_{S}$= *Leubim* fish skin waste meal)

Relatively to the carcass weight, the percentage of breast was higher in the groups

Table 4. Weights and percentages of cut-ups

Cut-ups		Experimental diets				
		CCP	CFM	LFW$_{W}$	LFW$_{S}$	LFW$_{-S}$
Breast	(g bird^{-1})	495±56	527±152	602±66	557±111	540±80
	(% bird^{-1})	36.52±1.43^{a}	37.87±3.61^{a}	40.49±2.19^{b}	38.23±2.4^{a}	37.49±1.40^{a}
Thighs	(g bird^{-1})	408±41	410±71	422±36	430±63	422±57
	(% bird^{-1})	30.12±0.87	30.00±2.37	28.46±1.67	29.76±1.35	29.36±1.64
Wings	(g bird^{-1})	139±13	140±20	148±18	145±19	150±15
	(% bird^{-1})	10.30±1.13	10.31±0.76	9.96±0.76	10.08±0.81	10.50±1.09
Backs	(g bird^{-1})	312±32	298±47	316±57	318±58	325±45
	(% bird^{-1})	23.06±1.36	21.81±1.30	21.09±2.35	21.93±1.49	22.65±2.13

[a,b] The number in the same row with different superscripts indicated a significant difference (P<0.05)

Table 5. Weights and percentages of internal organs

Internal organs		Experimental diets				
		CCP	CFM	LFW$_{W}$	LFW$_{S}$	LFW$_{-S}$
Crop	(g bird^{-1})	5.25±2.05	5.13±0.99	6.25±2.92	5.63±2.20	5.38±2.50
	(% bird^{-1})	0.28±0.13	0.27±0.07	0.31±0.19	0.28±0.09	0.27±0.11
Gizzard	(g bird^{-1})	30.25±8.10	33.75±4.83	35.38±6.00	39.13±5.49	36.75±5.85
	(% bird^{-1})	1.59±0.39	1.75±0.37	1.71±0.29	1.97±0.33	1.84±0.34
Intestine	(g bird^{-1})	46.25±6.40	46.75±8.22	48.00±7.01	48.13±7.10	50.88±7.92
	(% bird^{-1})	2.47±0.26	2.45±0.39	2.33±0.41	2.45±0.40	2.56±0.30
Pancreas	(g bird^{-1})	2.75±1.04	3.13±1.13	3.63±1.19	3.25±1.16	3.00±0.76
	(% bird^{-1})	0.15±0.06	0.17±0.08	0.17±0.05	0.16±0.04	0.15±0.03
Liver	(g bird^{-1})	43.88±6.33	47.38±8.50	46.38±4.75	44.38±3.25	45.38±5.32
	(% bird^{-1})	2.33±0.40	2.48±0.63	2.25±0.30	2.27±0.39	2.27±0.28
Spleen	(g bird^{-1})	2.38±0.92	3.50±1.60	2.75±1.28	2.88±2.30	2.75±1.04
	(% bird^{-1})	0.13±0.06	0.19±0.11	0.13±0.07	0.15±0.13	0.14±0.06
Heart	(g bird^{-1})	7.13±0.99	8.00±1.69	7.75±0.89	7.00±0.93	7.13±0.83
	(% bird^{-1})	0.38±0.06	0.41±0.10	0.37±0.04	0.35±0.04	0.36±0.04

of birds feeding the LFW-based diets with a significantly higher (P<0.05) was detected at the LFW$_{W}$-based diet in comparison to the CCP diet. In the broiler, the breast deposits a lot of muscle, and this part is high in response to the dietary nutrients. Thighs, wings, and backs seemed comparable. The percentages of cut-up parts of the broilers from all groups were illustrated in Figure 2.

Weights and percentages of the internal organs

Weights and percentages of the internal organs of broilers from all groups were shown in Table 5. ANOVA indicated that substituting the partial commercial diet with the mixture feeds constituted of all kinds of *leubim* fish waste (LFW) meals each added with yellow corn and top mix did not significant effect (P>0.05) on the weights and percentages of all internal organs of broilers. Although statistically no significant differences were detected among the treatments, broilers consuming the LFW-based diets tended to have the weights of all internal organs rather higher than those fed the CCP diet. This could be explained that the latter had higher LW, therefore, their organ weights were normally higher too since those associated with each other.

Relatively to LW, the percentages of intestines and crops of the broilers consuming the LFW-based diets were comparable to the controls (CCP, CFM) but the percentages of gizzards appeared higher at those fed the fish meal-based diets. It seemed birds fed these diets increased the gizzard works to degrade all kinds of fish meals used in this study.

DISCUSSION

The increased carcass was related to the live weights of which broilers fed the LFW-based diets had higher live weight (LW). A study reported by [2] also showed that feeding broilers on feed mixture composted of LFW meal + yellow corn + top mix to substitute part of the commercial diet increased final body weight (FBW) compared to those fed a full commercial diet. Increased carcass weight followed the increased FBW that indicated the nutrition in the LFW meals was qualified to perform carcass. Although made up of the by-product of fish cutting, the LFW meal still possessed high protein i.e. 49.24% [2] and this protein increased to 55.84% when the waste was processed with the exclusion of the skin (LFW$_{-S}$), while in the only skin (LFW$_{S}$) was in moderate protein i.e. 46.72% (Table 2). A previous study showed that all parts of *leubim* fish waste contained high protein [13]. This was in agreement with [14], fish waste had a high nutritive value because of its presence of a considerable amount of protein and lipid content, especially in bones. Similarly reported by [15], the overall nutritional composition of each trash fish category was above 15% and contained important minerals which prove that the trash fishes were of good nutritional value, which could be explored in wide standpoints such as food supplements, poultry feed, and various by-products, for instance, fish protein concentrate, fish fertilizer, and fish meal. Fish waste can also be utilized in the production of numerous value-added products such as minerals, proteins, oil, bioactive peptides, enzymes, gelatin, collagen, and amino acids [16].

So far, there was no information about the composition of amino acids in the LFW meal but those were highly supposed excellent. Commonly, fish meal contains high amino acids and is promptly obtainable in most of the world [11]. As reported by [16], fish comprises well-balanced amino acid compositions containing 8 EAA and 8 non-EAAs thus bringing that to be used as fish meal, fish silage, fish sauce, and fertilizer. According to [11], because of its amino acid profile, fish meal has been believed as an attractive protein supplement. They reported that fish meal is a good source of methionine (3.02 g/100 g CP) and lysine (7.91 g/100 g CP). Methionine is an aliphatic, sulfur-containing, EAA, and a precursor of *succinyl*-CoA, cysteine, *homocysteine*, *carnitine*, and *creatine* and has the roles in metabolism, diseases, and oxidative stress [17].

Statistically, not significantly different, but the higher carcass weight was recorded at the LFW$_W$-based diet. Additionally, even though increased protein content, excluding the skin/scales from the waste to perform LFW$_{-S}$-based diet did not result in better carcass weight compared to the LFW$_W$-based diet. The LFW$_S$–based diet did not depress carcass weight but seemed somewhat lower than the LFW$_W$. This directed that the LFW should not be removed from its skin in processing a meal. This might be possible due to any complementary effects in nutrients of all body parts of *leubim.* As reported by [16], fish proteins were located in all parts of the fish. Fish skin was a plenty source of gelatin and collagen [18]. A study by [19] reported that there were 15 amino acids (AAs) found within gelatin of salmon fish skin, the lowest was L-arginine (8.45%) and the highest was L-isoleucine (0.92%). As reported by [20], glycine existed mainly on fish skin. The EAAs which were available in the fish skin were supposed to appropriate contribution to other parts of LFW$_W$ meal resulting in the better formation of broiler carcass. Unfortunately, the AA profile of the LFW$_W$ meal has not been studied yet and this becomes crucial to establish further research concerning the AA contents in this meal because the AA composition may vary among the fish.

The protein in the skin/scales of LFW was previously suspected indigestible which might cause retard the chicken growth and then produce in low yield weight of broilers fed the diet containing this LFW$_S$ but it was found conversely. It was unbelievable that the use of the LFW$_S$ + corn + top to replace a few commercial diets could produce carcass weight somewhat higher than at the CFM diet and the CCP diet. The carcass weight at the LFW$_S$ diet was similar to at the LFW$_W$ and the LFW$_{-S}$ diet. Fish processing plants generate the skin/scales which are discarded protein sources [21]. Those were not fed to the birds nor simply destroyed the forager microorganisms, so that necessitated the proper treatments such as hydrolyzation to construct the renewed protein arrays. In the recent study, LFW$_S$ was boiled in hot water causing the texture of skin/scales to become weak thus expected to destroy the bound complexes. According to [3], fish scales treated hydrothermally (physically) could recover protein approximately 4.5 times higher than treated conventionally (chemically) in their pretreatments.

The carcass percentage was highly reflected from the quality of the diet but it may vary among the strains and slaughter ages. In the present study, carcass weights increased proportionally to live weight. It designated that broilers having the diets containing the LFW meal were able to perform carcass in line with their LW. The LFW-based diet did not cause to produce an excessive amount of inedible parts relative to the live weight of broilers. The nutritional contents in LFW meals could be well employed by the birds.

The birds in the groups feeding LFW-based diets were able to constitute better cut-up yields which was breast compared to those in the groups feeding the CCP-based diet. The LFW meals were predicted to have good sources of EAA, predominantly methionine. Methionine holds many pivotal functions such as protein synthesis and a precursor of S-adenosylmethionine, the methyl donor for DNA methylation [22]. A study reported by [23] stated that full removal of fish meal adversely impacted the optimum development of the cut-up parts and as such 0.5–1% fish meal may be incorporated into the broiler finisher diets for the maximum expansion of carcass components. The CCP diet also is composed of fish meal, removing some of this diet leads to running it out. In advantage, the replacement feed consisted of the better fish meals which were LFW meals which in combination with yellow corn + top mix can develop valuable cut-up.

Increased breast percentage was stressing the notion that the LFW meals were thought rich in EAA. A good protein quality suggested in the LFW meals was supported by the achievement of breast yield. The development of the breast meat yield in broilers was under the role of the methionine function [22], the EAA highly found in fish meal. Therefore, a higher percentage of the breast was in expectancy since this part had more economic value than the other parts.

There is a connection between the weights of internal organs of the birds to their live weights. Increased internal organ weights normally were subject to the increased LW. In comparison to the CFM diet, the birds from the LFW treatments also had a tendency in the higher weights of digestive organs (crop, gizzard, and intestine) and the supplementary digestive organs (pancreas and liver) in linearly to their LW, conversely, slightly lower in their other organ weights such as liver, spleen, and heart. Nerveless, statistically all of those were not significant differences. The most important things were to contrast the weights of the internal organs to their LW.

Increased the percentages of the gizzards in the birds fed the fish-meal-based diets were highly supposed in connected to feed digestion. Fish meals were composed of rough materials such as the particles of the bones and skin/scales that stimulated the gizzard to increase their activity to digest those mechanically. This result indicated that the broilers had adapted their organ development and metabolism in response to an increase in digestion, absorption, and utilization efficiency [24]. Despite this, the percentages of gizzards of all groups were in the normal ranges (1.6–2.3% refers to [25]). However, the nutrients within the fish meals were contemplated digestible since the percentages of other related digestive organs such as intestines and pancreases appeared in normal sizes which were equal to the CCP diet. These organs work more chemically in feed digestion by releasing the proper enzymes aiding to break down the complex compounds to become simple forms to be easily absorbed into the body system. The percentage of pancreas was close to reported by [25] i.e. 0.22–0.24%. Indigestible feeds promote these organs to be more active causing their extended volumes but these were not found in the birds fed the experimental diets involving the LFW-based diets.

The liver, heart, and spleen are typically subjected to feed poisonousness. The feed toxicity can cause the excessive mass of these organs. The liver functions to secrete bile entering the small intestine to support the digestion of fats and is involved in the metabolism of fats, carbohydrates, and proteins. The liver has a role in detoxification and expands when infiltrated by dietary poisons [4]. Consuming contaminated feed, for example, aflatoxins can cause significant enlargement of the liver [26]. The spleen is the major source of antibody production and functions as a major blood-filtering organ as well as protects the body from invading pathogens and antigens. If a chicken was infected by the disease, the spleen was likely to enlarge. As reported by [27], chickens fed mycotoxin-contaminated diets of 5 mg/kg resulted in heavier spleens. In the recent study, in relatively to LW, the weights of livers, spleens, and hearts of the birds fed the LFW-based diet were in the range of normal sizes and analogous to those fed either the CCP-based diet or the CFM-based diet. In the broiler, the usual percentages of liver, heart, and spleen were 1.7–2.3%, 0.42–0.70%, and 0.14–0.17%, respectively [25]. It signaled that the LFW meals made up of all parts of *leubim* fish waste were free from pathogenic agents that make this waste highly acceptable to integrate into the poultry diets.

CONCLUSION

This study concluded that *leubim* fish waste (LFW) meal whether made up wholly, excluded skin, or the only skin added with yellow corn and top mix could be used to substitute a few commercial diets without adverse effects on carcass and internal organs of broilers. The skinless LFW meal did not result in better carcass weight in comparison to the whole LFW meal. The carcass weights of broilers fed the sole skin LFW meal were relatively comparable to those of those fed the whole or skinless LFW meal. Therefore, in producing LFW meals, the skin/scales should not need to exclude due to its highly valuable nutrition permissively incorporated in the poultry diets thus carrying to zero waste.

CONFLICT OF INTEREST

The authors declare no conflict of interest with any financial organization regarding the material discussed in the manuscript. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

ACKNOWLEDGMENTS

The authors are grateful to the Extension and Research Center, Syiah Kuala University, Banda Aceh for supporting funds for this study.

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