Effect of animal by-products on the growth performance of broiler chickens

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Journal of Livestock Science (ISSN online 2277-6214) 13:58-66
Received on 13/11/21; Accepted on 1/1/22; Published on 15/1/22
doi. 10.33259/JLivestSci.2022.58-66

Abstract

This study was conducted to determine the growth performance of broilers fed diets containing fishmeal and different animal by-products meals as feather meal, meat and bone meal (MBM), and blood meal from 15 to 42 days of age. A total of 240 male Ross 308 broiler chickens aged 14 days were individually weighed and randomly allocated to four experimental treatments by using a completely randomized design (CRD). Each treatment consisted of 6 replicates and 10 birds per replicate. From days 15 to 42, chickens were provided four experimental diets: treatment 1 (T1)- 5% fish meal based diet as control, treatment 2 (T2)- 5% feather meal based diet, treatment 3 (T3)- 5% meat and bone meal based diet, and treatment 4 (T4)- 5% blood meal based diet. Broiler feed intake, weight gain and feed conversion ratio (FCR) were measured and calculated on weekly basis. On weekly performance basis, feed intake of broilers did not differ significantly (p>0.05) among all treatments on 4^{th} and 5^{th} weeks, and the weight gain of broilers fed different dietary treatments were not significant differences (p>0.05) on 5^{th} and 6^{th} weeks. Other results based on weekly and cumulative performance showed T1 was highest feed intake, weight gain, final body weight and FCR among the treatments, then T3 was higher performance than T2 and T4. The treatment 4 was the poorest cumulative FCR among all different dietary treatments. It can be concluded that broiler fed diet with 5% fishmeal is the most beneficial, and 5% blood meal is the poorest performance among the treatments.

Keywords: broilers; fishmeal; feather meal; meat and bone meal; blood meal

Introduction

In poultry industry, feed is one of the major cost accounting for about 65-70 percent of the total cost of production. A critical cost of appraisal of poultry feed formulae shows protein, especially protein of animal origin, to be the most expensive per unit cost (Sahraei *et al*., 2012). The price of the protein ingredients is comparatively higher than that of the other ingredients; protein costs involve about 45% of the total feed cost. There are two sources of feed proteins i.e. protein of animal origin and protein of plant origin (Ahmad *et al*., 2006).

Nowadays, most of the poultry farmers have been using different protein concentrates in poultry diet instead of fishmeal (Kamruzzaman *et al*., 2006). Fish meal is widely used as an animal source protein in broiler diet. Fish meal is not only used in poultry feed composition but also in ruminant feeding, aquaculture feeding and also used as a fertilizer. This creates a big gap between supply and demand resulting in boosting its price and allowing makers to adulterate it with other ingredients like fish bone, sand, stone, soil and sawdust, which affects the overall quality of the feed (Karimi, 2006). Successful use of cheaper protein source as substitute of costly fish meal may reduce the production cost of balanced poultry feed and at the same time it will reduce dependence on fish meal. For this reason, it is very important to find out the possibilities of using alternate source of low-cost animal protein sources such as animal by-products to substitute expensive fish meal (Hasni *et al*., 2014).

Animal by-products supply nutrients with economic advantage for poultry diet formulation. Meanwhile, a challenge for nutritionists is the lack of uniformity of these ingredients, but each ingredient of animal origin has its specific nutritional characteristics (Xavier *et al*., 2011). The most common animal by-products used in broiler diets are meat and bone meal, blood meal, feather meal, and poultry offal meal. These feedstuffs contain high protein levels and may partially replace conventional protein source in feeding broiler chickens (Caires *et al*., 2010).

Feather meal (FM) is by-product from poultry production and slaughter house. In each slaughter house, the feathers obtained were ±6% from the life body weight of a broiler chicken (Moreira *et al*., 2006). The chicken feather meal is a potential source of poultry feed, because the crude protein content is high around 83-87% (Tiwary and Gupta, 2012; Ajayi, 2014) and as poultry production increases so will the feather wastes. Feather wastes are usually disposed by burial in landfills but its conversion to a useful material is important environmentally and economically. Feathers can be converted to feather meal which is a potential alternative to expensive protein feedstuffs for animal feeding (Ajayi and Iyayi, 2014). Hasni *et al*. (2014) reported that broiler fed with 100% feather meal as replacement of fish meal proved to be most economically raised, without any negative effect on their performance. Some studies also reported inclusion of feather meal up to 5% without any negative impact on feed intake (Mandubuike *et al*., 2009; Xavier *et al*., 2011).

Meat and bone meal (MBM) is produced by recycling slaughter house by-products of pig, cattle and sheep, and their main components are residual bone, skin, fat, offal and meat after removal of the edible parts using advanced processing technology and high temperature sterilization to make the organic components more absorbable and palatable to the animals (Parsons *et al*., 1997; Jayathilakan *et al*., 2012). It is a potential feed supplement for dairy, poultry and pet animals (Hendriks, 2002; Jacob, 2015; Moutinho *et al*., 2017). Meat and bone meal is a good source of protein (48-52%), fat (8-12%) and ash (33-35%) which has widely been utilized as a protein source in animal and pet foods to improve the quality of livestock feed. It may contribute up to 30% of the dietary protein supply in poultry and pig ration. Besides being a valuable protein source, MBM also serves as a vital source of energy, calcium, phosphorus and other trace minerals (Hendriks *et al*., 2002) and can successfully replace up to 50% of the dietary fish meal (Yang *et al*., 2004). Some studies observed that MBM supplementation up to 10% in broiler and turkey diets had not negative effect on broiler performance even if included at highest level (Martosiswoyo and Jensen, 1988; Baker and Firman, 1988).

Blood meal (BM) is a by-product of the slaughtering industry and is used as a protein source in the diets of non-ruminants and ruminants (Seifdavati *et al*., 2008). Blood meal is a dark chocolate-coloured powder with characteristics smell. It contains about 80-85% crude protein, this variation is due to difference in methods of preparation (McDonald *et al*., 1992). It is one of the richest sources of lysine, a rich source of arginine, methionine, cystine, leucine but is very poor in isoleucine and contain less glycine than either fish meal or bone meal (NRC, 1994). There is some evidence showing that 1 to 4% blood meal can be incorporated in the poultry diet with better growth performance (Petkov *et al*., 1980; Nuarautelli *et al*., 1987; Donkoh *et al*., 2001). Other authors used higher level of blood meal without adverse effect on growth of chickens (Toor and Fahimullah, 1972; Hassan *et al*., 1974; Onwudike, 1981; Donkoh *et al*., 2001). Today, mostly blood meal is being used as by-pass protein ingredient in ruminant diet (Kamalak *et al*., 2005; Taylor, 2005). The practice of feeding additives like yeast (Tsugkieva et al 2021) and adsorbents (Temiraev et al 2020) to increase the growth and productivity of broiler chickens has also been reported previously. However, very little information is available of blood meal use in broiler diet.

More work is needed in order to be able to make firm recommendations on incorporating animal by-products in broiler diets. Moreover, there is paucity of information on the use of animal by-products in broiler diets. Therefore, this study was carried out to investigate the growth performance of broiler chickens fed diets containing animal by-products such as feather meal, meat and bone meal and blood meal.

Materials and Methods

Experimental site, design, animals and management

The experiment was conducted at the poultry farm in the campus of University of Veterinary Science, Yezin, Nay Pyi Taw, Myanmar. The area is situated between 19°50′27″ North latitude and 96°16′13″ East longitude. A completely randomized design (CRD) was used in this experiment. A total of 240 male Ross 308 broiler chickens aged 14 days were individually weighed and randomly allocated to four experimental treatments. Each treatment consisted of 6 replicates and 10 birds per replicate. Chickens in all treatments were kept under the similar management condition. Feed and drinking water were supplied *ad libitum* throughout the experimental period. On day 7, all chicks were vaccinated against Newcastle Disease and Infectious Bronchitis (Live ND+IB) via intraocular route and booster was done on day 21 in the same route of administration. On days 14 and 28, the chicks were vaccinated against Infectious Bursal Disease (IBD) by oral drop.

Experimental diets

Before feeding the experimental diets to the chickens, proximate analysis of the feed ingredients was performed at the Department of Animal Science, University of Veterinary Science, Yezin, Nay Pyi Taw. All chicks were provided commercial diets from day-old chicks (DOC) to 14^{th} day of age. From days 15 to 42, chickens were provided four experimental diets: treatment 1 (T1)- 5% fish meal based diet as control, treatment 2 (T2)- 5% feather meal based diet, treatment 3 (T3)- 5% meat and bone meal based diet and treatment 4 (T4)- 5% blood meal based diet. For preparation of the experimental diets, the different ingredients were purchased locally and the diets were formulated to maintain a constant ratio of energy and protein to meet the minimum requirements of broiler chickens (NRC, 1994). All experimental diets were isocaloric and isonitrogenous. The composition, calculated nutrient contents and feed cost of different dietary treatments are shown in Table 1.

Measurements

Feed consumption

Prior to feeding in the morning, the required amount of feed for each group was weighed. The residual feed was collected and weighed again the next morning. The feed given and feed residue was measured in grams by using an electronic digital balance and then an average was calculated. The daily feed consumption was recorded and the average feed consumption per bird per day was calculated.

Body weight

After arrival, the initial body weight of each broiler was recorded and measured again on days 7, 14, 21, 28, 35 and 42. The body weights of the birds were weighed in grams by using an electronic digital balance.

Feed conversion ratio

Feed conversion ratio for all treatments was calculated on a weekly basis.

Statistical analysis

Data from the feeding trial was analyzed with a one-way analysis of variance (ANOVA) to determine significant differences ($p<0.05$) among treatment means. All statistical analyses were performed with the statistical package for social sciences SPSS 16.0 version (2007). The significant differences among treatments were determined at $p<0.05$ by Duncan's Multiple Range Test (DMRT).

Table 1- Composition, calculated nutrient contents and feed cost of different dietary treatments for broilers (from 15 to 42 days of age)

Ingredients	Feed cost (Kyats/kg)	T1		T2		T3		T4	
		(%)	Feed cost (Kyats)	(%)	Feed cost (Kyats)	(%)	Feed cost (Kyats)	(%)	Feed cost (Kyats)
Maize	306.75	51.7	15858.98	51.3	15736.28	51.4	15766.95	51.6	15828.3
Broken rice	398.77	7.1	2831.267	9.1	3628.807	6.3	2512.25	9.6	3828.2
Rice bran	306.75	5.1	1564.425	4.6	1411.05	4.3	1319.03	5.2	1595.1
Soybean meal	797.55	26.8	21374.34	25.7	20497.04	28.7	22889.69	24.5	19540.0
Fishmeal	1200	5	6000	0	0	0	0.00	0	0.0
Feather meal	1100	0	0	5	5500	0	0.00	0	0.0
Meat and bone meal	625	0	0	0	0	5	3125.00	0	0.0
Blood meal	1300	0	0	0	0	0	0.00	5	6500.0
Oil	1963.2	3.7	7263.84	3.4	6674.88	3.7	7263.84	2.9	5693.3
Premix	17000	0.2	3400	0.3	5100	0.2	3400.00	0.4	6800.0
Lysine	3500	0.2	700	0.3	1050	0.2	700.00	0.4	1400.0
Methionine	10000	0.2	2000	0.3	3000	0.2	2000.00	0.4	4000.0
Feed cost (Kyats/100kg)		100	60992.8	100	62598.05	100	58976.75	100	65184.8
Feed cost (Kyats/kg)			609.93		625.98		589.77		651.85
Feed cost for 1 kg body weight gain (Kyats)			1049.08		1446.01		1203.13		1610.07
Calculated nutrients									
ME (kcal/kg)		3083.02		3098.87		3070.63		3106.1	
CP (%)		21.22		21.49		21.21		21.54	
Energy protein ratio		145.27		144.2		144.76		144.18	

Results and Discussion

Final body weight and Cumulative Growth Performance

The final body weight, cumulative feed intake, weight gain and FCR of broilers are shown in Table 2. The final body weight of broilers fed T1 were significantly highest ($p<0.01$) among the treatments, and T3 was significantly higher ($p<0.01$) than that of group fed T2 and T4, but T2 and T4 were not significantly different ($p>0.05$). The present result was in agreement with the findings by several researchers who investigated that fishmeal contain an unidentified growth factor which improved the palatability of this feedstuff when fed to broilers and resulted in an improvement in growth (Barlow and Windsor, 1984; EI Boushy and van der Poel, 1994). These results concurred with observation by Caires *et al*. (2010) who found that broiler fed diet with 5% MBM were higher final body weight than that of group with 5% feather meal and 5% blood meal. The inclusion of 5% blood meal showed lowest final body weight. This result was in disagreement with previous studies where broiler diets supplemented with MBM (2, 3.5 and 5%), feather meal (33, 67 and 100%) and blood meal (50 and 100%) instead of fishmeal were not significant effect on final body weight (Bozkurt *et al*., 2004; Hasni *et al*., 2014; Seifdavati *et al*., 2008). Moreover, Frempong *et al*. (2019) found that replacing fish meal with poultry by-products meal resulted in higher body weights. The results differences may be due to quality, palatability and digestibility of different dietary treatments.

The cumulative feed intake of broilers fed T1 was significantly higher ($p<0.05$) than that of broilers fed T2, T3 and T4, but cumulative feed intake of broilers fed T2, T3 and T4 were not significant differences ($p>0.05$) with each other. These results are in agreement with the findings of Caires *et al*. (2010) who did not find significant feed intake when broiler fed diets with 5% MBM, 5% blood meal and 5% feather meal. Faria Filho *et al*. (2002) reported that inclusion of 6% MBM in broiler diet was lower feed intake. Xavier *et al*. (2011) also indicated that formulation of diets up to 6% feather and blood meal for chickens was lower feed intake. In contrast, other studies reported that broiler fed with 5% feather meal, 5% MBM, and 5% blood meal, respetively as replacement of fishmeal were not significantly influence on feed intake (Hasni *et al*., 2014; Bozkurt *et al*., 2004, Khawaja *et al*., 2007).

The cumulative weight gain of broilers fed T1 was significantly highest ($p<0.01$) among the treatments, and T3 was significantly higher ($p<0.01$) than that of group fed T2 and T4, but T2 and T4 were not significantly different ($p>0.05$). In this study, broiler diet containing fishmeal was highest the cumulative weight gain among the treatments, which may be due to protein quality of the fishmeal is better than others and a suitable amino acid supplementation can lead to acceptable results with the fishmeal as the main dietary animal protein concentrate. The present results are in accordance with the findings by Seifdavati *et al*. (2008) who established that cumulative weight gain was significantly higher in bird fed fishmeal than that of bird fed 50, 75 and 100% substitution by blood meal. Caires *et al*. (2010) also suggested that the inclusion of 5% blood meal negatively affected the weight gain. Others, Faria Filho *et al*. (2002) reported inclusion of 6% MBM in broiler diets resulted lower weight gain. However, Guichard (2008) verified that the use of 1% feather meal in broiler diets resulted in better weight gain than the diet based on corn and soybean meal.

The cumulative FCR of broilers fed T1 was significantly narrowest ($p<0.01$) among the treatments, then T3 was significantly narrower ($p<0.01$) than that of group fed T2 and T4, and T2 was significantly narrower ($p<0.01$) than that of group fed T4. Treatment 4 is the poorest FCR among the treatments. This finding was in agreement with the results of Caires *et al*. (2010) who found that the FCR of 42-day old broilers fed diets containing 5% blood meal was the worst FCR among control diet, 5% MBM, 5% blood meal, 5% feather meal and 5% poultry offal meal. The poor performance of blood meal may be related to a possible amino acid unbalance in broiler diet. Onwudike (1981) also suggested that FCR in broiler chickens was impaired with incorrect concentrations of blood meal due to very low levels of the sulphur containing amino acids and isoleucine are responsible the poor utilization of blood meal. However, the present results were not in line with some studies, where broiler diets included with MBM, feather meal and blood meal, respectively as replacement of fishmeal were not significantly effect on cumulative FCR (Hasni *et al*., 2014; Bozkurt *et al*., 2004; Khawaja *et al*., 2007). Frempong *et al*. (2019) also reported that they replaced fishmeal with poultry by-product meal on broiler diet and recorded no difference in FCR.

Weekly Growth Performance

The weekly feed intake of broiler chickens fed different dietary treatments during the experimental period is shown in Table 3. On 4th and 5th weeks, the feed intake of broilers did not differ significantly ($p>0.05$) among all treatments. The result of this study was in agreement with the findings of Caires *et al*. (2010) who indicated that the feed intake of 35-day-old broilers fed different dietary treatments (control diet, 5% meat and bone meal, 5% blood meal, 5% feather meal and 5% poultry offal meal) were not significant differences ($p>0.05$). Gerry (1956) and Fuller (1956) also investigated the effect of replacing fishmeal with poultry by-product meal on broilers and observed similar performance between dietary treatments. These results are also agree with the findings of Sartorelli (1998) and Junqueira *et al*. (2000), who did not find significant performance differences when MBM was added in the feeds fed to birds of the same age. Bozkurt *et al*. (2004) also reported that supplementation of MBM up to 5% to broiler diets instead of fish meal was not significant effect on feed intake. Moreover, broiler fed with 100% feather meal and blood meal as replacement of fishmeal didn’t cause any adverse effect on their performance (Hasni *et al*., 2014; Seifdavati *et al*., 2008).

On 3rd and 6th weeks of age, the feed intake of broiler chickens fed T1 was significantly higher ($p<0.01$) than that of group fed T2, T3 and T4 but feed intake of broilers fed T2, T3 and T4 did not differ significantly ($p>0.05$) with each other. It might be due to palatability of fishmeal is better than other feedstuffs, and stimulate feed intake. The present result was in agreement with the findings of Karimi *et al*. (2006) who indicated that using higher levels of fishmeal had beneficial effects on broiler performance mainly via stimulation of feed intake especially during the latter growth periods. The researchers attributed their findings to the nutritional profile of fishmeal, which impacted its palatability. However, contrary to the findings of this study observed lower feed intake for birds fed fishmeal diets than poultry by-product meal. It could be due to a reduction in its palatability, or an increased palatability of the other. The palatability of feed depends on the quality of the ingredients as well as how an animal is first introduced to it (Forbes, 2011; Provenza, 1995).

The weekly weight gain of broiler chickens fed different dietary treatments during the experimental period is shown in Table 4. On 3rd and 4th weeks, the weight gain of broilers fed T1 was significantly highest ($p<0.01$) among all treatments, and T3 was significantly higher ($p<0.01$) than that of group fed T2 and T4. The weight gain of broilers fed T2 and T4 were not significantly different ($p>0.05$). On 5th and 6th weeks, however, there were no significant differences ($p>0.05$) among the weight gain of broilers fed different dietary treatments. The present results on 5th and 6th weeks were in line with the finding of Caires *et al*. (2010) who reported the weight gain on day 35 of birds fed control diet, 5% MBM, 5% blood meal, 5% feather meal and 5% poultry offal meal were not significant differences ($p>0.05$), and the weight gain on 42 day was similar result in present study of 3rd and 4th weeks that they mentioned the inclusion of 5% blood meal negatively affected the weight gain.

Table 2- Final body weight, cumulative feed intake, cumulative weight gain and cumulative FCR of broilers affected by four different dietary treatments

Performance	Treatment (Mean±SEM)				Significant Level
	T1	T2	T3	T4	
Final body weight (kg)	2.64±0.05^c	2.09±0.04^a	2.32±0.06^b	2.00±0.00^a	0.01
Cumulative feed intake (kg)	3.86±0.03^b	3.65±0.01^a	3.68±0.02^a	3.68±0.02^a	0.05
Cumulative weight gain (kg)	2.23±0.03^c	1.57±0.03^a	1.80±0.06^b	1.50±0.00^a	0.01
Cumulative FCR	1.72±0.01^a	2.31±0.04^c	2.04±0.05^b	2.47±0.01^d	0.01

$^{a-d}$The mean within the same row with no common superscripts differ at p<0.01 and p<0.05
SEM= Standard error of mean; T1= 5% fish meal based diet as control; T2= 5% feather meal based diet
T3= 5% meat and bone meal based diet; T4= 5% blood meal based diet

Table 3- Weekly feed intake of broilers affected by four different dietary treatments

Age of birds	Weekly feed intake (kg), Mean±SEM				Significant Level
	T1	T2	T3	T4	
3rd week	0.66±0.00^b	0.60±0.01^a	0.61±0.01^a	0.61±0.01^a	0.01
4th week	0.90±0.01	0.89±0.00	0.90±0.01	0.88±0.00	NS
5th week	1.01±0.02	1.00±0.01	0.98±0.02	0.98±0.01	NS
6th week	1.30±0.01^b	1.16±0.01^a	1.20±0.02^a	1.20±0.02^a	0.01

$^{a-b}$The mean within the same row with no common superscripts differ at p<0.01
NS= Not significant ; SEM= Standard error of mean; T1= 5% fish meal based diet as control
T2= 5% feather meal based diet; T3= 5% meat and bone meal based diet; T4= 5% blood meal based diet

Table 4- Weekly weight gain of broilers affected by four different dietary treatments

Age of birds	Weekly weight gain (kg), Mean±SEM				Significant Level
	T1	T2	T3	T4	
3rd week	0.49±0.00^c	0.26±0.01^a	0.32±0.01^b	0.27±0.01^a	0.01
4th week	0.54±0.01^d	0.47±0.00^b	0.51±0.01^c	0.42±0.01^a	0.01
5th week	0.54±0.05	0.43±0.02	0.49±0.02	0.39±0.01	NS
6th week	0.55±0.00	0.42±0.01	0.49±0.01	0.42±0.01	NS

$^{a-d}$The mean within the same row with no common superscripts differ at p<0.01
NS= Not significant ; SEM= Standard error of mean; T1= 5% fish meal based diet as control
T2= 5% feather meal based diet; T3= 5% meat and bone meal based diet; T4= 5% blood meal based diet

Table 5- Weekly FCR of broilers affected by four different dietary treatments

Age of birds	Weekly FCR (Mean±SEM)				Significant Level
	T1	T2	T3	T4	
3rd week	1.33±0.01^a	2.29±0.03^c	1.94±0.05^b	2.29±0.02^c	0.01
4th week	1.66±0.00^a	1.90±0.01^c	1.75±0.03^b	2.10±0.03^d	0.01
5th week	1.68±0.04^a	2.35±0.11^c	2.01±0.06^b	2.56±0.03^d	0.01
6th week	2.12±0.02^a	2.74±0.03^c	2.43±0.06^b	2.86±0.04^c	0.01

$^{a-d}$The mean within the same row with no common superscripts differ at p<0.01
SEM= Standard error of mean; T1= 5% fish meal based diet as control
T2= 5% feather meal based diet; T3= 5% meat and bone meal based diet
T4= 5% blood meal based diet

The findings of Bozkurt *et al.* (2004) who observed that broiler fed 0, 2, 3.5 and 5% MBM instead of fish meal were not significant (p>0.05) effect on body weight gain at 22-42 days of age. These findings were in agreement with the present results of 5th and 6th weeks although those were in contrast with this study of 3rd and 4th weeks. Likewise, the body weight gain of broiler fed 50, 75 and 100 % blood meal, and also 0, 33, 67 and 100% feather meal as replacement of fish meal were not significant differences (p>0.05) between the groups (Selfdavati *et al.*, 2008; Hasni *et al.*, 2014). Moreover, Sartorelli (1998) and Junqueira *et al*. (2000) did not find significant performance differences when feeding broilers with MBM on days 14, 21 and 35, whereas Faria Filho *et al*. (2002) found that the inclusion of 6% MBM resulted in lower weight gain in that period, and argued that performance was impaired because the diets were formulate on total amino acid basis and not on digestible amino acids. The differences among these results may have been due to protein source, quality and processing of dietary treatments, and performance variation depend on the age of the birds.

The weekly FCR of broiler chickens fed different dietary treatments during experimental period is shown in Table 5. The FCR of broilers fed T1 was significantly narrowest (p<0.01) among the treatments, and T3 was significantly narrower (p<0.01) than that of broilers fed T2 and T4. On 3rd and 6th weeks, the FCR of broilers fed T2 and T4 did not differ significantly (p>0.05) with one another. On 4th and 5th weeks, the FCR of broilers fed T2 was significantly narrower (p<0.01) than that of group fed T4. Therefore, the weekly FCR for birds fed T1 was the best and T4 was the worst. The poorest performance of broilers fed blood meal diet may be due to its digestible protein content, odor, palatability and visual appraisal.

The results in this study was in accordance with the findings of Karimi (2006) who investigated that the inclusion levels of fishmeal around or below 5% can improve FCR and its biological value for poultry. Beski *et al*. (2015) also reported that the high digestibility of fishmeal (>90%) improves FCR and support faster growth. In contrast, Caires *et al*. (2010) compared 5% meat and bone meal, 5% blood meal and 5% feather meal diets in broiler feed and observed no significant effect on FCR. Other studies also reported that replacing fishmeal with poultry by-products meal was similar FCR for all birds (Gerry, 1956; Fuller, 1956; Frempong, 2019). Seifdavati *et al*. (2008) indicated that FCR in broiler chickens didn’t influence by substitution of 25, 50, 75 and 100% blood meal instead of fishmeal.

Conclusion

According to the present findings, 5% fishmeal based diet was the best final body weight, cumulative feed intake, cumulative weight gain and cumulative FCR among the treatments, and 5% MBM based diet was better performance than 5% feather meal and 5% blood meal. The inclusion of 5% blood meal was the poorest FCR in broiler diet. It can be concluded that the use of 5% fishmeal in broiler diet is the most beneficial among the treatments. Continuous studies are needed to find the optimal inclusion levels of MBM, feather meal and blood meal in diets of broiler chickens generally to further reduce cost and improve growth performance.

Conflict of interest

All authors have approved the submission of this manuscript and do declare that there is no conflict of interest. The manuscript has not been published previously and is not under consideration for publication elsewhere.

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