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≪Research Note≫

Effect of Shrimp Meal Made of Heads of Black Tiger (*Penaeus monodon*) and White Leg (*Litopenaeus vannamei*) Shrimps on Growth Performance in Broilers

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The present study was conducted to measure the growth performance in growing broilers given shrimp meal (SM) made of heads of black tiger (*Penaeus monodon*) (BT) and white leg (*Litopenaeus vannamei*) (WL) shrimps. Forty-two male broiler chicks (8 days old, Ross 308) were randomly divided into 7 dietary groups (control, 5% BT, 10% BT, 15% BT, 5% WL, 10% WL and 15% WL) having similar body weight (6 birds per diet). Metabolisable energy and CP were adjusted to about 3,180 kcal/kg and about 235 g/kg, respectively, and other nutrients were formulated to meet or slightly exceed the requirements. Diet and water were provided *ad libitum* during the experimental period (8 to 21 days old). The results revealed that body weight gain decreased in BT groups with increasing level of SM ($P < 0.05$), and feed intake decreased slightly with increasing level of SM in diets. As the result, feed conversion ratio also deteriorated with increasing level of SM. Similar trend was observed in WL groups, but the adverse effects of SM were milder comparing with BT groups. Nitrogen retention in both BT and WL groups tended to decrease with increasing level of SM. Chitin digestibilities in WL groups were greater than the corresponding values in BT groups. In conclusion, it is suggested that WL heads can be more nutritious SM for broiler diets than BT heads.

Key words: black tiger, broiler, growth performance, shrimp meal, white leg

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Introduction

Shrimp meal (SM) has been tried to use as an alternative protein source in chicken diets, while the performances in chickens given SM are not consistent among the reports (Rosenfeld *et al*., 1997; Gernat, 2001; Khempaka *et al*., 2006a). Such inconsistency can be explained in part, by the differences in quality of SM originating from different shrimp species (Ngoan *et al*., 2000), and portion (Meyers, 1986). In this connection, we measured nutritional values and *in vitro* digestibilities of different SM, such as heads and hulls of white leg (*Litopenaeus vannamei*) (WL), black tiger (*Penaeus monodon*) (BT) and Argentine red (*Pleoticus muelleri*), and suggested that heads of WL were among the most nutritious source in poultry diets and heads of BT were among the second most nutritious (Rahman and Koh, 2014). Considering the practical use of these SM as a poultry feed ingredient, *in vivo* data, such as growth performance and feed efficiency, should be needed, but information about them is quite limited (Islam *et al*., 1994; Oduguwa *et al*., 2004; Khempaka *et al*., 2006a; Khempaka *et al*., 2011).

The aim of the present study was to measure growth performance of growing broilers given SM made of heads of the above two different shrimp species and to discuss their dietary quality.

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Materials and Methods

This research was conducted in accordance with guidelines for regulation of animal experimentation of Shinshu University, Japan.

Preparation of SM

SM was prepared from heads of BT (about 18.4 cm) and WL shrimps with 1.0 mm aperture, as explained in our previous report (Rahman and Koh, 2014) and the data on proximate analyses and chitin content were quoted from the report (Table 1).

Birds, Diets and Sampling

Prior to diet formulation, amino acid compositions of SM were analysed using an automated amino acid analyser (JLC-

Table 1. **Chemical and amino acid composition of SM made of BT and WL heads and soybean meal (air dry matter basis)**

Components	Black tiger*	White leg*	Soybean meal[1]
		g/kg	
Crude protein	523.0	543.6	450.0
Crude fiber	107.6	84.6	53.0
Ether extract	63.7	97.4	1.9
Ash	203.7	157.7	64.0
Chitin	141.4	106.9	—
ME, kcal/kg	1230[1]	1230[1]	2400
Amino acids (g/kg)			
Arginine	31.2	36.8	36.4
Lysine	29.0	34.5	32.9
Histidine	11.8	14.4	13.2
Phenylalanine	22.8	26.3	25.7
Methionine	9.5	9.6	6.8
Leucine	32.6	36.9	40.3
Isoleucine	20.5	22.6	22.0
Cysteine	5.3	5.7	7.8
Threonine	20.5	22.7	19.9
Valine	25.1	28.3	23.1
Alanine	34.5	36.9	22.1
Glycine	36.2	38.9	21.9
Proline	27.9	32.4	25.1
Glutamic acid	66.6	73.2	89.0
Serine	18.9	22.3	25.5
Aspartic acid	44.5	54.1	57.3
Tryptophan	5.8	6.9	6.8
Tyrosine	17.9	20.7	16.2
Total amino acid (g/kg)	460.6	523.2	492.0

[1] Standard Tables of Feed Composition in Japan (NARO, 2009).
* The data on proximate composition and chitin content were cited from Rahman and Koh (2014).

500V, JEOL Ltd. Japan) and HPLC (Table 1). Control, 5% BT, 10% BT, 15% BT, 5% WL, 10% WL and 15% WL diets were prepared: in the BT and WL diets, SM was added mainly in substitution of soybean meal. Metabolisable energy (ME) and crude protein (CP) of these diets were formulated at about 3,180 kcal/kg and about 235 g/kg, respectively (Table 2), and other nutrients to meet or slightly exceed the requirements of broilers defined by Japanese feeding standard for poultry (2011). A total of 42 male broiler chicks (8 days old, Ross 308) were divided into 7 dietary groups having similar body weight (BW). Each group was allocated to one of the above experimental diets. Diet and water were provided *ad libitum* during the experimental period (8 to 21 days old). Body weight and feed intake were recorded daily. Excreta were collected from 19 to 22 days of age and stored at −20℃ in a freezer until analysis. Nitrogen (N) in diets and excreta was measured using a CHNS/O analyser (PerkinElmer 2400 Series II), and chitin in excreta was analysed according to Ghanem *et al*. (2003) to estimate their retention and digestibility values, respectively.

Statistical Analysis

Statistical significances among the dietary treatment groups were determined with Tukey's multiple comparison tests at a significance level of 5% after one-way ANOVA. In addition, two-way ANOVA was performed by omitting the control group to test for main and interaction effects between BT and WL groups.

Results and Discussion

Amino acid analyses revealed that SM made of BT and WL heads had greater contents of methionine, threonine, glycine and valine, but smaller contents of cysteine and leucine comparing with the corresponding values for soybean meal (Table 1). Therefore, SM used in the present study is recognised to be suitable to fulfill the amino acid requirement in growing broiler defined by Japanese feeding standard for poultry (2011).

In case of BT, final BW and body weight gain (BWG) in control and 5% groups were similar to those in broiler performance objectives (Aviagen, 2007), but these values were decreased dose-responsively with increasing level of SM ($P<0.05$) (Table 3). Feed conversion ratio (FCR) was deteriorated with increasing level of SM. Nitrogen retention decreased significantly in 15% group ($P<0.05$). This may

Table 2. **Ingredients and chemical composition of the experimental diets (g/kg)**

Ingredients	Control	BT groups			WL groups		
		5%	10%	15%	5%	10%	15%
Commercial diet[1]	550	550	550	550	550	550	550
Soybean meal	184	128	72	17	126	68	10
Corn	239	233	228	221	236	232	229
Shrimp meal	None	50	100	150	50	100	150
Corn oil	11	23	34	46	22	34	45
Premix[2]	16	16	16	16	16	16	16
Calculated amino acid composition (g/kg)							
Methionine+Cystine	9.2	9.1	9.0	8.9	9.1	9.0	8.9
Lysine	12.4	12.1	11.6	11.3	12.3	12.1	11.9
Arginine	13.5	13.1	12.6	12.1	13.3	13.0	12.7
Isoleucine	8.5	8.3	8.1	7.9	8.4	8.2	8.1
Threonine	8.3	8.2	8.1	8.0	8.3	8.3	8.2
Valine	9.8	9.8	9.7	9.6	9.9	9.9	10.0
Tryptophan	2.5	2.4	2.3	2.2	2.5	2.4	2.4
Analyses							
Crude protein (g/kg)	236	235	235	234	235	235	234
Crude fibre (g/kg)	3.2	3.6	3.9	4.3	3.4	3.6	3.9
Ash (g/kg)	50	56	63	70	54	58	63
Chitin (g/kg)	—	7	15	22	6	11	17
ME (kcal/kg)[3]	3180	3179	3178	3179	3179	3180	3179

[1] Supplied from Nippon Formula Feed Mfg. Kanagawa, Japan (Broiler starter diet: CP≥23.5%, ME≥3050 kcal/kg).
[2] Vitamin mineral mixtures (Velu *et al*., 1971).
[3] Calculated value.

be explained by the fact that chitin a non-digestible amino polysaccharide physically blocks the access of digestive enzymes to lipids and proteins, thus affecting the utilisation of these nutrients (Karasov, 1990). Consequently, the maximal inclusion level of SM made of BT heads may be 5%. Similar trend was found in WL groups: decreased final BW and BWG were observed, but this decreasing trend was milder than that in BT groups and significant decrease was found only in 15% group. FCR and N retention were similar to the corresponding values in BT groups. Therefore, the maximal inclusion level of SM made of WL heads seems to be not more than 10%. The difference in maximal inclusion level of SM between BT and WL may be reasonable, because data in our *in vitro* study (Rahman and Koh, 2014), namely Table 1, showed that WL was poor in ash, crude fibre and chitin and rich in CP, comparing with BT. As shown above, birds given BT diets showed inferior growth performance to those given WL. It is noteworthy that SM made of large BT was used in the present study. The values may probably be improved if SM made of small BT was employed instead of large BT, because of better nutritional values in SM made of small BT (Rahman and Koh, 2014).

There are some reports concerning maximal inclusion level of SM in chicken diets, and most of them found that the level ranged from 4% to 15% (Islam *et al*., 1994; Fanimo *et al*., 1996; Gernat, 2001; Khempaka *et al*., 2006a; Khempaka *et al*., 2011). Interestingly, Rosenfeld *et al*. (1997) showed that as high as 32% of SM could be included, but this looks to be an unusual case. In this connection, the maximal inclusion levels suggested in the present study was within the above range, but relatively poor values.

Chitin digestibility decreased with increasing level of chitin in diets, which is agreed with the previous studies (Famino *et al*., 1996; Oduguwa *et al*., 1998; Khempaka *et al*., 2006b). Chitin digestibility was greater overall in WL (25.1%–30.1%) than BT (19.3%–27.8%). Moreover, chitin digestibility was significantly affected by level of chitin in diets and by species (Table 3). This may be premised that the chitin content was lower and absorption rate was higher in WL than that in BT. In addition, the difference in the physical structure can be clue, because SM of WL is softer than that of BT.

From the viewpoint of practical use of SM, some treatments, such as chemical, enzymatic and physical treatments, may be needed to increase the safety margin of SM as a protein source in chicken diets. So far, limited numbers of studies have been conducted to improve the nutritional value of SM, for instance, Oduguwa *et al*. (1998) showed that crude ash in SM decreased with HCl treatment and Fox *et al*. (1994) showed that crude ash and chitin in SM decreased with formic acid treatment, suggesting that these chemical treatments may be effective to improve the nutritional values in SM. However, these reports were conducted for development of rats and shrimp diets.

In conclusion, the results obtained here confirmed that SM made of WL heads was more nutritious protein source in broiler diets than that of BT heads, and suggested that some treatment is needed to improve the nutritional quality to use

Table 3. **Growth performance, nitrogen retention and chitin digestibility of growing broilers given dietary SM made of heads of BT and WL shrimps**[1]

Treatments	Final BW, g	BWG, g/2 wks	Feed Intake, g/b/d	FCR, g of feed /g of BW	N retention, %	Chitin digestibility, %
Control	914±9[a]	731±12[a]	78±7.64	1.48±0.05[a]	67.3±0.4[a]	—
5% BT	910±5[a]	725±3[a]	76±7.37	1.47±0.02[a]	68.8±0.1[b]	27.8±0.6[a]
10% BT	868±11[b]	685±11[b]	75±7.05	1.53±0.06[a]	66.8±0.3[a]	25.8±0.4[b]
15% BT	772±3[c]	587±5[c]	74±7.10	1.77±0.04[bc]	63.4±0.3[c]	19.3±0.4[c]
5% WL	913±6[a]	728±4[a]	78±8.32	1.50±0.02[a]	68.9±0.2[b]	30.1±0.5[d]
10% WL	883±3[ab]	701±3[ab]	78±7.93	1.54±0.01[a]	67.2±0.1[a]	28.0±0.4[a]
15% WL	816±6[d]	630±4[d]	80±8.67	1.78±0.03[c]	64.9±0.4[d]	25.1±0.4[b]
			P-value			
Contrasts						
Species	0.0029	0.0025	NS[2]	NS	0.0015	0.0018
Treatment	<0.0001	<0.0001	NS	<0.0001	<0.0001	<0.0001
Species vs. treatment	0.0137	0.0159	NS	NS	0.0059	NS

[1] Values for each parameter represent mean±SE values with 6 observations. [2] Non significant ($P>0.05$)
[a–d] Means in a column with different superscripts are significantly different ($P<0.05$).

SM as a practical ingredient, because the inclusion level was as low as 10% even in SM made of WL.

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