

Substitution of Golden Apple Snail Meal for Fishmeal in Giant Freshwater Prawn, *Macrobrachium rosenbergii* (de Man) Diets

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ABSTRACT

Substitution of golden apple snail meal for fishmeal in giant freshwater prawn, *Macrobrachium rosenbergii* (de Man) diets was conducted by CRD with 5 treatments and 3 replications. The study was divided into two trials. Firstly, the pepsin digestibility of raw material and snail meal substitution for fish meal diets was investigated. The results indicated that the protein digestibility of diets containing snail meal were decreased ($p < 0.05$) by increasing percentage of snail meal (from 0 to 100%). The percentages of digestibility were 82.86 and 74.80% for 0 and 100% substitution, respectively. Secondly, the growth performance and feed efficiency were conducted on giant freshwater prawn fed with isonitrogenous ($34 \pm 1\%$ CP) and isocalorics ($3,100 \pm 100$ DE kcal/kg) diets containing 0, 25, 50, 75 and 100% golden apple snail meal substitution for fish meal. The results indicated that there were no significant difference ($p > 0.05$) on growth performances and feed efficiency during the first two month while these values were significantly different ($p < 0.05$) in the third month. Therefore, snail meal can totally substitute for fishmeal in a short period not longer than two months. For practical diet, snail meal can substitute for 25% of protein in fishmeal or 8.75 % of snail meal by weight. Moreover, the maximum level of snail meal substitution for fishmeal in giant freshwater prawn diet should not exceed 50% of protein in fish meal or 17.5 % of snail meal by weight.

Key words: freshwater prawn diet, snail meal, growth performance, feed efficiency, *Macrobrachium rosenbergii*

INTRODUCTION

Giant freshwater prawn, *Macrobrachium rosenbergii* (de Man) has been regarded as prime aquaculture prospect in many countries. It is the largest of the freshwater prawn and has been classified as a omnivore based on analyses of foregut content (Weidenbach, 1982). In a successful prawn culture, consideration is generally given to the dietary protein component. The retention of dietary protein for growth is the goal of nutritionists for the development of cost effective diets. Maximum utilization of dietary protein for growth

is related to both the dietary inclusion level of protein and the quality of raw material. For producing low cost effective diets, high protein feedstuffs for fishmeal substitution was investigated.

The golden apple snail meal (*Pomacea caniculata*) is one of the feedstuffs that could be used as protein source from animal product. It has similar proximate composition as fish meal with about 54% crude protein (CP). The golden apple snail grows and reproduces very rapidly. The price of golden snail meal is relatively cheap compared with fishmeal (Hertrampf and Piedad-Pascual,

2000). So, the golden apple snail meal may be the most promising protein source for partial or total replacement of fish meal in fish diets. However, very little is known about the feasibility of using golden snail meal as a source of dietary protein in feed formulations for giant freshwater prawn. The objectives of this study were to investigate the digestibility of raw materials and to formulate feeds using golden apple snail meal substitution for fish meal and to evaluate the growth performance and feed efficiency in giant freshwater prawn after feed diets containing golden apple snail meal as substitution for fish meal.

MATERIAL AND METHOD

Five experimental diets were formulated from ingredients with 0, 25, 50, 75 and 100% of snail meal substitution for fish meal. The proximate compositions of raw material such as moisture, protein, lipid, fiber, ash and NFE (nitrogen free extract) before diet preparation and the feed after processing were analyzed as described by AOAC (2000). The diets were isonitrogenous ($34 \pm 1\%$ CP) and isocalorics ($3,100 \pm 100$ DE kcal/kg). The feed formula was shown in Table 1.

The study was divided into two trials. Firstly, study on the digestibility of raw material and diets contained snail meal substitution for fish meal at the level of 0% and 100% were conducted by pepsin digestibility method (AOAC, 2000). Secondly, study on growth performance and feed efficiency of giant freshwater prawn fed with 0, 25, 50, 75 and 100% of golden apple snail meal substitution for fish meal diets. Ten female giant freshwater prawn of individually 21.22-21.69 g body weight were stocked in one ton tank as one replicate. Prawns were fed with test diets twice a day on 07.00-08.00 am, and 16.00-17.00 pm. Two hours after feeding, the uneaten feed was collected and dried then weighed to determine total feed consumption.

All prawns in the tank were weighed biweekly for adjust feed allowance. All tanks were

located indoor and the water was changed every day. Growth performance including weight gain, percentage of weight gain, average daily gain, specific growth rate and survival rate were studied. The study on feed efficiency including feed consumption, food conversion ratio (FCR), protein efficiency ratio (PER) and net protein utilization (NPU) or appearance net protein retention (ANPR) were determined.

This study was conducted in completely randomized design (CRD) with five treatments and three replicates. All data were analyzed by one-way ANOVA (analysis of variance). The Duncan's Multiple Range Test was used to determine the differences between the treatment means. The alphabetical notation was used to mark the differences at significant level of an alpha 0.05 (Gomez and Gomez, 1984). All research was conducted at the Laboratory of Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand.

RESULTS

Digestibility

The nutrient digestibility of raw material and test diets by pepsin digestibility were presented in Table 2. The results showed that protein digestibility of raw material were ranged from 80.12 to 88.69 % which were in the acceptable range for fish and prawn feed. The protein digestibility (pepsin digestibility) of freshwater prawn diets containing snail meal substitution for fish meal were significantly lower ($P < 0.05$) than the diet without snail meal (0% of substitution).

Growth performance

The growth performance of female freshwater prawn conducted for 3 month was investigated. The result was shown in Table 3. During the first two month, growth performance of freshwater prawn fed the diets containing different levels of snail meal substitution for fish meal were in the same range ($P > 0.05$). On the third

Table 1 Composition of experimental diets containing different snail meal levels substitution for fish meal.

Material (%)	Percentage of snail meal substitution for fish meal in giant freshwater prawn diets				
	0%	25%	50%	75%	100%
Fish meal	30.2	22.65	15.1	7.55	0
Snail meal	0	8.75	17.5	26.25	36
Soy bean meal	35	35	35	35	35
Shrimp meal	5	5	5	5	5
Tapioca flour	20.225	19.025	12.825	10.025	4.425
Tuna oil	3	3	4	5	6
Soy bean oil	4	4	5	5	6
Cholesterol+ Lechitin	1	1	1	1	1
Binder+ Premix ¹	1.5	1.5	1.5	1.5	1.5
Dicalcium-phosphate	0	1.125	3	2	3
Sod.Phosphate (25%)	0	0	0	1.6	2
Vitamin C+E	0.075	0.075	0.075	0.075	0.075
Total	100	100	100	100	100
Chemical composition by proximate analysis (as fed)					
Moist (%)	4.80	5.31	5.77	5.94	6.25
Protein (%)	34.54	34.44	33.25	33.34	33.65
Fat (%)	11.26	10.64	11.61	12.25	13.75
Fiber (%)	4.93	4.660	4.47	4.94	4.47
Ash (%)	13.94	14.59	14.53	14.63	14.94
Digestible energy (Kcal/kg)	3176.91	3131.19	3173.91	3196.85	3189.5
Gross energy (Kcal/kg)	4619.49	4597.12	4608.16	4587.68	4631.58

Note: 1 Vitamin mix (g/kg premix): vit.A 3,500,000 IU; vit D 800,000 IU; vit E 40; vit K₃15; vit B₁ 20; vit B₂ 15; vit B₆ 20; vit B₁₂ 0.01; niacin 40; panthothenic acid 40; folic acid 4; biotin 0.4; inositol 150; vit C 35% 126.

Table 2 Digestibility (pepsin digestibility) of raw material and freshwater prawn diets containing different levels of snail meal substitution for fish meal.

Items	Types of raw material			Percentage of snail meal substitution for fish meal in freshwater prawn diets			
	Fish meal	Snail meal	Shrimp meal	0%	100%	P-value	Pool SE
Protein digestibility (pepsin) (%)	88.69	86.36	80.12	82.86 ^a	74.80 ^b	0.004	1.59

Note: values in the same row followed by different letters (a, b superscript) were significantly different ($P < 0.05$)

Table 3 Growth performance of freshwater prawn fed diets containing different levels of snail meal substitution for fishmeal during 3 months.

Items	Percentage of snail meal substitution for fish meal in freshwater prawn diets					P-value	Pool SE
	0%	25%	50%	75%	100%		
0-1 month							
Initial weight (g/ind.)	21.25	21.30	21.65	21.69	21.22	0.999	2.97
Final weight (g/ind.)	25.03	24.42	25.42	24.52	24.30	0.991	3.26
Weight gain (g/ind.)	3.77	3.12	3.77	2.83	3.07	0.658	0.947
Percent. weight gain (%)	18.47	14.96	17.33	13.05	14.32	0.674	4.98
Average daily gain (g/ind./d.)	0.14	0.11	0.13	0.10	0.11	0.61	0.034
Specific growth rate (%/day)	2.09	1.73	1.99	1.53	1.67	0.678	0.526
Survival rate (%)	100	100	100	100	100	<u>1</u>	<u>1</u>
0-2 months							
Final weight (g/ind.)	29.94	30.30	29.62	29.26	26.90	0.916	4.88
Weight gain (g/ind.)	8.68	8.99	7.97	7.57	5.67	0.496	2.37
Percent. weight gain (%)	40.95	41.67	35.90	34.99	26.83	0.274	8.41
Average daily gain (g/ind./d.)	0.16	0.16	0.14	0.13	0.10	0.509	0.042
Specific growth rate (%/day)	4.26	4.34	3.81	3.74	2.96	0.269	0.77
Survival rate (%)	100	100	100	100	100	<u>1</u>	<u>1</u>
0-3 months							
Final weight (g/ind.)	35.29	34.44	35.08	32.47	29.72	0.586	4.712
Weight gain (g/ind.)	14.03	13.14	13.42	10.78	8.49	0.096	2.44
Percent. weight gain (%)	66.49 ^a	61.27 ^a	62.24 ^a	50.07 ^{a b}	40.31 ^b	0.042	9.62
Average daily gain (g/ind./d.)	0.17	0.16	0.16	0.13	0.10	0.105	0.029
Specific growth rate (%/day)	6.33 ^a	5.96 ^a	6.04 ^a	5.06 ^{a b}	4.21 ^b	0.039	0.77
Survival rate (%)	100	100	100	100	100	<u>1</u>	<u>1</u>

Note: values in the same row followed by different letters (a,b,c superscript) were significantly different ($P < 0.05$)

^{1/} Statistical analysis can not show the different because of data were not difference

month, growth performance of freshwater prawn fed the diets containing 100% snail meal substitution for fish meal was significantly decreased ($P < 0.05$). Freshwater prawn fed diets containing 0, 25 and 50% of snail meal substitution for fish meal showed highest specific growth rate (5.96-6.33 %/day). The lowest growth rate was found in group of snail meal substitution for total fishmeal diet (4.21%/day). Freshwater prawn growth performance was decreased by increasing percentage of snail meal substitution for fishmeal in the diets.

Feed efficiency

The feed efficiency of snail meal substitution for fishmeal diets were evaluated and presented in Table 4. During the study period, feed intake of freshwater prawn fed diets of 25-100% snail meal substitution for fishmeal were increased by increasing percentage of snail meal in the diets. On the first two months, feed efficiency, feed conversion ratio and protein efficiency ratio were not significantly different ($P > 0.05$). The effect of substitution fishmeal by snail meal was noticed on the third month. The results showed that feed

Table 4 Feed efficiency of freshwater prawn fed diets containing different levels of snail meal substitution for fish meal during 3 months.

Parameter	Percentage of snail meal substitution for fish meal in freshwater prawn diets					P-value	Pool SE
	0%	25%	50%	75%	100%		
0-1 month							
Feed Intake (g/ind./day)	0.23 ^c	0.24 ^{bc}	0.34 ^a	0.27 ^{bc}	0.29 ^{ab}	0.005	0.03
Feed Efficiency (%)	58.36	46.46	39.10	37.59	36.95	0.256	12.50
Food conversion Ratio	1.89	2.22	2.58	2.86	2.74	0.291	0.58
Protein Efficiency Ratio	1.62	1.29	1.08	1.04	1.02	0.252	0.34
0-2 months							
Feed Intake (g/ind./day)	0.22 ^c	0.25 ^{abc}	0.29 ^a	0.25 ^{bc}	0.28 ^{ab}	0.013	0.02
Feed Efficiency (%)	69.50	62.28	47.93	53.70	35.86	0.153	15.45
Food conversion Ratio	1.53	1.69	2.33	1.89	2.82	0.119	0.58
Protein Efficiency Ratio	1.93	1.73	1.33	1.49	0.99	0.152	0.42
0-3 months							
Feed Intake (g/ind./day)	0.24 ^c	0.25 ^{bc}	0.28 ^a	0.25 ^{bc}	0.28 ^{ab}	0.023	0.02
Feed Efficiency (%)	70.60 ^a	61.63 ^a	56.33 ^{ab}	50.69 ^{ab}	36.41 ^b	0.030	10.83
Food conversion Ratio	1.47 ^b	1.67 ^b	1.79 ^b	1.99 ^b	2.80 ^a	0.006	0.33
Protein Efficiency Ratio	1.96 ^a	1.71 ^a	1.56 ^{ab}	1.41 ^{ab}	1.01 ^b	0.029	0.30
Net Protein Utilization	0.51 ^a	0.59 ^a	0.41 ^{ab}	0.39 ^{ab}	0.21 ^b	0.014	0.11

Note: values in the same row followed by different letters (a,b,c superscript) were significantly different ($P < 0.05$)

efficiency, feed conversion ratio, protein efficiency ratio and net protein utilization (appearance net protein retention) of the diets containing 25%, 50% and 75% snail meal substituted for fishmeal were not significantly different ($p > 0.05$) when comparing to the diet containing 0% snail meal and also feed efficiency, protein efficiency ratio and net protein utilization of prawn fed with diets containing 50 and 75 % snail meal were not significantly different ($p > 0.05$) when comparing to the diet containing 100% snail meal. Feed conversion ratio of prawn fed with diets containing 50 and 75 % snail meal were lower than ($p < 0.05$) the group of prawn fed diet containing 100% snail meal. Feed efficiency, feed conversion ratio, protein efficiency ratio and net protein utilization of 0% and 25% snail meal diets were significantly better than diet containing 100% snail meal. ($p < 0.05$)

DISCUSSION

Protein digestibility of diet containing 100% snail meal substituted for fishmeal was lower than fishmeal diet (74.80% and 82.86%, respectively) and protein digestibility of snail meal (86.36%) trended to be slightly lower than fishmeal (88.69%). Generally, the digestion coefficient of protein-rich feedstuff is in the range of 75-95 % (National Research Council, 1993). The decrease of protein digestibility was probably caused by the structure of protein in snail, mainly fibrous protein, and the high percentage of ash (18.33%) (Hertrampf and Piedad-Pascual, 2000). This could cause low digestibility and high feed consumption resulted on poor growth performance and feed efficiency. The effect of snail meal substitution for fishmeal on growth performance and feed efficiency in this

study did not agree with the study on tiger shrimp, *Penaeus monodon*, reported by Bombeo-Tuburan *et al.* (1995) that shown the higher shrimp production was attained from mixed feed of snail with either maize or cassava compared with maize and golden snail alone. In additional, the study of Cagauan and Doria (1989) cited by Cagauan and Joshi (2002) on freshwater prawn (*Macrobrachium rosenbergii*) larvae showed that larvae fed with 60% golden apple snail meat meal in dried form mixed with rice bran, shrimp meal and fish meal showed good growth. The optimum level of snail meal in freshwater prawn diet obtained from this research was 25-50% of snail meal substitution for protein in fishmeal or 8.75-17.5% of snail meal by weight. This level was lower than finding reported by Cagauan and Doria (1989) but in the same range as the suggestion of AQUACOP(1976) that reported freshwater prawn feed contained snail meal 15% by weight showed the better growth and feed contained 5-10% boiled snail flesh by weight also showed good growth performance. The research of Bombeo-Tuburan *et al.* (1995) on freshwater prawn feed by using boiled snail flesh mixed with corn or tapioca indicated that prawn production was higher than fed with feed compose with snail and concentrate feed.

CONCLUSIONS

The study on substitution of 0, 25, 50, 75 and 100% golden apple snail meal for protein in fishmeal in giant freshwater prawn, *Macrobrachium rosenbergi* (de Man) diets indicated that for the period shorter than two months snail meal can totally substitute for fishmeal in giant freshwater prawn feed (0-100% substitution). For the practical the level of 25 % snail meal substituted for protein in fishmeal or 8.75 % of snail meal by weight, is the effective level. Moreover, the maximum level of snail meal replacement for fishmeal in giant freshwater prawn diet should not exceed 50% of protein in fish meal or 17.5 % of snail meal by weight when focusing

on the growth performance and feed efficiency.

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