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Effect of Replacing Fish Meal Protein By Shrimp Waste Meal Protein With or Without Amino Acids on Serological, Hematological Parameters and Carcass Traits of Broilers

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Abstract

The present experimental evaluation was to assess the effect of feeding Shrimp waste meal as a replacement for fish meal on serological, hematological parameters and carcass traits in broilers. A growth trial was conducted for 42 days using 375 commercial day old chicks which were distributed randomly into five treatments groups with three replicates of twenty five birds each. In pre-starter diet fish, meal contribution to the dietary crude protein was replaced with shrimp waste meal at 0% (T_1), 20% (T_2), 30% (T_3), T_2 + synthetic lysine and methionine (T_4), T_3 + synthetic lysine and methionine (T_5). In starter and finisher diets the shrimp waste meal protein was added up to the 0% (T_1), 50% (T_2), 100% (T_3), 50% + synthetic lysine and methionine (T_4), 100% + synthetic lysine and methionine (T_5). In pre-starter and starter phases no significant difference was noticed regarding levels of serum total protein (g/dl), albumin (g/dl), globulin (g/dl), glucose (mg/dl) and cholesterol (mg/dl) among treatments. Similarly, in finisher phase there were no significant difference in levels of serum total protein (g/dl), albumin (g/dl) and glucose (mg/dl) among treatments, except the serum cholesterol levels (mg/dl) and globulin levels (g/dl) were found significantly ($p < 0.01$) higher in birds fed T_1 diet than birds fed other diets (T_2, T_3, T_4 and T_5). Non significant differences were noticed among treatment groups regarding RBC count during the three phases of the study. During pre-starter phase the WBC count ($10^3/\mu l$) was significantly higher ($p < 0.01$) in the birds fed with the diets T_2, T_3, T_4 and T_5 when compared to the birds fed with T_1(control diet). During starter and finisher phases the WBC count ($10^3/\mu l$) was significantly higher ($p < 0.01$) in the birds fed with the diets T_2 and T_3 than the birds fed with T_1, T_4 and T_5. During the pre-starter and starter phases. Lymphocyte (%) count was significantly higher ($p < 0.01$) in T_2 and T_3 than in T_1, T_4 and T_5 fed birds. Whereas during the finisher phase there was no significant difference among treatments. At the end of experiment, the live weight gain, hot carcass weight and the dressing percentage were found significantly ($p < 0.01$) higher in birds fed T_4 diet when compared to birds fed other diets. The liver, gizzard and heart weights (g) were found significantly ($p < 0.01$) higher in birds fed T_4, T_2, and T_1 diets when compared to T_3 and T_5 group. The results of the present study depicts that the Protein from FM can be safely substituted up to 30% with the SWM protein in pre-starter and up to 50% in starter and finisher broiler diets along with the supplementation of synthetic amino acids (lysine and methionine).

Keywords: Shrimp waste meal; Fish meal; Amino acids; Serological and hematological parameters; Carcass traits; Broilers.

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Introduction

Poultry industry in India is recognized as an organized and scientifically based industry and potential tool to fight poverty and malnutrition. The potential of poultry industry in alleviating the challenges of low availability of animal protein for human consumption in developing countries is being hampered by high cost of production. The use of agro–industrial by–products have been one of the panaceas for high feed cost in developing countries. One such unconventional protein supplement for broilers is Shrimp Waste Meal (SWM). Shrimp waste can be potentially channeled as a substitute for fish meal in poultry diets. Haematological observations provide valuable information about health of human and animals. According to Afolabi et al., (2010), changes in haematological parameters are often used to determine health status of the body and to know the degree of environmental, nutritional and/or pathological stresses and Maxwell et al., (1990) also stated that blood analysis is a readily available and fast means of assessing clinical and nutritional health status of animals on feeding trials because, ingestion of dietary components has measurable effects on blood composition. Togun et al., (2007) reported that when the haematological values fall within the normal range for the animal, it is an indication that diets not have any adverse effect on haematological parameters during the experimental period. Serum biochemical constituents are positively correlated with the quality of the diet (Brown and Clime, 1972, Adeyemi et al., 2000). Measuring blood metabolites (RBC, WBC, Lymphocyte %), serum constituents (Total protein, Glucose, Cholesterol, Albumin, Globulin) of birds fed SWM can be used as a basis for comparison to fish meal. However, there is paucity of information on the hematology and serum chemistry of the broilers fed with SWM based diet. It is based on this background that the present experimental study was taken up to assess the effect of feeding Shrimp waste meal as a replacement for fish meal on serological, hematological parameters and carcass traits in broilers.

Materials and Methods

Three hundred and seventy five, day old commercial broiler chicks were distributed randomly to five treatments with three replicates of twenty five birds each. The experimental diets in pre-starter phase were prepared by replacing fish meal protein of the basal diet with the Shrimp waste meal protein at 20% level (T_2), 30% level (T_3) and T_4, T_5 diets were prepared by adding synthetic lysine and methionine in T_2 and T_3 diets. In starter and finisher phases five experimental diets were prepared by replacing fish meal protein of the basal diet with the Shrimp waste meal protein at 50% level (T_2), 100% level (T_3) and T_4, T_5 diets were prepared by adding synthetic lysine and methionine in T_2 and T_3 diets. The basal diet T_1 was used as control containing maize, SBM, DORB and 10% fish meal. All diets were iso-nitrogenous and iso-caloric. Experimental diets were formulated as per ICAR, 2013 specifications for broiler diets. During growth trial randomly two birds per replicate in each treatment were slaughtered and blood samples were collected at the end of pre starter, starter and finisher phases from each bird for estimation of blood cell count (RBC, WBC, Lymphocyte %) in whole blood and serum was also separated to estimate serum metabolites. The separated serum was then made clear by centrifuging at 3000 RPM for 10 minutes and transferred to dry, clean ependorf tubes and stored in a refrigerator at (–20°C) for estimation of serum parameters (Total protein, Albumin, Globulin, Glucose, Cholesterol)

Table. 1: Ingredient composition (%) and chemical composition (%) of broiler pre-starter experimental diets

Ingredients	T_1	T_2	T_3	T_4	T_5
Maize	58	57.9	58	57.9	58
Soybean meal	20.55	20.4	20.3	20.34	20.21
Fish meal	10.0	8.0	7.0	8.0	7.0
Shrimp waste meal	0	2.18	3.27	2.18	3.27
De-oiled rice bran	5.0	5.0	4.83	5.0	4.83
Palm oil	3.7	3.77	3.85	3.77	3.85
Mineral mixture*	2.0	2.0	2.0	2.0	2.0
DL-methionine	0.2	0.2	0.2	0.21	0.21
L-lysine	0.55	0.55	0.55	0.6	0.63

Ingredients	T_1	T_2	T_3	T_4	T_5
Feed additives**	+	+	+	+	+
Total	**100**	**100**	**100**	**100**	**100**
Chemical composition					
CP	22.1	22.05	22.0	22.08	22.04
ME (kcal/kg)	3002	2998	2999	2997	3000
Lysine	1.18	1.15	1.13	1.20	1.19
Methionine	0.51	0.51	0.50	0.52	0.51
Ca	1.01	1.02	1.02	1.02	1.02
Available P	0.7	0.66	0.63	0.66	0.63
Cost (Rs/kg)	28.7	28.96	28.89	29.04	29.04

* Contained Ca, 25; P, 15; NaCl, 2.5; Fe, 0.35% and Cu, 100; Mn, 200; Co, 50; I, 100 ppm.

** All diets contained Meriplex® – FDS @ 10g/100 kg : (Each gram contains: Vit-B_1, 8 mg; Vit-B_6, 16 mg Vit-B_{12}, 80 μg; Vit-E_{50}, 80 mg; Niacin, 120 mg; Folic acid, 8 mg; Calcium D Pantothenate, 80 mg, Merivite® –AB_2D_3K @ 10 g/100 kg: (Each gram contains: Vit-A 82,500 IU, Vit-B_2 52 mg, Vit-D_3 1200 IU, Vit-K 10 mg, Calcium 166 mg, Phosphate 395 mg) and Cosmodot @ 50g/100 kg: (3–5, Dinitro-O-Toluamide: 25 percent W/W)

Table 2: Composition of broiler starter and finisher experimental diets

Ingredient	T_1		T_2		T_3		T_4		T_5	
	Starter	**Finisher**	**Starter**	**Finisher**	**Starter**	**Finisher**	**Starter**	**Finisher**	**Starter**	**Finisher**
	Ingredient composition (%)									
Maize	59	65	60.25	65	59.51	64.81	60.25	65	59.77	65.24
Soybean meal	19.3	14	19.5	14.2	19.8	14.7	19.39	14.06	19.3	14
Fish meal	10	10	5	5	0	0	5	5	0	0
Shrimp	0	0	5.45	5.45	10.89	10.89	5.45	5.45	10.89	10.89
De-oiled rice bran 5 4.8	5	4.8	3	3.65	2.5	2.5	3.0	3.65	2.5	2.5
Palm oil	4.1	3.8	4.2	4.3	4.7	4.7	4.2	4.3	4.7	4.7
Mineral mixture*	2	2	2	2	2	2	2	2	2	2
DL-methionine	0.17	0.1	0.17	0.1	0.17	0.1	0.18	0.11	0.2	0.13
L-lysine 0.43 0.3	0.43	0.3	0.43	0.3	0.43	0.3	0.53	0.43	0.64	0.54
Feed additives** + +	+	+	+	+	+	+	+	+	+	+
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1.00**
	Chemical composition (%) DM Basis									
CP	21.5	19.55	21.49	19.5	21.5	19.5	21.5	19.6	21.5	19.5
ME (kcal/kg)	3049	3096	3049.3	3102	3048	3099	3047	3099	3049.2	3098
Lysine	1.09	0.92	0.99	0.83	0.99	0.74	1.01	0.93	1.01	0.92
Methionine	0.48	0.4	0.46	0.39	0.4	0.37	0.47	0.4	0.47	0.4
Ca	1.01	1.07	1.01	1.09	1.02	1.01	1.01	1.08	1.01	1.09
Available P	0.7	0.69	0.58	0.57	0.46	0.45	0.58	0.57	0.46	0.45
Cost (Rs/kg)	28.39	26.39	28.30	26.53	28.49	26.71	28.53	26.82	29.06	27.56

* Contained Ca, 25; P, 15; NaCl, 2.5; Fe, 0.35% and Cu, 100; Mn, 200; Co, 50; I, 100 ppm.

** All diets contained Meriplex® – FDS @ 10 g/100 kg : (Each gram contains: Vit-B_1, 8 mg; Vit-B_6, 16 mg Vit-B_{12}, 80 μg; Vit-E_{50}, 80 mg; Niacin, 120 mg; Folic acid, 8 mg; Calcium D Pantothenate, 80 mg, Merivite® – AB_2D_3K @ 10 g/100 kg: (Each gram contains: Vit-A 82, 500 IU, Vit-B_2 52 mg, Vit-D_3 1200 IU, Vit-K 10 mg, Calcium 166 mg, Phosphate 395 mg) and Cosmodot @ 50g/100 kg: (3–5, Dinitro-O-Toluamide: 25 percent W/W)

Serum total protein was estimated calorimetrically using diagnostic kit (M/s Span diagnostics limited) by Biuret method (Varley et al., 1980). Serum albumin was estimated calorimetrically by using diagnostic kit (M/s Robonic (India) Pvt. Ltd., as per the bromocresol green method (Doumas et al., 1971). The serum globulin values were calculated by subtracting the values of serum albumin from the corresponding values of total protein. Serum glucose was estimated calorimetrically using diagnostic kit (M/s Robonic (India) PVT. LTD.,) by enzymatic GOD/POD method. Serum cholesterol was estimated calorimetrically by using diagnostic kit (M/s Robonic (India) PVT. LTD.,) by enzymatic method of Allian, (1974).

At the end of experiment, two birds from each replicate and thus a total of six birds per each treatment were randomly chosen, weighed and slaughtered to study carcass characteristics. The liver, gizzard and heart were collected and weighed and the percentages were calculated on live weight basis. All the data obtained in this experiment was subjected to analysis of variance (Snedecor and Cochran, 1994).

Results and Discussion

Serological parameters

No significant differences were observed in serum total protein content (Table 3, 4 and 5) among treatment groups during pre-starter, starter and finisher phases but, there was a slight increase in the serum total protein content in the groups fed with SWM diets when compared to control. The study of Li et al., (2007) well supported the findings of present study that broilers supplemented with chito-oligosaccharide at 100 mg/kg level than other treatment birds have higher serum total protein content. Jabbal et al., (1998); Wang et al., (2003); Tang et al., (2005) also claimed that there was an increase in the level of serum total protein in pigs supplemented with chito-oligosaccharides.

There was no significant difference in serum albumin values among treatment groups during pre-starter, starter and finisher phases (Table 3, 4 and 5). The results are in consonance with the findings of Olayemi, (2001). Similarly, non-significant differences were noticed in serum globulin contents of different treatments during pre-starter and starter phases while, the values differed significantly ($p < 0.01$) in finisher phase.

During pre-starter and starter phases non significant differences were observed in serum cholesterol levels among different treatments (Table 3, 4 and 5, Fig. 1). Significant ($p < 0.01$) reduction in the levels of cholesterol was noticed in the finisher phase with the increase in the level of SWM inclusion and the values ranged from 111.26 mg/dl (T_3) to 120.85 mg/dl (T_1). The observations of the present study are in harmony with the several earlier reports of Li et al., (2007), Kobayashi and Itoh (1991), Razdan and Patterson (1994) who reported the beneficial effect of chito-oligosaccharides present in SWM in reducing blood cholesterol levels. On contrary, Abiodun Adeyeye et al., (2014) reported that the levels of serum cholesterol increased as the level of SWM substitution increased in turkey poults.

During the experimental period, irrespective of the growth phase no significant differences were observed among different treatment groups regarding serum glucose levels (Table 3, 4 and 5). The results of present study were in conformity with the findings of Olayemi, (2001) who reported that there was no significant difference among dietary treatments.

Table. 3: Effect of supplementation of shrimp waste meal on serum parameters during pre starter phase (At the end of 2 weeks of age)

Treatment	Total Protein[NS] (g/dl)	Albumin[NS] (g/dl)	Globulin[NS] (g/dl)	Cholesterol[NS] (mg/dl)	Glucose[NS] (mg/dl)
T_1	4.08 ± 0.11	2.56 ± 0.06	1.52 ± 0.07	112.99 ± 0.59	379.02 ± 2.29
T_2	4.26 ± 0.05	2.58 ± 0.05	1.68 ± 0.07	116.0 ± 0.58	378.03 ± 0.99
T_3	4.25 ± 0.07	2.72 ± 0.02	1.52 ± 0.06	113.44 ± 1.04	376.52 ± 0.81
T_4	4.36 ± 0.06	2.7 ± 0.02	1.66 ± 0.06	114.34 ± 0.85	374.83 ± 0.94
T_5	4.56 ± 0.05	2.64 ± 0.04	1.72 ± 0.08	115.65 ± 1.08	371.5 ± 0.76

[ab] Values in a row not sharing common superscripts differ significantly **($p < 0.01$), NS-Non-significant

Table 4: Effect of supplementation of shrimp waste meal on serum parameters during starter phase (At the end of 4 weeks of age)

Treatment	Total Protein[NS] (g/dl)	Albumin[NS] (g/dl)	Globulin[NS] (g/dl)	Cholesterol[NS] (mg/dl)	Glucose[NS] (mg/dl)
T_1	4.43 ± 0.06	2.56 ± 0.08	1.93 ± 0.09	116.43 ± 1.05	285.5 ± 2.52
T_2	4.50 ± 0.14	2.46 ± 0.03	2.03 ± 0.15	118.53 ± 0.9	284.33 ± 3.45
T_3	4.56 ± 0.1	2.75 ± 0.04	1.81 ± 0.11	118.36 ± 1.7	284.83 ± 2.72
T_4	4.71 ± 0.13	2.58 ± 0.06	2.13 ± 0.13	116.58 ± 1.38	284.16 ± 3.78
T_5	4.35 ± 0.1	2.57 ± 0.08	1.77 ± 0.09	117.51 ± 0.68	284.21 ± 1.05

NS- Non-significant

Table 5: Effect of supplementation of shrimp waste meal on serum parameters during finisher phase (At the end of 6 weeks of age)

Treatment	Total Protein^{NS} (g/dl)	Albumin^{NS} (g/dl)	Globulin** (g/dl)	Cholesterol** (mg/dl)	Glucose^{NS} (mg/dl)
T_1	4.58 ± 0.08	2.68 ± 0.04	2.06^a ± 0.19	120.85^a ± 0.84	373.75 ± 10.9
T_2	4.63 ± 0.06	2.75 ± 0.02	1.71^{ab} ± 0.13	113.65^{bc} ± 1.64	383.22 ± 2.82
T_3	4.31 ± 0.13	2.63 ± 0.02	1.41^b ± 0.08	111.26^c ± 1.75	386.36 ± 1.73
T_4	4.55 ± 0.12	2.58 ± 0.06	1.5^b ± 0.16	115.58^b ± 1.38	380.43 ± 2.58
T_5	4.28 ± 0.1	2.81 ± 0.03	1.61^b ± 0.07	113.78^{bc} ± 1.28	386.23 ± 1.93

^{abc} Values in a row not sharing common superscripts differ significantly **($p < 0.01$), NS- Non-significant

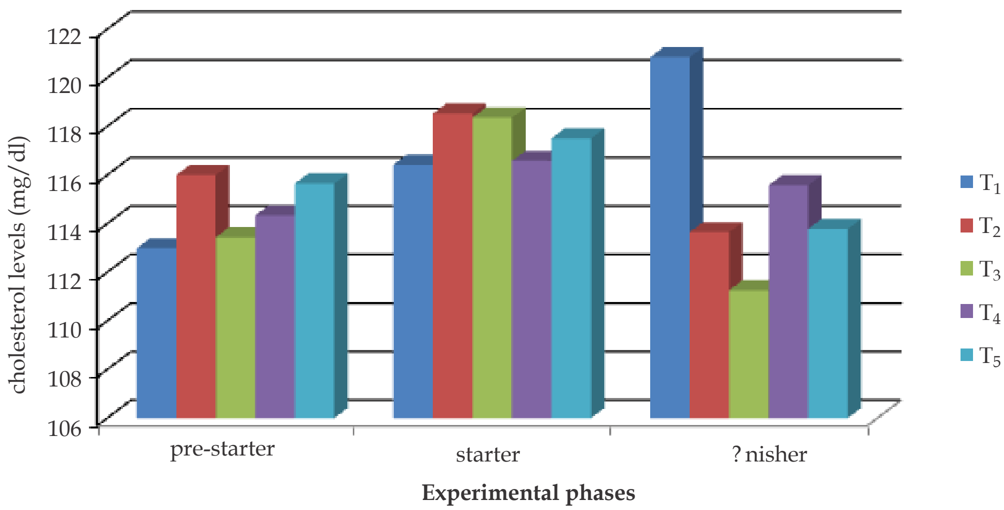

Fig. 1: Effect of supplementation of shrimp waste meal on cholesterol (mg/dl) of Broilers

Hematological Parameters

RBC count did not differ significantly among the treatments in all the phases of Experimental period (Table 6). Significant ($p < 0.01$) differences were observed in WBC count and the values were higher in the birds supplemented with SWM (Table 7). During pre-starter and starter phases higher ($p < 0.01$) lymphocyte (%) was observed in birds fed T_2 and T_3 diets than in other treatments (Table 8). But, in finisher phase no significant difference was observed in lymphocyte (%) among treatments.

Increase in WBC (Meng et al., 2010), RBC (Zhou et al., 2009) were reported due to feeding of chito-oligosaccharide in poultry diets. Chen et al., (2009) reported that supplementation of 5 g/kg chito-oligosaccharide did not affect the WBC, RBC count and lymphocyte (%).

Table 6: Effect of supplementation of shrimp waste meal on RBC count ($10^6/\mu l$)

Phases	T_1	T_2	T_3	T_4	T_5
Pre-starter ^{NS}	2.20 ± 0.05	2.29 ± 0.12	2.16 ± 0.08	2.39 ± 0.2	2.47 ± 0.24
Starter ^{NS}	3.10 ± 0.31	3.38 ± 0.14	3.35 ± 0.16	3.61 ± 0.07	3.08 ± 0.18
Finisher ^{NS}	2.36 ± 0.14	2.55 ± 0.21	2.59 ± 0.14	2.87 ± 0.07	2.71 ± 0.07

NS- Non-significant

Table 7: Effect of supplementation of shrimp waste meal on WBC count ($10^3/\mu l$)

Phases	T_1	T_2	T_3	T_4	T_5
Pre-starter**	27.65^b ± 0.34	29.6^a ± 0.22	29.86^a ± 0.20	29.22^a ± 0.25	29.12^a ± 0.35
Starter**	29.4^c ± 0.17	30.26^a ± 0.03	30.07^{ab} ± 0.09	29.79^b ± 0.06	29.9^b ± 0.09
Finisher**	29.48^c ± 0.23	30.22^a ± 0.06	29.94^{ab} ± 0.12	29.82^{bc} ± 0.05	29.82^{bc} ± 0.05

^{abc} Values in a row not sharing common superscripts differ significantly **($P < 0.01$)

Table. 8: Effect of supplementation of shrimp waste meal on lymphocyte (%)

Phases	T_1	T_2	T_3	T_4	T_5
Pre-starter**	$56.68^c \pm 0.27$	$60.04^{ab} \pm 0.55$	$61.17^a \pm 0.12$	$58.7^b \pm 1.11$	$58.16^{bc} \pm 0.68$
Starter**	$57.47^b \pm 0.31$	$58.89^a \pm 0.28$	$58.31^{ab} \pm 0.32$	$57.43^b \pm 0.3$	$57.63^b \pm 0.39$
Finisher^{NS}	68.21 ± 0.6	67.25 ± 0.83	68.75 ± 0.57	68.17 ± 0.37	67.63 ± 0.4

^{abc}Values in a row not sharing common superscripts differ significantly **($p < 0.01$), NS- Non-significant

Carcass characteristics

The live weight ($p < 0.01$) at slaughter, hot carcass weight ($p < 0.01$) and dressing (%) ($p < 0.01$) were higher ($p < 0.01$) in birds fed on T_4 and lower weight gains were observed with T_3 and T_5 diets (Table 9). The better performance of the birds fed on T_4 diet might be due to improved utilization of SWM protein with the synthetic amino acids supplementation. On contrary, lower performance of the birds fed on T_3 and T_5 diets might be due to decreased utilization of nutrients at higher levels of chitin in the diets with the complete replacement of FM protein with SWM protein. Hector and Lourdes, (2005) and Fanimo et al. (1996) also reported decrease in live weight and carcass % with increase in SWM in the diet**.**

The liver, gizzard and heart weights at slaughter differed significantly ($p < 0.01$) and higher weights were noticed in the birds fed on T_4 diets while, lower weight gains were observed with T_3 and T_5 diets. In contrary the findings of Okonkwo et al. (2012), Agunbiade et al. (2004), Olayemi, (2001) and Mahata et al. (2008) showed non significant effect of feeding different levels of shrimp waste on liver, gizzard and heart weights of broilers.

Table 9: Effect of supplementation of shrimp waste meal on carcass characteristics of broilers

Treatment	Live wt.** (kg)	Hot carcass wt.** (kg)	Dressing ** (%)	Liver wt.** (g)	Gizzard wt.** (g)	Heart wt.** (g)
T_1	$2.09^b \pm 0.03$	$1.36^{ab} \pm 0.02$	$65.51^c \pm 0.20$	$45.86^a \pm 0.99$	$36.83^b \pm 0.90$	$9.98^{ab} \pm 0.25$
T_2	$2.08^b \pm 0.04$	$1.39^{ab} \pm 0.03$	$66.83^b \pm 0.35$	$46.01^a \pm 0.56$	$39.72^a \pm 0.56$	$9.69^{abc} \pm 0.35$
T_3	$1.81^c \pm 0.06$	$0.98^c \pm 0.18$	$63.51^d \pm 0.12$	$43.38^b \pm 0.55$	$34.58^{bc} \pm 1.32$	$9.27^{bc} \pm 0.08$
T_4	$2.21^a \pm 0.04$	$1.49^a \pm 0.03$	$67.68^a \pm 0.13$	$46.78^a \pm 0.63$	$40.02^a \pm 0.61$	$10.27^a \pm 0.39$
T_5	$1.90^c \pm 0.05$	$1.21^{bc} \pm 0.04$	$64.32^e \pm 0.2$	$44.95^{ab} \pm 0.64$	$34.07^c \pm 0.57$	$8.96^c \pm 0.1$

^{abcd} Values in a row not sharing common superscripts differ significantly **($p < 0.01$)

Conclusion

On the basis of present findings it can be concluded that the shrimp waste meal can be utilized as a promising alternative protein source to fish meal in broiler diets and the protein from FM can be safely substituted up to 30% with the SWM protein in pre-starter and up to 50% in starter and finisher broiler diets for good economic returns and productive performance. Supplementation of synthetic lysine, methionine improved the utilization of shrimp waste meal protein.

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