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Replacement of soybean meal protein in fish meal diet in organic marine shrimp feed

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Abstract

Organic shrimp is the main export product of the National Organic Agriculture Development Plan in Thailand. However, organic shrimp farming is limited by high price of the organic feeds which in turn limits the total protein level and protein sources. To solve this problem and to develop a management system for organic marine shrimp feed for black tiger prawn (*Penaeus monodon*), a trial was conducted to replace the current of 25% fermented soybean meal protein with 100% of fish meal diet. After rearing shrimp in a cage for 30 days with the different test diets, the final growth, ADG and survival rates were compared. In addition, evaluation of fish meal replacement using soybean meal as protein source was conducted in the laboratory scale for 30 days to compare growth, survival rate, digestibility and percentage of protein in shrimp muscle. The results show there were no significant differences of shrimp ADG growth performance and survival rate among the test diets in cage culture experiment. The laboratory experiment confirmed that 25% fermented soybean replacement was equally effective to 100% fish meal diets for shrimp growth and performance, although the survival rate is lower. No significant differences in shrimp digestibility were measured between the soybean meal replacement and fish meal diets. However the protein in shrimp muscle which received fish meal diet was higher than soybean meal replacement diet. These results demonstrate that soybean meal of at least 25% can be replaced by fish meal protein source in practical organic shrimp feed without compromising production and economic performance of

black tiger shrimp. The governmental sector should increase research to improve the use of organic feeds using alternative plants as combination protein sources for replacement fish meal in diet at difference levels. This will be lead to reduce cost of production and increase sustainable agriculture activity in Thailand.

Keywords: Organic marine shrimp feed; *Penaeus monodo*; soybean meal; fish meal; fermented soybean curt

Introduction

Shrimp feed is one of the most important factors to be considered to reduce shrimp production costs, as well as increase profitability to producers. The use of feeds with low levels of fish meal but high levels of less expensive sources from high quality plant protein is a possible method for achieve profitability. In general, current commercial shrimp feed formulations commonly represent the primary and most expensive protein ingredient and include 25 % to 50 % fish meal (Dersjant-Li, 2002; Tacon and Barg,1998;Gonzales-Rodriguez and Abdo de la Parra, 2004). Among plant protein sources, soybean meal give the most effective results in the replacement of fish meal in aquatic animal feeds due to its worldwide availability in lower price. More over, soybean meal can give a balanced amino acid profile and more consistent composition (Akiyama, 1988; Hardy, 1999; Tacon, 2000; Samocha et al., 2004). However, soybeans can contain many anti-nutrients which cause low digestibility in animals (Rackis, 1974). Therefore fermented soybeans are preferable as a replacement to fish meal. The results of using fermented soybean meal as protein source of formulated diet for young swine gave excellent average daily growth rates (Kiers et al., 2003). Fermented soybean meal also gave good results when used in a chicken formulate diet (Feng et al., 2002). For a fish diet, the replacement of fermented soybean meal to fish meal has been shown to be positive in term of growth performance (Ingh et al., 1991; Hsu, 2005; Kiers, et al., 2003; Mile and Chapman, 2006; Pham et al., 2007; Shimeno et al., 1993; Wu, et al., 2003). However there is no research of this field in shrimp production.

Organic shrimp feed is an important factor driving the organic aquaculture development. One of the organic aquaculture's standard limits the proportion of using fish meal. It suggests that the use of vegetable ingredients in fish feed, should be typically at the 30 % level to shows the sustainable level of fish meal ingredient which taken from the sea (FAO, 2002; FAO, 1997). Other factors influencing the use of vegetable ingredients include the reduction of environmental contaminants such as PCBs and dioxins found in fish oil (Bridson, 2008; Lem, 2004). The aim of this study was to test the efficiency of soybean meal replacement to fish meal diet in formulated marine shrimp feed on digestibility, percent of protein in shrimp muscle, growth and survival rate of shrimp in laboratory scale and cage culture in the earth ponds.

Materials and Methods

Shrimp source

Black tiger shrimp, BT, (*Penaeus monodon*) average body weight 10 g. were obtained from organic shrimp farm system (Sureerath Farm, Chantaburi) and acclimatized in the experimental condition for two days before commencing the test.

Organic shrimp feeds

Two formulations of organic marine shrimp diets containing 25 % of total protein were produced by Thai Union Feed Meal Co. Ltd., Thailand using AOAC (1990) method. Hundred percent of fish meal protein was formulated for the control diet. The control feed contain 100 % of fish meal protein (200 MH 06/50) while the test diet was replaced by 25 % soybean meal protein to fish meal protein (200 MH 08/50).

Laboratory experiment

The black tiger shrimp samples (average 10 g. of body weight) were transferred to the laboratory at Chulalongkorn University, Department of Sciences. Fifty shrimp samples were stocked in each 200 L dark color tank fill with 30 ppt. sea water. Air pumps were set for each tank to maintain sufficient dissolved oxygen. Water qualities were daily checked twice a day. Shrimp were fed at 3 % of body weight with each diet twice a day at 9 am and 5 pm. Two hours after feeding excess feeds and shrimp feces were collected and dried in 60 °C incubator for 90 min. then kept for analysis. About 20 % of water were changed every day after collecting the wasted samples of the evening meal.

Body weight of 20 shrimp samples from each tank were measured every two weeks. After the shrimp received the diets for 30 days, total weight, specific growth rate, survival rate, and feed conversion ration were analyzed using T-test and Duncan's New Multiple Range test (P=0.05).

Cage culture design experiment

Five hundred of BT were stocked and reared for four weeks in each cage (5×5 m.×1.8 m. dept) which were set in 20-25 ppt. salinity of the earth pond in Sureerath shrimp farm, Chantabury. A paddle wheel was set to supply sufficient dissolved oxygen (DO). Water qualities include pH, DO, alkalinity and N-NH3 were checked twice a day using the method of Boyd (1987). The daily feeding rate of each diet is 3-5 % of shrimp body weight and distributed 4 times per day. Each treatment was conducted three times (replicates). Fifty shrimp samples were random sampled from each cage and their body weight measured every two weeks. After rearing for four weeks average daily growth, survival rate and feed conversion ration were recorded. Comparison of the diets efficiency were analyzed using Duncan's New Multiple Range test (P= 0.05).

Results and Discussion

The results of the nutrient analysis of the fish meal and soybean meal is presented in Table 1 and shows similar nutritional component qualities needed for shrimp production (Fox et al., 2006). Consequently, the feed formulas of three difference diets used for laboratory comparisons showed the same nutritional quality (Table 2). Comparison of shrimp digestibility test there was noshowed difference between the control and the soybean replacement diet (Fig. 1), however there was a significant difference in the digestibility between the fermented soybean meal replacement diets. These observations confirm the results of Hsu (2005) who used fry stage Cobia (*Racycentron canadum*) fed with fish meal protein, soybean meal replacement protein and fermented soybean meal replacement protein. He found that Cobia fed fry with fermented soybean replacement diet had slower growth than fish fed with meal and soybean meal. This result was not from differences in the nutritional values in diets, but was due to digestibility of the fish samples. These results from the laboratory test show that the highest average specific growth, percentage weight and length gain, feed efficiency ratio and survival rate of the shrimp fed was from the 25 % soybean meal replacement diet (Table 4). However, average total weight, feed efficiency and survival rate of shrimp fed 100% fish meal diet and 25% fermented soybean meal replacement had similar results. Similar feeding

experiments comparing fish meal, soybean meal and fermented soybean meal diets to tilapia fry showed slower growth in fish fed with soybean meal and fermented soybean meal, while the food conversion ratio, protein efficiency ratio were not significantly different between the control and test feeds (Wu et al., 2003). Wu et al., (2003) concluded that these results may be due to the palatability of the fish diet, where soybean meal and fermented soybean meal have no taste and was more attractive to the fish. Further work should be conducted to research this issue.

The results from cage culture experiment is presented in Table 3, which shows there were no significance differences on average daily growth, percentage weight gain of the black tiger shrimp between control (100 % fish meal protein) and 25% fermented soybean meal replacement protein diets after 30 days treatment. There was also no significant difference in survival rate and food conversion rate.

The results of both the laboratory and cage culture experiments showed that the 25% soybean meal or fermented soybean meal can be used for replacement to fish meal protein in black tiger shrimp without any reduction in growth performance or survival rates. However to stimulate shrimp feeding behavior, a suitable feed attractant should be considered to enhance the feeding rate and digestibility.

Table 1: Nutritional quality analysis of raw materials used as feed ingredients in the test diets.

%	Fish meal	Soy bean(Sy)	Fermented Soy bean (FSy)
Crude protein	65.51	47.39	50.25
Fat	10.2	1.87	-.
Fiber	3.27	9.45	3.27
Moisture	7.58	8.0	7.94
Ash	13.07	8.52	-

Table 2: **Nutritional quality of organic feed formulas used in the laboratory test.**

	Feed formulas		
%	(Control) fish meal 100%	25% Sy supplement	25% FSy supplement
Crude protein	23.86±0.43	29.33± 0.55	22.87± 0.28
Moisture	11.11	9.28	11.9
Ash	7.81±0.14	9.83± 0.28	7.32±0.53
Fat	7.63	6.29	5.23
Fiber	1.06	1.01	0.82

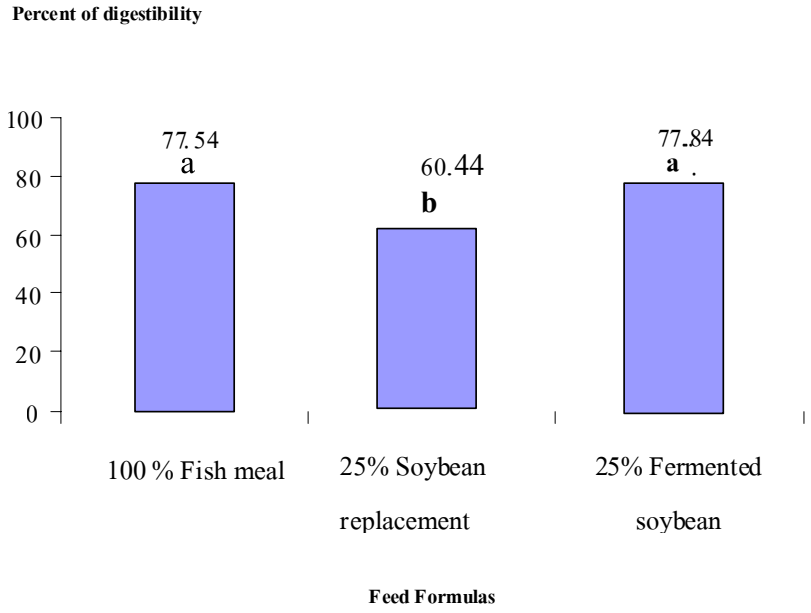

Figure 1: Comparison of shrimp digestibility after received three difference feed formulas (100% fish meal protein, replacement 25% soybean protein, and replacement 25% fermented soybean protein) after 30 days treatment. The same letters on % digestibility mean no significance different (P=0.05)

Table 3: Shows weight gain, average daily growth and survival rate of shrimp groups after received the control (C) and test feeds for 30 days

Feeding duration(day)	Control group (200 MH06/50)			Test group (200MH08/50)		
	C1	C.2	C.3	Test 1	Test 2	Test 3
	W (g)	W (g)	W(g)	W (g)	W (g)	W (g)
0	12.05	12.05	12.05	12.23	12.23	12.23
15	16.91	16.40	17.36	17.40	17.78	17.57
30	22.90	20.38	19.62	23.54	20.22	20.76
% weight gain(g)	10.85	8.33	7.57	11.31	7.99	8.53
Ave. % wt. gain (g)		8.92 ^{A}			9.28 ^{A}	
ADG	0.362	0.278	0.362	0.278	0.362	0.278
Average ADG (g)		0.297 ^{B}			0.309 ^{B}	
Survival rate %	92	84	87	89	80	95
Average %		87.66 ^{c}			88.00 ^{c}	

Same capital letter in the same row mean non significant difference in statistic values (P=0.05).

Table 4: Specific average growth ratio, food efficiency ratio, percentage weight and length gains and survival rate of BT after received three different feed formulas after 30 days treatment.

	Feed formula		
	Fish meal 100%	25% Sy	25% FSy
Average initial W. (g)	3.51 ±0.06	3.85±0.14	4.34 ±0.19
Average total W (g)	4.39 ± 0.07b	5.57±0.17a	4.80 ±0.18b
SGR	0.75 ± 0.05b	1.23± 0.02 a	0.34± 0.04c
Weight gain (%)	25.12 ±1.88b	44.62 ±0.80a	10.65± 1.37c
Length gain (%)	3.55 ± 0.13b	5.46 ±0.40a	1.05 ±0.39c
FCE	1.08±0.04	1.38±0.11	1.21±0.13
Survival rate (%)	92.22± 1.92	93.33 ±3.33	91.11± 3.85

Same letter above the values mean non significant difference (P = 0.05). Specific growth rate (SGR) = (l n final weight – l n initial weight0 x 30 / days. Percentage weight gain = 100*[(final wt - initial wt)]/initial wt. Percentage length gain (%PLG = length gain/initial length). Feed efficiency ratio (FCE) = (Shrimp weight / feed intake).

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