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Waste Output and Loading in Prawn *(Macrobrachium rosenbergii* De Man) Culture at Different Sizes and Feeding Frequencies

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ABSTRACT

The waste from freshwater giant prawn cultured water were evaluated after feeding with diet of 7.09±0.04 % moisture, 32.60±0.14 % protein, and 4.80±0.13 % fat. The leaching from formulated feed at 0.5, 1, 2, and 3 hours showed soaking period affected on the nutrient leaching and feed stability ($p<0.05$). Leaching rates were highest in the 0.5 hour (20.97±0.06 g/100 g feed/h), but continued for 3 hours. The highest dry weight lost of 15.92±0.08 % was found at 3 hours. Protein was significant lower but fiber was significantly higher ($p<0.05$) in longer soaking period feed. The Digestibility and feces leaching of different size prawns (medium size, 100.97 g and large size, 146.56 g) at different feeding frequency (2 and 3 times/day) were also examined. The results showed that prawn sized and feeding frequency were not affected on the daily feed intake. However, the large size prawn had feeding digestibility of 90.61-93.33 % which were higher than medium size prawns (85.05-87.44 % feeding digestibility). The highest nitrogenous waste loaded were found in large size prawn fed 3 times/day.

Key words: *Macrobrachium rosenbergii* culture, nutrient leaching, waste loading

INTRODUCTION

Freshwater giant prawn (*Macrobrachium rosenbergii* De Man) is the largest freshwater prawn. It is an economically important indigenous species with high demand at both domestic and export markets. Freshwater prawn culture has expanded considerably in recent years, especially in Asian countries (New, 2005). In 1998, Thailand produced 7,800 tons of freshwater giant prawn by pond culturing. This was approximately 6% of global production, which was 129,533 tons valuing US$795.1 millions (FAO, 2000). The advantages of freshwater giant prawn culture are seed availability from captive brooders and unlimited culture areas. The prawn can be reared in totally freshwater hence not necessarily at coastal zone (New and Valenti, 2002). Freshwater giant prawn culture in Thailand is semi-intensive. Prawn seeds are densely stocked (10/m^2) in earthen ponds of 0.5-1.6 ha (New, 2000). At the culture period of 4-6 months, average production is 270 kg/rai (1 rai=1,600 m^2)(New, 1998). However, farmers are still unable to produce the popular size of 150-250 gm prawn, which are 4-6 times higher price than the smaller ones.

Prawn culture mostly gives good production in newly constructed ponds. The production is usually decreased after some consecutive crops as pond environment are

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deteriorated. Some farmers moved to new culture areas and created the same problem there. Culture of marine shrimp in inland areas is prohibited in Thailand. This leads to more freshwater giant prawn culture in the country. The prawn juveniles require 30-38% protein feed (D'Abramo and Sheen,1994). Decomposition of protein in metabolic process of aquatic fauna releases ammonia to surrounding media contributing to 80% of total released nitrogen (Millikin *et al*., 1980). In aquaculture, nitrogen added to the system increase toxic condition. Uneaten feed and excreta are the major sources of nitrogen in farmed ponds. Decomposition of organic substances by microbes resulted in deposition of free ammonia (NH_3-N) and nitrite compounds (NO_2-N), which are toxic to aquatic fauna at very low concentration, to the system (Anger, 1989). Draining of effluents from farm ponds cause pollution to the riparian waters and could cause epidemic (Boonyaratpalin, 1983). Control of nitrogenous compound deformation in ponds and control of feed utilization in aquaculture system are increasingly necessary. Study on waste loading of giant freshwater prawn culture pond in the different conditionsof feeding frequencies and prawn sizes will provide information to the development of sustainable giant freshwater prawn culture system.

MATERIALS AND METHODS

In order to determine the waste products from feeding, experiments were conducted to quantify waste output and loading in prawn culture : 1) in formulated feed and the rate at which nutrient is leached from the feed 2) in the feces of giant freshwater prawn and the rate at which waste is leached from excreta.

Nutrients leaching experiment

Experiment was conducted to determine the leach of nutrients from formulated feed. Initially, 50 gm prawn feed was put to 2 liters distill water for $^1/_2$, 1, 2 and 3 hrs. Remaining feed was separately removed at respective time, dried at 100°C, weighed and calculated for weight lost. The feed was further analyzed for protein, lipids, fiber and ash following AOAC (2000) to calculate quantity of dissolved nutrients and remaining nutrients.

Study on nutrients lost was conducted at 1/2, 1, 2 and 3 hrs after feeding. Prawn feed was tested for its stability following AOAC (2000) to observe percentage dry weight lost. Water samples were analyzed for total ammonia nitrogen (TAN) using the modified indophenol method, nitrite and nitrate using the cadmium reduction method, ortho-phosphate using the ascorbic acid method, biological oxygen demand (BOD) using the azide modification method, total Kjeldal nitrogen (TKN) using Nesslerization method, total dissolved solids (TDS) and total suspended solids (TSS) following APHA, AWWA and WPCF (1995) to observe nutrient leaching. Percentage dry weight lost and nutrient leaching at different intervals was calculated percentage nutrient waste.

Waste from excreta of freshwater giant prawn

Experiment was conducted to determine feed digestibility and the leach rates of feces. Medium and large size prawns (mean weight of 100.97±14.55 and 101.66±11.91 gm for medium size, 146.56±17.34 and 140.57±21.59 gm for large size, respectively) were acclimated in 45×60×18 cm aquaria for 5-7 days prior to experiments. During the experiments, the prawns were fed 35% protein feed *ad libitum* 2-3 times daily. Amounts of ingested feed were recorded. Water samples from experimental aquaria were analyzed for TAN, nitrite, nitrate, ortho-phosphate, BOD and TKN (APHA, AWWA and WPCF, 1995).

One hour after feeding, faeces were collected from the collectors every three hours and kept frozen. Each week, faeces were pooled, dried and weighed to calculate he quantity of solid excreta. The dried faeces were further analyzes for phosphorus and protein to assess quantity of nitrogenous compounds released to environment. Feed digestibility was calculated using the below formula:

$$\text{Nutrients digestibility (\%)} = \frac{\text{ingested nutrient} - \text{nutrient in faeces}}{\text{Ingested nutrient}} \times 100$$

All data were assessed by one-way analysis of variance (ANOVA), and the means were compared by the Duncan's multiple range tests at 95% confidence of interval ($p<0.05$). All statistical analyses were carried out using SPSS 11.0 software (SPSS, Chicago, IL, USA).

RESULTS AND DISCUSSION

Nutrient leaching

Nutrient leaching after soaking feed for 0.5, 1, 2, and 3 hrs was conducted. Proximate composition of feed was presented in Table 1. The results indicated that nutrient leaching to water was significantly correlated to soaking period ($p<0.05$). Mean leaching by weight lost was 10.48±0.03% in half an hour and increased to 15.92±0.08% after three hours. However, leaching rates were highest in half an hour (20.97±0.06 g/100 g feed/h), but continued for 3 h. Feed stability reduced significantly at longer soaking period ($p<0.05$), averaging 84.08±0.08 % after 3 hours.

Protein leached to water significantly according to increasing soaking period ($p<0.05$). Prawn feed soaked in water for 0, 1/2, 1, 2 and 3 hours had mean protein content of 32.60±0.14, 31.89±0.11, 31.41±0.15, 30.93±0.19 and 29.02±0.15%, respectively. The longer prawn feed soaked, the lower its protein content. The feed soaked for 3 hours had lowest remaining protein content ($p<0.05$). Mean protein lost were 0.70±0.09, 1.19±0.28, 1.67±0.25 and 3.58±0.29% and percentage protein lost were 2.16±0.28, 3.63±0.86, 5.13±0.75 and 10.98±0.84% for the soaking periods of 30 minutes, 1, 2 and 3 hours, respectively.

Fiber contents in soaked prawn feed were increased significantly according to soaking period ($p<0.05$). However, fat lost to water were only 1.25±0.04, 2.92±0.21, 4.50±1.16 and 5.97±5.44%

Table 1 Nutrient leaching (dry weight, Means±SD) from prawn diet at different soaking times.

Nutrients	Soaking time (hours)				
(g/100 g feed)	0	0.5	1	2	3
Weight lost	0.00 ± 0.00^{a}	10.48 ± 0.03^{b}	12.27 ± 0.24^{c}	14.95 ± 0.04^{d}	15.9 ± 0.08^{e}
Weight lost /h	0.00 ± 0.00^{a}	20.97 ± 0.06^{e}	12.27 ± 0.24^{d}	7.48 ± 0.02^{c}	5.31 ± 0.03^{b}
Feed stability	100.00 ± 0.00^{e}	89.52 ± 0.03^{d}	87.73 ± 0.24^{c}	85.05 ± 0.04^{b}	84.08 ± 0.08^{a}
Protein remaining	32.60 ± 0.14^{e}	31.89 ± 0.11^{d}	31.41 ± 0.15^{c}	30.93 ± 0.19^{b}	29.02 ± 0.15^{a}
Protein lost	0.00 ± 0.00^{a}	0.70 ± 0.09^{b}	1.19 ± 0.28^{c}	1.67 ± 0.25^{d}	3.58 ± 0.29^{e}
%Protein lost	0.00 ± 0.00^{a}	2.16 ± 0.28^{b}	3.63 ± 0.86^{c}	5.13 ± 0.75^{d}	10.98 ± 0.84^{e}
Fat remaining	4.80 ± 0.13^{ns}	4.74 ± 0.13^{ns}	4.66 ± 0.12^{ns}	4.58 ± 0.18^{ns}	4.51 ± 0.13^{ns}
Fat lost	0.00 ± 0.00^{ns}	0.06 ± 0.00^{ns}	0.14 ± 0.01^{ns}	0.22 ± 0.05^{ns}	0.29 ± 0.05^{ns}
%Fat lost	0.00 ± 0.00^{ns}	1.25 ± 0.04^{ns}	2.92 ± 0.21^{ns}	4.50 ± 1.16^{ns}	5.97 ± 5.44^{ns}
Fiber remaining	3.30 ± 0.51^{a}	3.66 ± 0.31^{ab}	4.03 ± 0.19^{abc}	4.35 ± 0.10^{bc}	4.45 ± 0.07^{c}
Fiber increasing	0.00 ± 0.00^{a}	0.36 ± 0.82^{ab}	0.72 ± 0.70^{abc}	1.05 ± 0.41^{bc}	1.15 ± 0.58^{c}
% Fiber increasing	0.00 ± 0.00^{a}	12.85 ±26.82^{ab}	14.89 ±14.17^{ab}	32.99 ±17.51^{b}	36.49 ±33.40^{b}

Means in the same column not sharing the common superscript letter are significantly different determined by Duncan's multiple range tests ($p<0.05$).

of total fat at 1/2, 1, 2 and 3 hours, respectively. Different soaking periods did not significantly affect fat content in feed ($p>0.05$).

Quantity of nutrient leaching from prawn feed to water at several of feed immersed periods is presented in Table 2. More nutrients in water were observed at longer soaking periods. TSS, BOD and TKN were significantly higher after soaking for 1/2, 1, 2 and 3 hours ($p<0.05$). In contrast, total ammonia, nitrite and phosphate leaching rate from feed to water reduced significantly at longer soaking periods ($p<0.05$).

If freshwater giant prawn ingests long soaked feed, it will get fewer nutrients (Burford and Williams, 2001), particularly protein, vitamins and mineral, which is necessary for its metabolism and growth. The prawn will also get more fiber from the long soaked feed, but fiber is less digestible and nutrient poor. Most of fiber, therefore, excretes out as faeces which are hard to digest. Protein and other nitrogenous compounds those leach to water, through decomposition process, are sources of hydrogen sulfide, ammonia and methane those are toxic to aquatic fauna (Islam *et al.*, 2004). It is, therefore, recommended that prawn should reach and ingest feed right after feeding and should finish all the given feed within $^1/_2$ hour. By this means, prawn will receive high quality nutrients from feed as formulated and nutrient lost to surrounding environment will be minimized. Excess feed in culture system will cause poor water quality and limit the growth of growing animals (Tanthunwesama and Pornprapa, 1995).

Waste from excreta of freshwater giant prawn

Medium and large size prawns fed two and three times/day had similar ingestion rate at 0.36±0.19, 0.40±0.23, 0.27±0.12 and 0.23±0.13 % of body weight, respectively (Figure 1a). However, significant differences in dry weight of feces and digestibility were found ($p<0.05$). the rate at which waste leached from feces of medium size prawns was significantly higher than of large size prawns ($p<0.05$). Feeding frequency had not significantly affected amount of medium size prawn feces ($p>0.05$), but large size prawns fed twice a day had significantly higher amount of feces ($p<0.05$). Furthermore, dry feed digestibility of large size prawn (90.61-97.33%) was higher than that of medium size prawns (85.05-87.44%) significantly ($p<0.05$) (Figure 1b).

Daily water analyses in experimental aquaria revealed that feeding frequency did not

Table 2 Effect of feed immersed periods on nutrient leaching / kg dry weight feed.

Nutrient leaching	Feed immersed periods (hours)			
	0.5	1	2	3
TDS (mg/l)	998.34 ± 2.87[a]	1177.22 ± 70.34[a]	1495.02 ± 4.31[b]	1824.25 ± 287.44[c]
TUR (NTU)	3482.60 ± 63.28[a]	3697.96 ± 64.42[b]	4274.22 ± 85.84[c]	4592.41 ± 141.24[d]
TSS (mg/l)	99.83 ± 0.29[a]	154.21 ± 7.94[b]	232.59 ± 29.09[c]	464.44 ± 30.82[d]
TAN (mg/l)	11.696 ± 0.652 [d]	4.273 ± 0.099[c]	3.580 ± 0.151[b]	2.679 ± 0.248[a]
Nitrite (mg/l)	3.003 ± 0.197[b]	1.077 ± 0.374[a]	1.187 ± 0.013[a]	1.231 ± 0.051[a]
Nitrate (mg/l)	0.00 ± 0.00 [ns]	0.00 ± 0.00[ns]	0.00 ± 0.00[ns]	0.00 ± 0.00[ns]
Ortho-phosphate (mg/l)	100.73 ± 7.37[c]	69.29 ± 3.25[b]	56.33 ± 0.98[a]	53.61 ± 4.79[a]
TP (mg/l)	110.40 ± 12.44[c]	74.39 ± 4.00[a]	76.17 ± 6.01[a]	94.67 ± 4.47[b]
BOD (mg/l)	1156.52 ± 60.87[a]	1855.75 ± 41.21[b]	4493.27 ± 66.88[c]	4638.47 ± 8.79[d]
TKN (mg/l)	1314.98 ± 109.05[a]	3231.06 ± 69.29[b]	4484.10 ± 150.98[c]	4774.58 ± 99.11[d]

Means in the same column not sharing the common superscript letter are significantly different determined by Duncan's multiple range tests ($p<0.05$).

affect water quality in medium size prawn experiment as total ammonia, nitrite, nitrate, orthophosphate, total phosphorus, BOD and TKN were comparable ($p>0.05$) but higher than initial value because of nutrients leaching and excreta accumulation.

Total ammonia of large size prawn, feeding three times/day treatment was significantly higher than that of feeding twice a day and also significantly higher than that of medium size prawn both feeding twice a day and three times/day ($p<0.05$). While other parameters were alike ($p>0.05$).

In addition, nitrite content in large prawn, feeding three times/day was significantly higher than that of feeding twice a day ($p<0.05$) but nitrate content were similar ($p>0.05$). In term of BOD, medium size prawn experiments released more BOD than large size prawn experiment significantly ($p<0.05$) (Table 3).

Feeding three times/day in large shrimp experiment created significantly higher TAN and TKN than feeding twice/day and both feeding twice and three times/day in medium size prawn experiment ($p<0.05$). Feeding three times/day in large shrimp experiment also created significantly

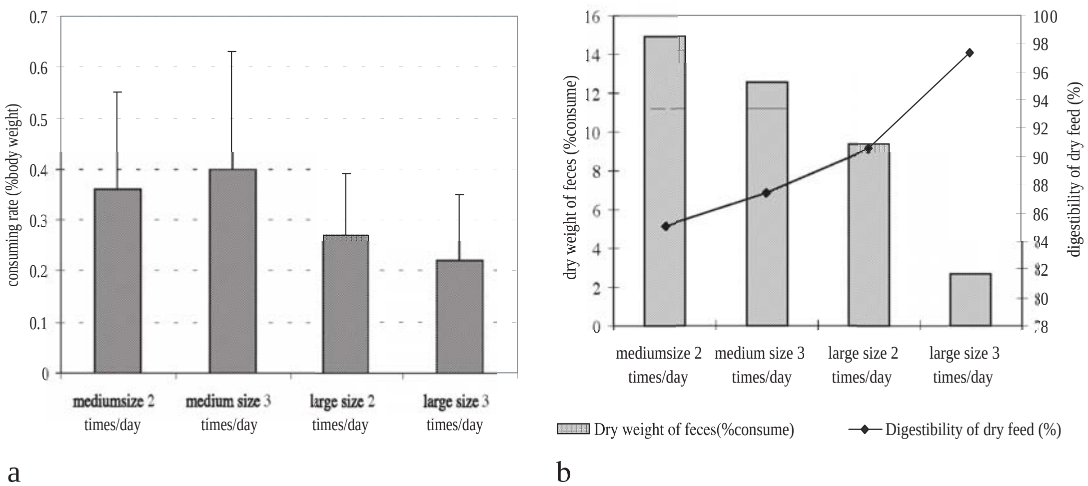

Figure 1 (a) Effect of prawn size and feeding frequency on consuming rate, (b) dry weight of faeces and digestibility of dry feed.

Table 3 Excretion and nutrient leaching from medium and large size prawn culture at 24 hour.

Nutrient leaching (mg/kg prawn)	Medium size		Large size	
	2 times/day	3 times/day	2 times/day	3 times/day
TAN	21.46 ± 4.61^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	391.72 ± 134.01^{b}
Nitrite	3.54 ± 2.34^{ab}	0.48 ± 0.44^{a}	9.48 ± 4.06^{ab}	13.31 ± 8.26^{b}
Nitrate	21.03 ± 20.70^{ns}	9.40 ± 8.68^{ns}	0.00 ± 0.00^{ns}	0.00 ± 0.00^{ns}
Ortho-phosphate	18.44 ± 10.02^{b}	0.45 ± 0.39^{a}	0.83 ± 0.77^{a}	0.00 ± 0.00^{a}
TP	1.41 ± 0.65^{ns}	0.21 ± 0.16^{ns}	3.22 ± 1.10^{ns}	2.75 ± 2.34^{ns}
BOD	701.55 ± 126.27^{c}	220.71 ± 56.59^{b}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}
TKN	0.00 ± 0.00^{a}	952.42 ± 459.05^{bc}	733.29 ± 296.54^{b}	973.39 ± 182.48^{c}

Means in the same column not sharing the common superscript letter are significantly different determined by Duncan's multiple range tests ($p<0.05$).

higher nitrite-nitrogen than feeding twice/day ($p<0.05$). As large size prawn ingested more feed than medium size prawn, feeding three times/day gave more chance to nutrient and feed lost to surrounding environment and bigger amount of faeces. In intensive shrimp farms, most of the N (90%) originates from added feeds (Briggs and Funge-Smith, 1994). Toxic substances in forms of free ammonia and nitrite-nitrogen can harm the prawn (Boyd, 1989). Appropriate feeding frequency should be carefully considered in order to generate reasonable growth, reduce nutrients and feed lost with may affect operation cost and deteriorate the environment quality.

CONCLUSION

The present study has provided detail data on waste output and loading in Prawn*(Macrobrachium rosenbergii* De Man) culture at different sizes and feeding frequencies**.**The leaching from formulated feed at 0.5, 1, 2, and 3 hours showed soaking period affected on the nutrient leaching and feed stability ($p<0.05$). Leaching rates were highest in the 0.5 hour. Protein was significant lower but fiber was significantly higher ($p<0.05$) in longer soaking period feed. The large size prawn had feeding digestibility higher than medium size prawns. However, the highest TAN and TKN loaded were found in large size prawn fed 3 times/day.

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