Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Physical and nutritional qualities of eggs and meats fed shrimp head meal to layer chicken

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Abstract

The experiment was conducted to investigate the effects of substitution of soybean meal of laying hens ration by shrimp head meal (SHM) on physical and nutritional quality of eggs and meats. Three hundred Hisex White laying hens were divided into five treatment groups and allocated five experimental diets included different levels of SHM. Soybean meal contents of control ration was substituted by SHM meal at the rate of 25, 50, 75 and 100%, respectively. Samples of SHM, eggs and meats were subjected to proximate analysis. Physical properties of eggs and meats were also analyzed following the standard procedures. Highest CP contents (%) of eggs were recorded to be 11.39±0.27 and 10.83±0.18 at initial and peak production periods, respectively in laying hens group fed ration substituted SBM by SHM at the rate of 25%. Significantly ($p<0.001$) highest value of redness (a^*) of egg yolk was recorded to be 1.39 in laying hens group fed diet where SBM was completely substituted by SHM and lowest to be -3.11 in control group (no substitution) at initial production stage (18^{th} to 20^{th} week). Significantly ($p=0.05$) highest CP (%) contents of meats was found to be 19.37±0.36 in laying hens fed diets substituted SBM at the rate of 75% by SHM and lowest in complete substituted group. It can be concluded that substitution of soybean meal of laying hens ration at the rate of 25% by SHM is suitable for better egg and meat quality.

Keywords: alternate protein source, carcass parts, egg weight, meat color, yolk color

 Bang. J. Anim. Sci. 2021. 50 (1):12-21

Introduction

Poultry is one of the fastest growing and most promising industries with the brightest future for Bangladesh. Following a high population growth, urbanization and demand elasticity, the demand for poultry products is expected to increase in the future. 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). Due to the unavailability and high cost of poultry feed particularly protein sources inhabit the formulation of least cost ration. The bulk of the feed cost arises from protein concentrates such as fishmeal, soybean meal and groundnut cake. Prices of these conventional protein sources have risen so high in recent times that it is not economical to use them in poultry feeds which have necessitated the search for alternatives to the expensive protein concentrates (Adeyemi, 2005). Animal nutritionists have therefore come to the conclusion that replacement of expensive conventional feed ingredients with cheap and available substitutes represents a suitable strategy at reducing feed cost and encouraging production. Many research efforts were taken in the search for alternatives to soybean meal in poultry diets. As a result poultry nutritionists have been working with various types of unconventional feed sources (Ani and Okorie, 2009).

It was estimated that 248.8 metric tons of shrimp waste is produced daily in 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). This waste product from the shrimp processing plants has the potential of being an alternative protein source in layer rations, partially or totally replacing conventional protein sources such as soybean meal (SBM), meat and bone meal and fish meal. 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). Gernat (2001) conducted an experiment and found that SHM had no significant effect on egg weight and specific gravity. Researchers suggest that shrimp meal contains high levels of Ca (Rahman and

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Koh, 2014) and carotenoid pigment (astaxanthin) (Gernat, 2001) which can improve the egg shell quality and yolk color, respectively. The eggshell strength and yolk color of chicken eggs was significantly ($p<0.05$) increased with the increasing levels of dietary shrimp meal (Rahman, 2016). According to Rahman (2016) the dressing yield was not varied significantly ($p>0.05$) due the inclusion of shrimp meal in the diet which was compatible with the findings of Fanimo *et al*. (1996). Similarly, shrimp meal had no significant effect on percentage of giblets yield among the dietary treatment groups ($p>0.05$) (Rahman, 2016). Therefore, the research was undertaken to investigate the effect of different levels of shrimp head meal on physical and nutritional quality of eggs and meats of laying hens.

Materials and Methods

Experimental site, design and laying hens

The experiment was conducted at Dr. Purnendu Gain Field Laboratory, Agrotechnology Discipline, Khulna University, Khulna, Bangladesh. The design of the experiment was based on completely randomized design (CRD). Hisex White laying hens were divided into five treatment groups and assigned at random to five different diets included 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.

Management practices

The experimental birds were kept in a shed having slate floor. The floor as well as feeders and waterers were cleaned regularly. Proper bio-security measures were taken during the experimental period. The experimental birds were debeaked earlier at 70 days of bird's age using electrical debeaker. During the experimental period from 18th week to 34th weeks of laying hens age, 16 hours lighting period and 8 hours dark period was maintained properly. During laying period to prevent Newcastle disease a live vaccine (Avinew) was applied regularly every 2 months interval and killed vaccine against Newcastle disease (Imopest) was also applied 5 months interval. Fowl cholera vaccine was applied during laying period. Birds were also vaccinated earlier (before 18 weeks of age) 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.

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

Proximate components (%)	Shrimp species	
	Black tiger shrimp (*Penaeus monodon)*	Giant freshwater prawn (*Macrobrachium rosenbergii)*
Dry matter (DM)	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 fibre (CF)	3.20	4.10
Ether extract (EE)	5.78	24.23

Preparation and proximate analysis of shrimp head meal (SHM), eggs and meats

Heads of black tiger shrimp (*Penaeus monodon*) were collected from shrimp processing plants. After arrival of shrimp heads in the experimental site it 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 (SHM) was estimated in the Animal Husbandry Laboratory of Agrotechnology Discipline, Khulna University, Bangladesh following the method of AOAC (2005). Proximate composition of head from two major species of shrimp such as giant freshwater prawn (*Macrobrachium rosenbergii*) and black tiger (*Penaeus monodon*) was determined separately (Table 1). Proximate composition of eggs and meats of laying hens under different treatments were also estimated following the same procedures.

Ration formulation and feeding system

After weighing, required quantity of feed ingredients and feed additives were mixed homogeneously using a feed mixing machine. In the experimental rations, main protein source (SBM) was substituted by SHM at the rate of 0, 25, 50, 75 and 100%, respectively. Other ingredients of five experimental rations were kept in constant proportions (Table 2). Feeds and water were supplied *ad libitum* to the experimental laying hens two times daily first in the morning at 7.30 am and second in the evening at 4.00 pm. Laying hens under all treatment groups fed isocaloric diets.

Physical traits and color determination

Physical traits of eggs and meats were determined according to Singh (1990). Meat samples were standardized into two 2.54 cm thick steak samples (AMSA, 1995) for objective color evaluation (L*, a*, b*, c* and h*). Before data collection the instrument was calibrated with a white calibration plate (L*=97.06, a*= -0.14 b*= 1.93,) covered in the same film wrapping the samples. Data were collected in CIE L*, a*, b* color space through the meat film. Lightness (L*), redness (a*), yellowness (b*) chroma [or color saturation, ða_2 þ b_2þ 0:5], and hue angle [arctangent (b*/a*)360_/(2_3.14)] were evaluated. Breast muscle and drumstick color coordinates (L*, a* and b*) were recorded with a digital Minolta CR300 chromometer (Minolta Co., Osaka, Japan) on the surface exposed by cutting. Coordinate a* ranged from red (+a*) to green (-a*) and coordinate b* from yellow (+b*) to blue (-b*) (Hunterlab, 1996). Three readings of L*, a*, b*, c* and h* values were obtained at different sites. Egg yolk color was also estimated in similar ways.

Data collection and statistical analysis

Egg weight data were recorded weekly and body weight at fortnightly from each pen. The data of egg weight were collected from the average weight of at least 10 eggs from each pen and the data of body weight of laying hens were collected from the average body weight of at least 5 birds. The data were analyzed using the GLM procedure of SAS version 9.1.3 (SAS, 2009). Effects of shrimp head meal were tested by analysis of variance and DMRT was used to compare the treatment means, with significance level considered at $p<0.05$.

Table 2: Composition (Kg/100Kg) of experimental diets under different treatments

Ingredients (Kg/100Kg)	Rate of substitution of SBM by SHM (%)				
	0	25	50	75	100
Maize (*Zea mays*)	50.00	50.00	50.00	50.00	50.00
Rice polish (*Oryza sativa*)	8.90	8.90	8.90	8.90	8.90
Wheat bran (*Triticum aestivum*)	4.000	4.00	4.00	4.00	4.00
Soybean meal (SBM)	22.00	16.50	11.00	5.50	00
Shrimp head meal (SHM)	00	5.50	11.00	16.50	22.00
Protein concentrate	5.00	5.00	5.00	5.00	5.00
Limestone	9.00	9.00	9.00	9.00	9.00
Ascovit poultry VM (vitamin)	0.125	0.125	0.125	0.125	0.125
Common salt	0.200	0.200	0.200	0.200	0.200
DL-methionine	0.125	0.125	0.125	0.125	0.125
ADM - lysine	0.050	0.050	0.050	0.050	0.050
Sodium bi carbonate	0.050	0.050	0.050	0.050	0.050
Choline chloride	0.100	0.100	0.100	0.100	0.100
Klinofeed plus (Mycotoxin binder)	0.200	0.200	0.200	0.200	0.200
Rovabio®Max (Enzyme)	0.020	0.020	0.020	0.020	0.020
Bioacid (anti-salmonela)	0.200	0.200	0.200	0.200	0.200
Hedox dry (Antioxidant)	0.020	0.020	0.020	0.020	0.020
Probiolac (probiotics)	0.010	0.010	0.010	0.010	0.010
Total	100	100	100	100	100
Energy content(Kcal/kg)	2734.00	2734.20	2734.40	2734.60	2734.80
Protein content (g/100g)	18.86	19.03	19.20	19.37	19.54

SBM, Soybean meal; SHM, Shrimp head meal

Results and Discussion

Physical properties of eggs

Data of the Table 3 showed that different physical traits like egg weight, specific gravity, haugh unit, shape index, albumen weight, albumen index, yolk index, shell weight and shell thickness were not varied significantly (p>0.05) due to the inclusion of shrimp head meal (SHM) in laying hens ration at the initial production stage (18th to 20th weeks). Yolk weight (g/egg) was found highest (p<0.01) in laying hens fed control diets (11.87±0.36) and lowest in laying hens group fed diets substituted soybean meal (SBM) by SHM at the rate 25% (10.05±0.35) at initial production stage. Shrimp head meal had a highly significant effect (p<0.001) on albumin index at peak production period (28th to 34thweeks) being highest (11.87%) in laying hens group fed diets substituted soybean meal (SBM) by SHM at the rate of 75% and lowest (7.68%) in 50% substitution group. Rest physical traits under study were statistically similar (p>0.05) for all treatment groups at peak production period (28th to 34th weeks). Inclusion of shrimp meal in laying hens ration had no significant effects (p<0.05) on egg weight, shell thickness and specific gravity (Rahman, 2016) which is consistent with the present findings. No significant effects of SHM in laying hens ration on egg weight and specific gravity was also reported by Gernat (2001). Another study suggests that shrimp meal contains high levels of Ca which can improve the egg shell (Rahman and Koh, 2014). However, in present study, eggshell weight and thickness were not differed significantly (p>0.05) among diet groups included different levels of SHM.

Table 3: Physical traits of the eggs (Mean±SE) of laying hens under different dietary treatments

Parameters	Rate of substitution of SBM by SHM (%)					P value
	0	**25**	**50**	**75**	**100**	
Initial production stage (18th to 20th weeks)						
Egg weight (g/egg)	47.76±1.68	45.29±2.44	45.97±0.99	42.78±1.61	44.13±0.51	0.30
Specific gravity of eggs (g/ml)	1.14±0.02	1.13±0.04	1.13±0.01	1.10±0.02	1.10±0.00	0.76
Haugh unit	92.06±0.41	92.43±1.06	91.92±0.41	92.58±0.71	91.40±0.72	0.78
Shape index (%)	65.31±2.23	67.94±0.59	65.96±1.77	64.52±2.59	66.05±0.33	0.72
Yolk weight (g/yolk)	11.87^{a} ±0.36	10.05^{b}±0.35	10.85^{ab}±0.13	11.09^{ab}±0.37	10.30^{b}±0.32	0.01
Albumin weight (g/egg)	29.18±1.28	28.05±1.04	28.10±0.94	25.98±0.54	27.25±1.11	0.31
Albumin index (%)	10.76±0.38	11.50±0.68	10.77±0.98	11.20±0.51	9.65±0.35	0.35
Yolk index (%)	40.96±0.44	43.54±1.29	42.18±1.55	44.37±0.90	42.50±0.27	0.23
Eggshell weight (g/egg)	4.83±0.14	4.83±0.34	4.89±0.18	4.65±0.18	4.80±0.10	0.93
Eggshell thickness (mm)	0.38±0.00	0.39±0.01	0.39±0.00	0.38±0.00	0.40±0.00	0.42
Peak production stage (28th to 34th weeks)						
Egg weight (g/egg)	56.13±1.32	55.34±2.51	54.22±1.70	53.52±0.91	52.24±2.71	0.66
Specific gravity of eggs (g/ml)	1.14 ±0.00	1.08 ±0.01	1.15±0.01	1.14±0.02	1.12±0.02	0.10
Haugh unit	90.56±0.39	90.61±0.58	91.70±0.55	91.58±0.10	91.44±0.68	0.37
Shape index (%)	77.77±0.77	74.86±2.63	75.86±0.37	77.50±0.65	77.35±0.16	0.46
Yolk weight (g/yolk)	15.83±0.25	15.29±1.14	15.81±0.90	15.05±0.48	15.12±1.25	0.94
Albumin weight (g/egg)	31.98±0.92	31.71±1.34	30.34±1.82	31.46±1.66	29.45±1.36	0.71
Albumin index (%)	8.37^{b}±0.74	7.68^{b}±0.21	11.18^{a} ±0.23	11.87^{a}±0.42	10.91^{a}±0.93	0.001
Yolk index (%)	43.33±2.23	41.70±0.34	46.27±0.66	44.48±0.86	45.86±1.56	0.06
Eggshell weight (g/egg)	5.16 ±0.06	5.35±0.27	5.27 ±0.09	5.37 ±0.05	5.13±0.07	0.68
Eggshell thickness (mm)	0.40 ±0.00	0.41±0.01	0.39±0.00	0.42±0.00	0.39 ±0.01	0.37

$^{a, b, c}$ Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM,Shrimp head meal; P values indicate significance level.

Table 4: Proximate composition of edible portion of eggs (Mean±SE) of laying hens under different dietary treatments

Proximate components (DM basis)	Rate of substitution of SBM by SHM (%)					P value
	0	25	50	75	100	
Initial production stage (18th to 20th weeks)						
Dry matter (%)	21.76±0.42	22.25±0.78	22.41±0.75	22.12 ±0.28	21.58±0.96	0.90
Crude protein (%)	10.69^{ab}±0.08	11.39^{a}±0.27	10.77 ^{ab}±0.10	9.29^{c}±0.08	10.26^{b}±0.39	0.0008
Ether extract (%)	8.35±0.05	8.45±0.56	8.64±0.98	9.64±0.28	8.67±0.46	0.53
Total ash (%)	1.08±0.00	1.15±0.01	1.11±0.04	1.06±0.02	1.12±0.01	0.17
Peak production stage (28th to 34th weeks)						
Dry matter (%)	21.90±0.26	21.75±0.51	21.83±0.37	20.43±0.58	20.60±0.36	0.08
Crude protein (%)	10.52^{a}±0.03	10.83^{a}±0.18	10.63^{a}±0.10	9.62^{b}±0.24	8.68^{c}±0.08	<0.0001
Ether extract (%)	8.46 ^{b}±0.17	8.26^{b}±0.12	9.10^{a}±0.23	8.26 ^{b}±0.12	9.00^{a} ±0.15	0.01
Total ash (%)	1.09±0.03	1.10±0.02	1.04±0.01	1.15±0.02	1.10±0.02	0.11

a, b, c Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.

Proximate composition of eggs

Crude protein contents of eggs varied significantly among the laying hens groups fed diets included different levels of SHM at both initial and peak production stages (Table 4). Highest CP contents (%) were recorded to be 11.39±0.27 and 10.83±0.18 at initial (18th to 20th weeks) and peak (28th to 34th weeks) production stages, respectively in laying hens group fed ration substituted SBM by SHM at the rate of 25%. Dry matter and total ash contents showed no significant variation ($p>0.05$) for both production stages. However, ether extract contents varied significantly ($p=0.01$) among different treatment groups at peak production stage (28th to 34th weeks) where the highest EE content of eggs was recorded to be 9.10±0.23 in laying hens group fed diets having 50% substitution.

Table 5: Color measurement of egg yolk (Mean ± SE) of laying hens under different dietary treatments

Color indicators	Rate of substitution of SBM by SHM (%)					P value
	0	25	50	75	100	
Initial production stage (18th to 20th weeks)						
Lightness (L*)	51.01±2.01	47.30 ±0.71	47.95±0.57	52.52±1.70	48.30±2.58	0.21
Redness (a*)	-3.11^{c}±0.11	0.50^{ab}±0.14	-0.65^{b}±0.59	0.17^{ab} ±0.74	1.39^{a} ±0.13	0.0003
Yellowness (b*)	36.49±1.34	34.92±0.95	33.67±0.71	39.70±2.82	36.43±2.21	0.25
Chroma (c*)	36.71±0.85	35.26±1.28	33.69±0.71	39.72±2.81	36.46±2.22	0.25
Hue angle (h*)	95.20^{a}±0.33	90.82^{b}±0.22	91.08^{b}±1.00	89.90^{bc}±1.14	87.81^{c}±0.18	0.0004
Peak production stage (28th to 34th weeks)						
Lightness (L*)	55.50±1.76	51.25±0.75	50.82±0.48	55.92±1.34	51.3±2.31	0.08
Redness (a*)	-5.69±0.63	0.55±0.13	-0.67±0.63	0.17±0.78	1.44±0.12	0.08
Yellowness (b*)	39.34±1.51	39.08±1.27	36.34±0.98	42.56±2.53	39.35±2.25	0.27
Chroma (c*)	35.85±1.03	39.01 ±1.50	36.44±0.49	42.65±2.46	39.85±2.34	0.10
Hue angle (h*)	69.28±29.41	94.12±0.07	94.70±0.79	92.60 ±1.29	91.24 ±0.37	0.62

a, b, c Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.

Color of egg yolk

Color measurements of egg yolk of laying hens fed diets included different levels of SHM is shown in Table 5. At the initial production stage (18th to 20th weeks), shrimp head meal (SHM) had a significant effect (p<0.001) on redness (a*) and hue angle (h*) of egg yolk. Significantly (p<0.001) highest value of redness (a*) was recorded to be 1.39 in laying hens group fed diet where SBM was completely substituted by SHM and lowest to be -3.11 in control group (no substitution) at initial production stage. Other color indicators of egg yolk like lightness (L*), yellowness (b*) and chroma (c*) were not varied significantly among different treatment groups in initial production period. On the other hand, all color measurement indicators studied for egg yolk did not show any significant variation among treatment groups at peak production stage (28th to 34th weeks). Highest value of redness (a*) of egg yolk in complete substituted group (1.39 ±0.13) and lowest in control group (-3.11±0.11) in the present study is due to the carotenoid pigment (astaxanthin) contents of SHM, because it is well known that this pigment can increase the yolk color (Anderson *et al*., 2008). In a study, yolk color of chicken eggs was significantly (p<0.05) increased with the increasing levels of dietary shrimp meal in the diets (Rahman, 2016)

Table 6: Weight measurement of different carcass parts of layer meats (Mean ±SE) under different dietary treatments

Parameters	Rate of substitution of SBM by SHM (%)					P value
	0	25	50	75	100	
Initial production stage (18th to 20th weeks)						
Live weight (kg/bird)	1.50^a±0.01	1.17^d±0.01	1.23^c±0.00	1.37^b±0.02	1.13^d±0.01	< .0001
Dressed weight (g/bird)	1144.00^a ± 6.65	906.67^{bc} ± 21.27	960.16^b ± 15.33	1093.17^a ± 58.41	853.66^c ± 20.64	.0002
Neck weight (g/bird)	35.20^a±0.61	33.73 ^{a}±0.69	34.26 ^{a}±0.33	26.73^c±0.49	30.83^b±0.20	< .0001
Full wing weight (g/bird)	49.06^a±0.35	48.03^b±0.08	45.83^{cd}±0.27	45.53^d±0.37	46.70^c±0.30	< .0001
Thing weight (g/bird)	69.30^a±0.41	48.26^d±0.18	53.23^b±0.38	51.23^c±0.48	48.00^d±1.05	< .0001
Back weight (g/bird)	182.66^a ±1.85	166.83^b ±6.19	174.33^{ab} ±0.33	139.00^c ±2.08	170.40^{ab} ±7.70	.0006
Breast weight (g/bird)	248.33^a ±1.66	181.33^d ±2.33	208.00^c ±1.15	222.66^b ±5.04	202.50^c ±3.81	< .0001
Drumstick weight (g/bird)	62.33^a±1.45	48.66^c±0.44	62.33^a±1.45	55.00^b±2.88	48.60^c±1.55	.0003
Peak production stage (28th to 34th weeks)						
Live weight (kg/bird)	1.79^a±0.02	1.36^c±0.02	1.56^b±0.02	1.44^c±0.02	1.54^b±0.02	<.0001
Dressed weight (kg/bird)	1.44^a±0.10	1.07^d±0.01	1.27^b±0.01	1.12^c±0.01	1.24^b±0.01	<.0001
Neck weight (g/bird)	34.00^b ±0.28	32.56^c±0.53	32.53^c±0.20	33.5^{bc}±0.17	35.93^a±0.06	<.0001
Full wing weight (g/bird)	52.51^a±0.01	46.38^b±0.44	45.50^c±0.17	46.73^b ±0.12	52.23^a ±0.14	<.0001
Wing tip weight (g/bird)	8.46^a±0.03	7.66^b±0.08	7.69^b±0.02	7.30^c±0.15	7.80^b±0.05	<.0001
Thing weight (g/bird)	69.70^a ±0.25	55.61^e±0.06	60.23^c±0.44	59.00^d±0.28	65.53^b±0.14	<.0001
Back weight (g/bird)	214.73^b ±0.23	169.9^d ±0.20	219.01^a ±0.10	197.83^c ±0.32	165.46^e±0.14	<.0001
Breast weight (g/bird)	264.66^a ±0.66	228.33^b ±0.12	206.08^d ±0.22	223.98^c ±0.18	206.90^d±0.20	<.0001
Drumstick weight (g/bird)	63.7^a±0.20	49.60^d±0.26	56.48^c±0.01	48.98 ^{d}±0.13	59.33^b±0.33	<.0001

$^{a,\ b,\ c}$ *Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.*

Weight of carcass parts of layer meats

Results revealed that the live weight, dressed weight and weights of other body parts were varied significantly due to the substitution of SBM of laying hens rations by different levels of SHM at both production stages (Table 6). The highest live weight of laying hens at initial egg production stage (18th to 20th weeks) was recorded to be 1.50kg/bird in control group and lowest to be 1.13kg/bird in complete substituted group. Dressed carcass weight also showed similar trends at initial production stage. Highest breast weight (g/bird) was recorded to be 264.66±0.66 in control group (no substitution) and lowest to be 206.08±0.22 in diet group substituted SBM at the rate of 50% by SHM. Highest drumstick weight (g/bird) was also reported to be 63.7±0.20 in control group. Rahman (2016) observed no significant effects of shrimp meal (p>0.05) on carcass traits among the dietary treatment groups. However, carcass traits varied significantly in the present study due the inclusion of SHM in laying hen's ration. Aktar *et al.* (2011) stated that dressed yield, thigh meat weight, breast meat weight and drumstick meat weight differed significantly due to substitute of fish meal of broiler ration by shrimp waste and marine waste. Similarly, significant variation observed in those traits due to inclusion of SHM in the diets in present study. According to Rahman (2016) the dressing yield was not varied significantly (p>0.05) due the inclusion of shrimp meal in the diet which was compatible with the findings of Fanimo *et al*. (1996). In contrast, dressing yield was varied significantly in the present study.

Weight of non-carcass parts of layer meat

Weights of different non-carcass parts like feather, head, gizzard, heart, bile sac, lung and liver were varied significantly among different diets groups included different levels of SHM at both production stages (Table 7). The highest liver weight (g/liver) was recorded to be 30.81±0.19 in 75% SHM group and 43.29±0.00 in complete substitution group at initial and peak production stages, respectively. The highest gizzard weights (g/gizzard) were recorded to be 24.09±0.23 and 24.87±0.01 in laying hens groups feed 75% substituted and control diets at initial and peak stages of production, respectively.

Table 7: Weight measurement of different non-carcass parts of layer meats (Mean±SE) under different dietary treatments

Parameters	Rate of substitution of SBM by SHM (%)					P value
	0	25	50	75	100	
Initial production stage (18th to 20th weeks)						
Feather weight (g)	207.22^{b} ±3.43	181.43^{c} ±5.52	237.26^{a} ±1.50	229.70^{a} ±2.97	183.80^{c} ±3.83	< .0001
Head weight (g)	50.96^{a}±0.29	38.80^{c}±0.36	39.76^{bc}±0.87	40.76^{bc}±0.78	41.46^{b}±0.20	< .0001
Gizzard weight (g)	23.05^{ab}±0.81	21.66^{b}±0.42	23.92^{a}±0.14	24.09^{a}±0.23	21.68^{b}±0.08	0.001
Heart weight (g)	6.50^{c}±0.05	6.10^{d}±0.14	5.67^{e}±0.04	7.09^{b}±0.09	7.41^{a}±0.08	< .0001
Bile with filled sac weight (g)	1.13^{bc}±0.01	1.28^{bc}±0.01	1.03^{c}±0.01	1.93^{a}±0.17	1.49^{b}±0.20	0.002
Lung weight (g)	7.53^{a}±0.01	6.65^{c}±0.05	6.98^{b}±0.06	5.84^{d}±0.03	7.66^{a}±0.10	< .0001
Liver weight (g)	29.83^{b}±0.19	26.06^{c}±0.07	20.46^{e}±0.32	30.81^{a}±0.19	21.71^{d}±0.39	< .0001
Shank weight (g)	25.00±0.28	22.16±1.16	23.26±0.49	26.33±2.72	21.76±0.93	0.19
Peak production stage (28th to 34th weeks)						
Feather weight (g)	252.73 ^{a}±0.39	184.86 ^{ab}±0.18	224.40^{a} ±0.40	216.95^{a} ±0.62	115.74^{b} ±57.00	0.02
Head weight (g)	67.90^{a}±0.20	56.50 ^{b}±0.76	50.56 ^{c}±0.28	55.46 ±0.26	68.50^{a}±0.28	< .0001
Gizzard weight (g)	24.87^{a}±0.01	23.76 ^{b}±0.13	22.25^{d}±0.02	23.39^{c}±0.05	24.83^{a}±0.04	< .0001
Heart weight (g)	7.87^{b}±0.01	6.36^{d}±0.00	6.65^{c} ±0.02	5.84^{e}±0.02	8.76 ^{a}±0.02	< .0001
Bile with filled sac weight (g)	2.76^{a} ±0.00	1.83^{d}±0.00	2.66^{b}±0.00	2.11^{c}±0.01	2.03^{c}±0.06	< .0001
Lung weight (g)	9.41^{a}±0.00	7.53 ^{d}±0.03	8.74 ^{b}±0.01	7.14 ^{e}±0.01	7.91^{c}±0.01	< .0001
Liver weight (g)	42.28 ^{b}±0.02	39.69 ^{e}±0.02	40.72 ^{d}±0.03	41.20^{c}±0.02	43.29 ^{a}±0.00	< .0001
Shank weight (g)	25.50^{a} ±0.17	22.33^{c}±0.08	23.13^{b}±0.06	23.51^{b}±0.15	23.23^{b}±0.14	< .0001

a, b, c Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.

Table 8: Proximate composition of layer meats (Mean±SE) under different dietary treatments

Proximate components (DM basis)	Rate of substitution of SBM by SHM (%)					P value
	0	25	50	75	100	
Dry matter (%)	22.03±0.29	20.63±0.58	21.51±0.93	22.50±0.35	21.06±0.38	0.21
Crude protein (%)	18.33^{ab}±0.11	17.79^{b}±0.33	17.69^{b}±0.69	19.37^{a}±0.36	17.60^{b}±0.26	0.05
Ether extract (%)	1.26^{a}±0.03	1.08^{b}±0.01	1.25^{a}±0.05	1.10^{b}±0.00	1.16^{ab}±0.01	0.05
Total ash (%)	1.08^{ab}±0.01	1.05^{c}±0.00	1.09^{a}±0.01	1.06^{bc}±0.00	1.06^{bc}±0.00	0.005

a, b, c Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.

Table 9: Color measurement of different body parts of layer meat **(**Mean±SE) under different dietary treatments

Body parts	Parameters	Rate of substitution of SBM by SHM (%)					P value
		0	25	50	75	100	
Initial production stage (18 to 20 weeks of age)							
Drum stick meat	Lightness (L^*)	28.85^{b}±1.30	31.72^{a}±0.37	32.04^{a}±0.07	31.68^{a} ±0.25	33.16^{a}±0.18	0.007
	Redness (a^*)	5.01^{b}± 0.06	5.51^{b}±0.22	5.56^{b}±0.21	3.48^{c}±0.27	7.51^{a}±0.19	<0.0001
	Yellowness (b^*)	8.79^{c}±0.19	9.39^{b}±0.25	6.54^{e}±0.21	7.85^{d}±0.04	11.58^{a}±0.12	<0.0001
	Chroma (c^*)	9.52^{c}±0.11	11.57^{b}±0.28	8.70^{d}±0.13	8.43^{d}±0.03	13.38^{a}±0.19	<0.0001
	Hue angle (h^*)	58.85^{c}±0.52	62.78^{b}±0.18	53.18^{a}±0.29	68.17^{e}±0.13	56.27^{d}±0.24	<0.0001
Breast meat	Lightness (L^*)	24.53±0.31	37.36±0.37	28.82±0.74	37.90±0.29	23.36±0.86	0.11
	Redness (a^*)	0.79^{a}±0.11	0.64^{a}±0.04	0.38^{b}±0.01	-1.31^{d}±0.09	-0.12^{c}±0.01	<0.0001
	Yellowness (b^*)	8.14^{a}± 0.10	7.28^{b}±0.04	6.70^{c}±0.22	6.44^{c}±0.22	7.56^{b}±0.08	<0.0001
	Chroma (c^*)	8.06^{a}±0.06	7.21^{c}±0.06	6.35^{d}±0.03	6.65^{d}±0.07	7.56^{b}±0.18	<0.0001
	Hue angle (h^*)	85.69^{c}±0.25	85.53^{c}±0.2	86.03^{c}±0.37	100.03^{a}±0.99	91.55^{b}±0.30	<0.0001
Peak production stage (28^{th} to 34^{th} weeks)							
Drums tick meat	Lightness (L^*)	24.67^{c}±0.20	29.83^{b}±0.36	16.34^{d}±0.35	32.73^{a}±0.18	9.95^{e}±0.40	<0.0001
	Redness (a^*)	4.85^{b}±0.13	3.84^{c}±0.10	7.76^{a}±0.57	3.02^{c}±0.23	4.79^{b}±0.16	<0.0001
	Yellowness (b^*)	7.96^{a}±0.18	3.73^{c}±0.14	6.96^{b}±0.30	4.34^{c}±0.03	3.89^{c}±0.13	<0.0001
	Chroma (c^*)	9.04^{b}±0.08	4.96^{d}±0.05	11.14^{a}±0.38	5.09^{d}±0.11	6.18^{c}±0.16	<0.0001
	Hue angle (h^*)	56.78^{b}±0.62	44.39^{c}±0.26	35.67^{e}±0.18	58.65^{a}±0.41	38.12^{d}±0.29	<0.0001
Breast meat	Lightness (L^*)	23.90^{b}±0.33	30.09^{a}±0.29	26.19^{b}±0.39	24.86^{c}±0.14	18.36^{e}±0.16	<0.0001
	Redness (a^*)	1.97^{c} ±0.14	1.36^{d} ±0.08	3.22^{a} ±0.07	1.43^{d} ±0.06	2.55^{b} ±0.10	<0.0001
	Yellowness (b^*)	4.34^{d} ±0.19	6.21^{a} ± 0.12	5.56^{b} ± 0.20	4.98^{c} ±0.06	4.91^{c} ± 0.10	<0.0001
	Chroma (c^*)	4.81^{b} ± 0.06	6.34^{a} ±0.18	6.47^{a} ±0.11	5.27^{b} ±0.10	5.25^{b} ±0.19	<0.0001
	Hue angle (h^*)	69.02^{c}±0.08	77.98^{a}±0.50	59.01^{e}±0.39	74.73^{b}±0.20	61.90^{d}±0.39	<0.0001

a, b, c Values in the same row bearing different superscripts are significantly different. SBM, Soybean meal; SHM, Shrimp head meal; P values indicate significance level.

Results of a study revealed that shrimp meal had no significant effect on percentage of giblets (liver, gizzard, heart, etc.) yield among the dietary treatment groups (p>0.05) (Rahman, 2016) but in the present study giblets weight varied significantly due to the inclusion of SHM in the diets. Live weight and dressed weight of laying hens reduced with the increasing levels of SHM indicates that the complete substitution of SBM contents of the ration by SHM meal is not suitable because it is well established that the high fiber and chitin contents of SHM reduced the digestibility of total ration (Khempaka *et al*., 2006).

Proximate composition of layer meats

Crude protein (CP), ether extracts (EE) and total ash contents of chicken drumstick meats were varied among different treatments (Table 8).

Highest CP (%) was found to be 19.37±0.36 in laying hens fed diets substituted SBM at the rate of 75% by SHM and lowest in complete substituted group. Ether extracts (%) was found highest in control group (1.26±0.03) and lowest in 25% substituted group (1.08±0.01).

Color measurement of layer meats

Color measurement indicators like lightness (L^*), redness (a^*), yellowness (b^*), Chroma (c^*) and hue angle (h^*) for drumstick and breast meats of laying hens both at initial and peak production stages are shown in Table 9. Color study revealed that different color indicators of drumstick and breast meats of laying hens at both initial and peak production stages differed significantly among diet groups included different levels of SHM except lightness (L^*) of breast meat at initial production stage (Table 9). The values of redness (a^*) for drumstick meat were found highest in complete substituted diet group (7.51±0.19) at initial production stage and in 50% substituted group (7.76±0.57) at peak production stage. Lightness (L^*) value of breast meat at peak production stage was found highest in hens group fed 25% substituted diet (30.09±0.29) and lowest in complete substituted group (18.36±0.16) at peak production stage.

Conclusion

From the present findings, it can be concluded that the shrimp head meal (SHM) is a good alternative source of protein in layer ration for good quality eggs and meats. Due to high fiber and chitin contents of SHM, complete substitution of soybean meal (SBM) contents of laying hens ration SHM is not suitable. Comparing with each treatment it was found that substitution at the rate of 25% of SBM of ration by SHM is suitable for better quality eggs and meats of chicken.

Acknowledgement

The authors are grateful to the Ministry of Education, People's Republic of Bangladesh for financial support under the "Grants for Advanced Research in Science".

Conflict of interest

There is no conflict of interest among the authors.

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