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Research Article

SUBSTITUTION OF SOYBEAN MEAL BY SHRIMP HEAD MEAL (*Penaeus monodon*) IN POULTRY RATION FOR THE PERFORMANCE OF GROWING PULLETS

S. S. Islam*, C. Paul and Md. B. Islam
Agro Technology Discipline, Khulna University
Khulna, Bangladesh

ABSTRACT

To minimize the production cost of poultry and poultry products, it is important to formulate low cost balanced ration utilizing unconventional feed resources. Therefore, the experiment was carried out to measure the effect of substituting soybean meal (SBM) by different levels of shrimp head meal (SHM) to the ration of growing layer pullets. A control corn-soybean layer grower (pullet) diet and four different levels of SHM included diets as substitution of SBMwere fed to five groups of Hisex White pullets from 5th to 18th weeks of age. All groups of pullets fed isocaloric feeds (2765 Kcal kg^{-1}). The control group T_0 (0 % SHM+20 % SBM) received grower ration formulated with traditional feed ingredients with no substitution of SBM. The SBM contents of other treatment groups were substituted at the rate of 25 %, 50 %, 75 % and 100 % by the SHM and were adjusted as 5 % SHM+15 % SBM (T_1), 10 % SHM+10 % SBM (T_2), 15 % SHM+5 % SBM (T_3) and 20 % SHM+0 % SBM (T_4) keeping other ingredients constant as of control. Cumulative feed intake increased with the increasing level of SHM of diets. Feed cost and mortality rate decreased with the increasing level of SHM in the ration. Significantly lowest FCR at most of the age categories, highest cumulative body weight ($p<0.05$) at 18 weeks and highest weight at maturity ($p<0.05$) were found in treatment group fed 5 % SHM. Therefore, it can be concluded that substitution of 25 % SBM of the ration by SHM is suitable for the better performance of growing layer pullets.

Keywords: Growth, Pullet, Shrimp head meal, Soybean meal, Unconventional feed

*Corresponding author: sardersislam@yahoo.com

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INTRODUCTION

In Bangladesh, poultry and poultry industries are contributing to a great extent in our national economy through providing food and nutrition, cash income and create employment opportunities. Prices of eggs and poultry meat in the country become very high due to high prices of poultry feeds in local as well as international markets. Feed cost which accounts for 65-75 % of the total cost of poultry, egg and meat production remains the major factor limiting the development and expansion of poultry farming (Kirkpinar and Acikgoz, 2018).Therefore, to keep the prices of poultry and poultry products within the capacity of people, it is important to formulate low cost balanced ration utilizing unconventional feed resources. Traditionally soybean meal (SBM) is the major protein source in commercial layer chicken ration elsewhere in the world. But it is prime concern yet because of its scarcity as well as expensive value. Shrimp head meal (SHM) may be an excellent source of cheap and abundant substitute of SBM. In the last four decades, the shrimp production in southern part of Bangladesh has grown significantly. It was estimated that 248.8 metric tons of shrimp waste is produced dailyin the shrimp processing industries located in the coastal region of Bangladesh which represents 37 % of total shrimp mass received by the industry (Hossain et al., 2018). Head meal of black tiger shrimp (*Penaeus monodon*) contains an average of 52.3 % crude protein, 6.4% ether extract, 10.8 % crude fiber and 20.4 % crude ash (Rahman and Koh, 2014). Information related to the practical use of SHM in poultry feed, relevant data such as growth rate and feed conversion efficiency is limited (Khempaka et al., 2011). Rahman and Koh (2014) reported head meal from black tiger shrimp (*Penaeus monodon*) as the second most nutritious source in poultry diets as compared to other waste parts of shrimp.Aktar et al. (2011) substituted the fish meal of broiler ration by shrimp meal and found that shrimp meal improved live weight and feed conversion but reduced feed intake. They also reported reduced feed cost and improved profitability by complete substitution of fish meal by shrimp meal.Results of another experiment revealed that body weight gain of broilers decreased with increasing level of SHM ($p<0.05$), and feed intake also decreased slightly with increasing level of SHM in diets (Rahman and Koh, 2016).Considering the view in mind the study was conducted to investigate the effect of inclusion of different levels of SHM inthe ration assubstitution of SBM on the performance of pullets.

MATERIALS AND METHODS

Experimental site, design and type of pullets

The experiment was conducted at Dr. Purnendu Gain Field Laboratory, Agro technology Discipline, Khulna University, Khulna. Hisex White layer hybrid pullets were selected to conduct the experiment as it was reported better performer among five different hybrids (Islam et al., 2013). The design of the experiment was assigned based on Completely Randomized Design (CRD). The experimental birds were divided into five treatment groups and assigned at random to five different rations having five different levels of shrimp head meal (SHM). There were 3 replications for each treatment and the number of birds under each replication was 20. Therefore, 60 birds were kept under each treatment and total number of birds was 300. The feeding trial was continued from 5th weeks of age up to the start of laying (18 weeks of age).

Bio-security measurement

Proper bio-security measures were taken during the experimental period. A disinfectant spray was used before entering into the shed. Entrance of visitors was restricted and there was no access to wild birds, predators, rodents or other animals.

Table 1. Proximate composition of shrimp head meal (% on DM basis)

Proximate components (%)	Shrimp species	
	Black tiger shrimp or Bagda (*Penaeus monodon*)	Giant freshwater prawnor Golda (*Macrobrachium rosenbergii*)
Moisture (on fresh basis)	77.39	54.61
Dry matter (DM, fresh basis)	22.61	45.39
Crude protein (CP)	52.26	32.34
Total ash (TA)	21.69	17.51
Acid insoluble ash(AIA)	0.59	0.62
Crude fiber (CF)	3.20	4.10
Ether extract (EE)	5.78	24.23

Management practices

The experimental birds were kept in a shed having slate floor. The floor as well as feeders and waterers were cleaned and disinfected regularly. Debeaking program was done at 70 days of bird's age using electrical debeaker. Seventeen hours of lighting was maintained at the start of experiment (5th week of age) which was gradually reduced in 12 hours at 8 weeks and continued up to the end of experiment. Birds were vaccinated against all infectious diseases such as Newcastle disease, infectious bursal disease, Marek's, fowl pox, salmonella, infectious laryngotracheitis, fowl cholera and egg drop syndrome according to the recommendation of the vaccine manufacturer. Deworming and medication against coccidiosis was provided routinely. All birds were kept in the similar environment and uniform management was allowed to all the birds.

Preparation and proximate analysis of shrimp head meal

Heads of black tiger shrimp (*Penaeus monodon*) were collected from shrimp processing plant at Rupsha, Khulna. After arrival of shrimp heads in the experimental siteit was allowed to sundry for three consecutive days. After drying the shrimp heads were crushed by a grinding machine. Proximate components (DM, CP, CF, EE and ash contents) of the shrimp head meal was estimated in the Animal Husbandry Laboratory of Agrotechnology Discipline, Khulna University following the method of AOAC (2005). Proximate composition of head from two major species of shrimp such as giant freshwater prawn popularly known as golda (*Macrobrachium rosenbergii*) and black tiger popularly known as bagda (*Penaeus monodon*) was determined separately (Table 1).

Ration formulation and feeding system

After weighing, required amount of feed ingredients and feed additives were mixed homogeneously using a feed mixing machine. The compositions of five experimental rations are shown in Table 2. In the experimental rations, main protein source (SBM @ 20 %) was substituted by SHM at the rate of 0, 25, 50, 75 and 100 %, respectively. Therefore, the combinations of SHM and SBM of the diets of five treatment groups were 0 % SHM+20 % SBM, 5 % SHM+15 % SBM, 10 % SHM+10 % SBM, 15 % SHM+5 % SBM and 20 % SHM+0 % SBM for treatments T_0, T_1, T_2, T_3 and T_4, respectively. Feeds and water were suppliesto the experimental pullets two times daily first in the morning at 7.30 am and second in the evening at 4.00 pm. Chicks under all treatment groups fed isocaloric diets (2765 Kcal kg^{-1}).

Data collection and statistical analysis

Data of feed intake were collected daily and body weight on weekly basis. Collected data were recorded in register properly. Analysis was done with the help of computer program 'MSTAT-C'. Least significant difference (LSD) was done to compare the treatment means for different parameters. Regression analysis was done using Microsoft Excel.

Table 2. Compositions (kg $100kg^{-1}$) of experimental diets under different treatments

Ingredients	Treatments				
	T_0 (0%SHM+20% SBM)	T_1 (5% SHM+15% SBM)	T_2 (10% SHM+10% SBM)	T_3 (15% SHM+5% SBM)	T_4 (20% SHM+0% SBM)
Maize (*Zea mays*)	56.00	56.00	56.00	56.00	56.00
Rice Polish (*Oryza sativa*)	17.00	17.00	17.00	17.00	17.00
Soybean meal (SBM)	20.00	15.00	10.00	5.00	0.000
Shrimp head meal (SHM)	0.00	5.00	10.00	15.00	20.00
Protein concentrate	4.00	4.00	4.00	4.00	4.00
Lime stone	1.535	1.535	1.535	1.535	1.535
Ascovit poultry VM (vitamin)	0.13	0.13	0.13	0.13	0.13
Common salt	0.225	0.225	0.225	0.225	0.225
DL Methionine	0.15	0.15	0.15	0.15	0.15
Di calcium phosphate (DCP)	0.25	0.25	0.25	0.25	0.25
ADM-Lysine	0.10	0.10	0.10	0.10	0.10
Sodium bi carbonate	0.025	0.025	0.025	0.025	0.025
Choline chloride (50%)	0.10	0.10	0.10	0.10	0.10
Hemicomoltox (toxin and mold inhibitor)	0.20	0.20	0.20	0.20	0.20
Rovabio®Max (Enzyme)	0.02	0.02	0.02	0.02	0.02
Bioacid (anti-salmonela)	0.20	0.20	0.20	0.20	0.20
Daconil (fungicide)	0.055	0.055	0.055	0.055	0.055
Probiolac (probiotics)	0.01	0.01	0.01	0.01	0.01
Total amount	100.00	100.0	100.00	100.00	100.00
Energy content($Kcalkg^{-1}$)	2765	2765.20	2765.40	2765.60	2765.80
Protein content ($g100g^{-1}$)	18.43	18.60	18.77	18.93	19.10
Calcium ($g100g^{-1}$)	1.09	1.62	2.15	2.68	3.22
Available phosphorus ($g100g^{-1}$)	0.58	0.61	0.65	0.68	0.72

SHM = Shrimp head meal

RESULTS AND DISCUSSION

Feed intake

Significant difference in cumulative feed intake was observed among different treatment means from $5^{th}$to 18^{th} weeks of age (Table 3). Regression result revealed that there were positive relationship between level of SHM and cumulative feed intake. Figure 1 showed that cumulative feed intake increased with the increasing of level of SHM in the diet and expressed by the equation of y=20.04 x + 286 (R^2=0.000). The increasing tendency of feed intake with increasing the level of

SHM is might be due to the aroma content of SHM which may increases the palatability of feed. Gernat (2001) observed that feed consumption increased significantly ($p<0.01$) under different levels of shrimp waste in layer diet, which was consistent with the present findings. Similarly, Okoye et al. (2005) reported increased feed consumption ($p<0.05$) of broilers fed shrimp waste meal. Ingweyeet al. (2008) also observed increased feed consumption with increasing levels of shrimp waste in broiler rations. In contrast, Aktaret al. (2011) reported reduced rate of feed intake in broiler fed shrimp waste and marine waste as the substitution of fish meal.

Table 3. Cumulative feed intake (gchick^{-1}) of pullet sat weekly basis under different dietary treatments

Age of bird (week)	Treatments					LSD	Significancelevel
	T_0 (0%SHM+20% SBM)	T_1 (5% SHM+15% SBM)	T_2 (10% SHM+10% SBM)	T_3 (15% SHM+5% SBM)	T_4 (20% SHM+0% SBM)		
5th	764.08^b	779.29^{ab}	795.25^a	793.58^a	796.00^a	23.69	**
6th	1,000.93^c	1,030.01^b	1,060.25^{ab}	1,052.58^{ab}	1,066.83^a	32.19	**
7th	1,290.29^c	1324.77^b	1364.75^a	1,357.08^a	1,375.33^a	28.75	**
8th	1,591.77^c	1,638.11^b	1,682.25^a	1,674.25^a	1,695.66^a	27.27	**
9th	1,984.95^c	2,032.02^b	2,079.50^a	2,078.41^a	2,093.91^a	28.36	**
10th	2,320.12^c	2,369.19^b	2,420.83^a	2,423.25^a	2,436.08^a	28.14	**
11th	2,587.45^d	2,634.69^c	2,687.16^b	2,696.58^b	2,717.08^a	20.01	**
12th	2,920.42^d	2,961.69^c	3,005.33^b	3,027.08^{ab}	3,045.25^a	32.30	**
13th	3,276.75^b	3,294.69^b	3,344.16^a	3,361.75^a	3,377.58^a	38.04	**
14th	3,664.75^c	3,693.02^{bc}	3,723.66^{ab}	3,745.58^a	3,745.58^a	39.20	**
15th	4,085.92^b	4,099.86^b	4,125.33^{ab}	4,141.41^{ab}	4,145.91^a	43.12	**
16th	4,512.92^b	4,518.02^b	4,538.00^{ab}	4,556.85^a	4,561.08^a	30.33	*
17th	4,919.08	4,903.02	4,924.16	4,941.25	4,943.08	28.04	NS
18th	5,323.75	5,306.36	5,333.33	5,345.58	5,341.41	31.58	NS

NS= Non-significant; * = $P<0.05$; ** = $P<0.01$

$^{a, b, c, d}$ Values in the same row bearing different superscripts are significantly different.

SHM=Shrimp head meal; SBM=Soybean meal; LSD=Least significant difference.

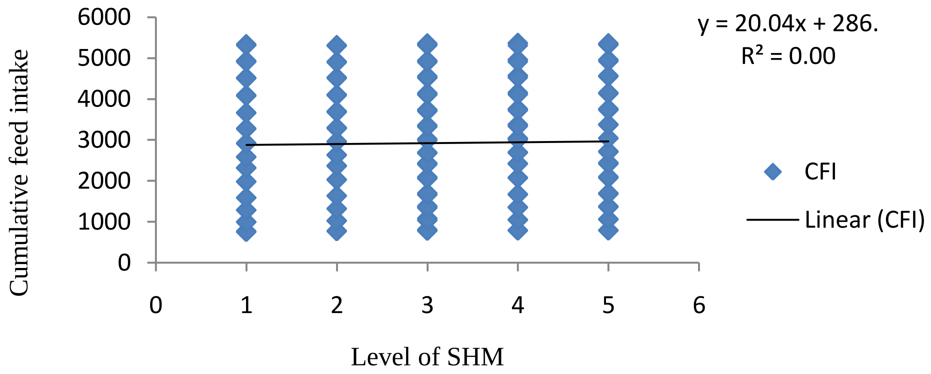

Figure 1. Relationship between level of shrimp head meal (SHM) and cumulative feed intake (g) of pullets CFI= cumulative feed intake

Feed conversion ratio (FCR)

The feed conversion ratio (feed intake in g/weight gain in g) of chicks receiving different dietary treatments is shown in Table 4. Significant differences observed in FCR among different treatment group sat 6th, 7th, 8th, 9th, 11th, 13th, 14th, 15th, 17th and 18th weeks of age. The lowest FCR values were observed in treatment group T_1 (5 % SHM+15 % SBM) compared to other treatments groups at 11th and 18th weeks of age. Aktar et al. (2011) also reported improved feed conversion ratio while fish meal of broiler diets is substituted by shrimp and marine waste meal. Increased FCR with increasing SHM in diets is supported by the findings of Ingweye et al. (2008), who stated that the feed conversion ratio increased with increasing levels of shrimp waste in broiler ration.

Table 4. Feed conversion ratio (FCR) of pulletsat weekly basis under different dietary treatments

Age of bird (week)	Treatments					LSD	Significance Level
	T_0 (0%SHM+20% SBM)	T_1 (5% SHM+15% SBM)	T_2 (10% SHM+10% SBM)	T_3 (15% SHM+5% SBM)	T_4 (20% SHM+0% SBM)		
5th	2.66	2.76	2.76	2.78	2.88	0.20	NS
6th	2.82^{b}	2.92^{b}	2.98^{b}	2.82^{b}	3.39^{a}	0.23	**
7th	2.78^{c}	3.21^{ab}	3.03^{ab}	3.12^{ab}	3.55^{a}	0.42	**
8th	2.88^{b}	3.26^{b}	3.28^{b}	3.34^{b}	3.84^{a}	0.49	**
9th	2.99^{c}	3.14^{bc}	3.49^{b}	3.42^{bc}	4.13^{a}	0.48	**
10th	3.71	3.74	4.12	4.49	4.70	0.70	NS
11th	3.36^{b}	3.28^{b}	3.75^{a}	3.93^{a}	3.73^{a}	0.33	**
12th	3.60	4.03	4.19	4.02	4.24	0.51	NS
13th	3.42^{b}	3.67^{b}	4.21^{a}	4.30^{a}	3.95^{a}	0.54	*
14th	3.78^{b}	3.92^{b}	3.97^{b}	3.94^{b}	4.38^{b}	0.33	**
15th	3.81^{b}	4.13^{a}	4.30^{a}	4.12^{a}	4.12^{a}	0.25	*
16th	3.91	4.13	4.21	4.16	4.30	0.27	NS
17th	4.01^{c}	4.07^{bc}	4.41^{a}	4.40^{ab}	4.49^{a}	0.34	**
18th	4.00^{bc}	3.88^{c}	4.26^{ab}	4.02^{bc}	4.55^{a}	0.33	*

NS= Non-significant; * = $P<0.05$; ** = $P<0.01$

$^{a,\ b,\ c}$ Values in the same row bearing different superscripts are significantly different.

SHM=Shrimp head meal; SBM=Soybean meal; LSD=Least significant difference.

Body weight gain

Significant differences in cumulative body weight gain of pullets were observed at 6th, 7th, 8th, 9th, 13th, 14th, 15th, 17th and 18th weeks of age (Table 5). The highest body weight was found in control group T_0 (0% SHM+20%SBM) at 6th, 7th, 8th, 9th, 12th, 13th, 14th, 15th, 16th, 17th and 18th weeks of age. Regression result revealed that cumulative body weight decreased with increasing level of SHM and expressed by the equation of $y=-20.77x + 818.2$ ($R^2=0.009$) which indicates little variation (0.9 %) in cumulative body weight due to level of SHM (Fig. 2). The lower body weight gain of pullets fed high content of SHM is may be due to the fact that higher fiber content of SHM causes lower digestibility of rations which results lower body weight gain of pullets. However, birds fed diet with a combination of 5 % SHM+15 % SBM(T_1) showed significantly higher weight gain compared to control (T_0) and others treatment groups at 10th, 11thand 18th weeks of age which indicate that substitution of SBM by SHM at the rate of 25 % is suitable. Ingweyeet al. (2008) also observed highest body weight gain of broilers at 25 % substitution of SBM by shrimp waste meal and fish waste meal. Similarly, Oduguwa, et al. (2004) reported that complete substitution of fish meal and soybean meal by shrimp waste was not suitable for better growth of Anak broilers. Okoye et al. (2005) observed insignificant difference in weight of broiler fed shrimp waste meal at finisher phase. However, Rosenfeld et al. (1997) found to be significantly higher ($p< 0.01$) body weight at 21, 28, 35, and 42 day of agein treatments in which shrimp meal was introduced at a 100 % substitution for SBM in broiler which is inconsistent with this result. Aktar et al. (2011) also reported improved weight gain while fish meal of broiler diets is substituted by shrimp and marine waste which is inconsistent with the present findings.

Table 5. Cumulative body weight gain (gbird^{-1}) of pullet sat weekly basis under different treatments

Age of bird (week)	Treatments					LSD	Significance level
	T_0 (0%SHM+20% SBM)	T_1 (5% SHM+15% SBM)	T_2 (10% SHM+10% SBM)	T_3 (15% SHM+5% SBM)	T_4 (20% SHM+0% SBM)		
5th	286.33	281.13	288.13	284.86	275.73	16.79	NS
6th	354.33^a	352.20^a	355.26^a	372.40^a	313.73^b	29.64	**
7th	464.16^a	411.66^b	450.00^a	434.16^{ab}	388.33^b	38.63	*
8th	551.00^a	502.91^a	511.83^a	500.83^a	442.50^b	52.46	*
9th	663.33^a	646.66^a	596.64^a	607.77^a	506.66^b	85.31	**
10th	625.55	634.44	587.77	546.66	526.66	88.62	NS
11th	769.00	802.77	715.55	718.88	727.76	56.33	NS
12th	811.11	736.66	716.66	761.10	722.22	100.4	NS
13th	955.55^a	897.77^{ab}	794.44^b	788.88^b	855.55^{ab}	104.4	*
14th	968.88^a	940.00^a	936.66^a	950.00^a	853.33^b	76.38	**
15th	1070.55^a	992.22^b	953.33^b	1004.44^a	1005.00^a	66.17	*
16th	1152.22	1098.88	1075.53	1093.33	1060.10	72.88	NS
17th	1227.22^a	1203.33^{ab}	1115.55^{bc}	1121.22^{bc}	1098.89^c	92.65	**
18th	1330.00^{ab}	1366.66^a	1250.00^b	1333.33^{ab}	1173.33^b	106.5	*

NS= Non-significant; * = P<0.05; ** = P<0.01

$^{a,\ b,\ c}$ Values in the same row bearing different superscripts are significantly different.

SHM=Shrimp head meal; SBM=Soybean meal; LSD=Least significant difference.

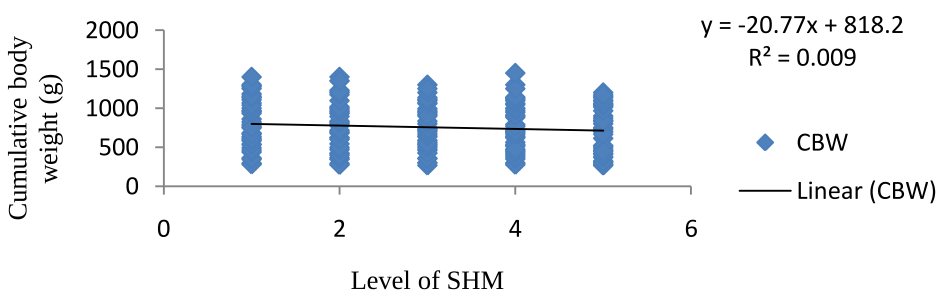

Figure 2. Relationship between level of shrimp head meal (SHM) and cumulative body weight of pullets

Age and weight at maturity

There was significant ($p<0.05$) difference in age at maturity (at 10 % egg production) under different treatment groups (Table 6). The highest average age at maturity (19.37 weeks) was found in T_4 (20 % SHM+0 % SBM) and the lowest (18.09 weeks) in T_0 (0 % SHM+20 % SBM). There was significant ($p<0.05$) difference in weight at maturity (at 10 % egg production) among different treatment groups (Table 6). The highest weight at maturity (1366.66 g bird^{-1}) was found in T_1 (5 % SHM+15 % SBM) and the lowest (1173.33 g bird^{-1}) was found in T_4 (20 % SHM+0 % SBM). Van Emouset al. (2018) reported that age at sexual maturity was not affected by differences in daily CP intake in broiler breeders. On the other hand, Ekmay et al. (2012) described the relation between body weight and sexual maturity who reported that the age at sexual maturity decreased with the increasing of body weight in broiler breeders.

Table 6. Age at maturity (week), weight at maturity (g bird^{-1}), mortality rate (%) and feed cost (BDT kg^{-1}) of pullets under different dietary treatments

Treatments	Age at maturity (week) at 10% egg production	Weight at maturity (g bird^{-1}) at 10% egg production	Mortality rate (%)	Feed cost for live weight gain (BDT[#] kg^{-1})
T_0 (0% SHM+20% SBM)	18.09^{b}	1330.00^{ab}	4.76a	115.73^{a}
T_1 (5% SHM+15% SBM)	18.61^{ab}	1366.66^{a}	3.25a	116.59^{a}
T_2 (10% SHM+10% SBM)	18.56^{b}	1250.00^{b}	3.33^{a}	113.55^{ab}
T_3 (15% SHM+5% SBM)	18.71^{ab}	1333.33^{ab}	0.00b	106.66^{bc}
T_4 (20% SHM+0% SBM)	19.37^{a}	1173.33^{b}	0.00^{b}	104.49^{c}
LSD	0.78	106.50	3.16	7.56
Significance Level	*	*	*	*

* = $p<0.05$; [a, b, c] Values in the same column bearing different superscripts are significantly different.

SHM=Shrimp head meal; SBM=Soybean meal; LSD=Least significant difference.
[#] BDT (Bangladeshi currency) 1 US$ = 85 BDT approx.

Mortality rate

There was significant ($P<0.05$) difference in mortality rate (%) of pullets among different treatment groups (Table 6). The highest mortality rate (4.76%) was observed in T_0 (0% SHM+20%SBM) and no mortality was observed in T_3 (15%SHM+5%SBM) and T_4 (20% SHM+0%SBM). Garnet (2001) found that no significant difference for mortality by shrimp meal inclusion, which was inconsistent with the present findings. Regression result revealed that there were negative relationships between level of SHM and mortality rate which indicate that the survivability rate of pullets increased with the increasing level of SHM in the diets. Figure. 3 showed that mortality decreased with increasing level of SHM and expressed by the equation of y= -1.277x + 6.10 (R^2=0.55) which indicates 55% variation in mortality rate due to level of SHM. However, in another study survivability of broilers was not affected due to the substitution of fish meal by shrimp and marine waste (Aktar et al., 2011).

Feed cost (BDT kg^{-1}) for live weight gain

Significant difference (P<0.05) was observed in feed cost kg^{-1} live weight gain of pullets among different treatment groups (Table 6). Lowest feed cost (104.49 BDTkg^{-1}) for live weight gain was found in treatment T_4 (20%SHM+0% SBM). Feed cost decreased with increasing level of SHM and expressed by the equation of y= -3.24x+121.1 (R^2=0.49) which indicates 49% variation in feed cost due to level of SHM (Fig.4). Aktar *et al.* (2011) also reported reduced feed cost while fish meal of broiler diets was substituted by shrimp and marine waste.

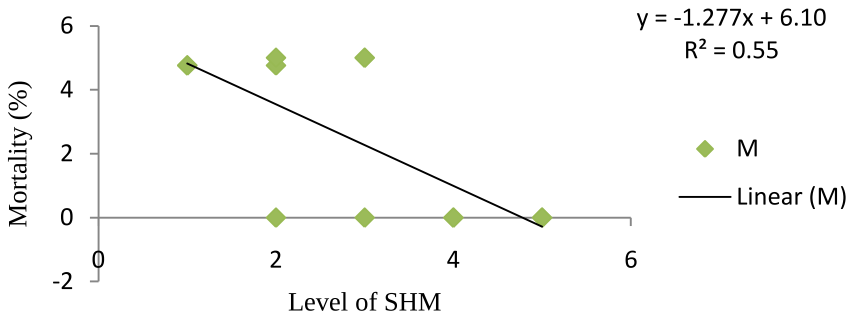

Figure 3. Relationship between the level of shrimp head meal (SHM) and mortality of pullets

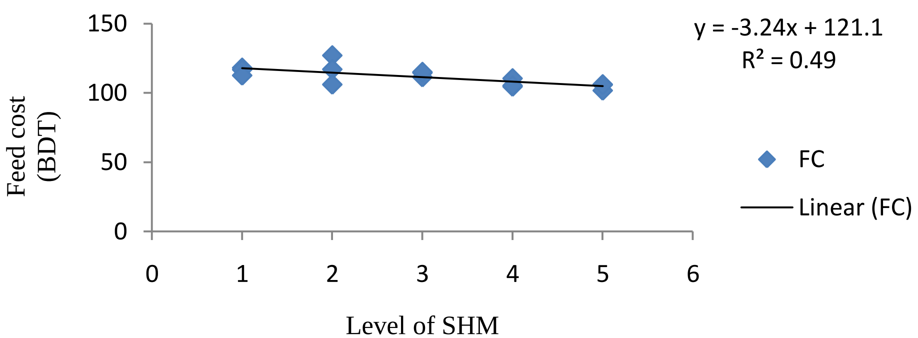

Figure 4. Relationship between the level of shrimp head meal (SHM) and feed cost of pullets

CONCLUSION

In the present study, cumulative body weight decreased and age at maturity increased with the increasing level of shrimp head meal (SHM) in the rations which indicate that complete substitution of soybean meal (SBM) by SHM is not suitable. However, feed cost and mortality rate decreased with the increasing level of SHM in the ration. Significantly lowest feed conversion ratio (FCR) at most of the age categories, highest cumulative body weight ($p<0.05$) at 18 weeks and highest weight at maturity ($p<0.05$) were found in treatment group fed ration with a combination of 5 kg SHM and 15 kg SBM100 kg^{-1}. Therefore, it can be concluded that the 25% substitution of SBM of the ration by SHM is suitable for better performance of growing layer pullets.

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