The consumption rate of tiger prawns (*Penaeus monodon*) on alive Amphipod-Crustacean

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**Abstract.** Alive amphipod has been considering as potential food for tiger prawn, *Penaeus monodon*, during growing period in aquaculture pond. The present experiment was aimed at investigating the rate of consumption of tiger prawn juvenile on the adult amphipod crustacean. The consumption rate of tiger prawn was tested at various density levels of amphipod using 2L volume of glass containers. Each container was filled with one liter of sterilized seawater with 30 ppt salinity and included one prawn juvenile. Seven levels of amphipod densities: 10, 20, 40, 80, 160, 320, and 640 ind./L were applied on three ranges of prawn sizes (Total length= TL: 45-60mm, 65-80mm, and 85-100mm) as replications. The percentage of amphipod consumed by each prawn during 4 hours of exposure is recorded and presented in tabular and graphical form. The different effect between treatments was also tested statistically. The results showed that the number of amphipod consumed by each prawn increases significantly (P<0.05) as the density of amphipod increase following the quadratic equation as Y= 3.3843+ 0.9583x -0.0005x^2 (R^2=0.9934). The optimum density of amphipod based on the equation is 955 ind./L with the maximum consumption at 459.6 ind.prawn^-1/4 hours^-1. However, the consumption rate of different sizes of prawns did not show any significant differences (P>0.05). Based on the consumption rate can be concluded that the amphipod-crustacean is suitable as a live food during the grow-out phase of tiger prawn. Nevertheless, more detail about the effect of amphipod on the growth performance of tiger prawn is still needed a more detailed study.

1. Introduction.

The availability of the right food at the right time for most fish is crucial, as starvation can lead to high mortality [1]. It has also been described that low larval survival commonly occurred during the initial feeding periods [2-3], which is most likely affected by a delay in feeding [4-6].

Amphipod is one of the major benthic fauna groups including in the marine environment, which plays an important role in trophodynamics [7]. In Thailand, amphipod was reported as a major food for Spotted Catfish (*Arius maculatus*), a common economic fish in this area [8]. The ability to reproduce quickly and can tolerate a wide range of environmental parameters, make them possible to be developed as live food in aquaculture. On the other hand, they are important as low trophic position organisms, which play a major role in the decomposition of algae inputs and facilitate the transfer of nutrients from the ocean to the coastline [9]. They are also considered as vital food for economically important fish species. Additionally, in some places, amphipods can be available all year round and it can reach 60.000 ind/m^2 densities. It also contains satisfactory protein content and fatty acid, with high levels of useful polyunsaturated fatty acids (DHA and EPA) [10]. Previous studies have explored amphipods as
alternative protein sources for Atlantic salmon, *Salmo salar* [11] and *Octopus maya* [12] with promising results.

![Amphipod-crustacea used in this study](image)

**Figure 1.** Photograph of Amphipod-crustacea used in this study (proposed as *Grandidierella megnae* Giles, 1888)

The amphipod used in this experiment is currently proposed as *Grandidierella megnae* (Giles, 1888), based upon its specific characters. This amphipod crustacean (Figure 1) found in the marine environment has been appearing in India and Thailand [7]. The size of the adult is <1 mm that makes them easy to prey by the other crustacean-like shrimp. Hence, this amphipod has been claimed as an endemic species in Suppa, Pinrang Regency of South Sulawesi, Indonesia, and named as “Phronima suppa” or *Phronima* sp. [13]. It has also been used as live food in shrimp farming in Pinrang Regency, especially very popular in Suppa district [14]. The same name has been adopted by different authors such as [15-17] that have been studying different aspects related to the biological aspect, life history, and the domestication of the species. However, there is no information related to the consumption rate of tiger prawn on this amphipod-crustacean. Therefore the present experiment was aimed at investigating the rate of consumption of tiger prawn juvenile on the adult amphipod crustacean.

2. Material and methods

2.1. Experimental prawns

The tiger prawn juveniles used in this study is coming from laboratory-reared post larvae (PL) to juvenile stage population at RIBAFE hatchery’s, Barru regency of South Sulawesi, Indonesia. Different sizes of tiger prawn juvenile were distributed individually into each 2-L volume of glass containers. An individual prawn was distributed in 21 2-L glassware filled with 1.0 L sterilized seawater (30 ppt). Each glassware equipped with slow aeration. The prawn keeps unfeed for about four hours prior to the amphipod is given. Each container then supplies with numbers of amphipod according to the treatment. The glassware was placed in a water bath equipped with two 100-watt heaters to maintain the water temperature at about 30°C.

2.2. Amphipod source

The amphipod used in this experiment is taken from a natural population in an outdoor concrete tank at RIBAFE. Only the adult individual (body weight, 0.00059±0.00008 g; body length 3.79±1.02 mm) were selected. Seven treatment were applied i.e.: 10, 20, 40, 80, 160, 320, and 640 ind.L⁻¹. Each treatment is with 3 replications.

2.3. Amphipod consumption

After 4 hours exposed to amphipod, the prawn from each experimental unit was removed and placed in different containers. The remaining amphipod in the glassware then counted. The difference between the number of amphipods stocked and the remaining one is to consider as amphipod consumption.

2.4. Data analysis
The data analysis was performed using the IBM SPSS-21 software package, and a significance level of $P < 0.05$ was used. One-way ANOVAs, followed by Tukey tests, were used to evaluate the differences in the means of the amphipod consumption. Results are shown as the mean±standard error of the mean (SE). Microsoft Excel version 2013 was used to perform a regression analysis between the density of amphipod and the consumption rate of crablet. Based on the regression equation, the optimum density of amphipod, which gives the maximum consumption is estimated.

3. Results and discussion
The number of amphipods consumed by each individual prawn at all sizes increased as prey concentration was raised. As prey level was increased from 10 to 40 ind. L$^{-1}$ there was no noticeable change in the number of amphipod consumption of tiger prawn, but the rates of increase in consumption steadily increased when prey density rose from 40 to 640 ind. L$^{-1}$ (Table 1; Figure 2). At the 640 ind. L$^{-1}$ prey levels, all sizes had the highest consumption rates. All sizes could consume between 15.48-68.29%, corresponding to the size of 5-1 g of body weight (Table 2).

Table 1. The consumption rate of tiger prawn *Penaeus monodon* juvenile on amphipod after 4 hours exposure at different stocking densities

| Amphipod densities (ind.L$^{-1}$) | The number of amphipods consumed (ind. Prawn$^{-1}$) | Amphipod consumption (%) |
|----------------------------------|---------------------------------|----------------------------|
| 10                               | 9.33±0.33a                      | 93.33±3.33a                |
| 20                               | 19.33±0.33a                      | 96.67±1.67a                |
| 40                               | 40.00±0.00a                      | 100.00±0.00a               |
| 80                               | 79.33±0.33a                      | 99.17±0.417a               |
| 160                              | 159.33±0.33a                     | 99.58±0.21a                |
| 320                              | 242.63±6.08b                     | 75.63±1.90b                |
| 640                              | 397.67±23.81c                    | 62.14±3.72c                |

Different superscript letters in the same column at different amphipod densities indicate significant differences between treatments ($P < 0.05$).

Table 2. Amphipod (*Grandidierella megnae* Giles, 1888) consumption of different sizes of tiger prawn *Penaeus monodon* juvenile exposed for 4 hours

| Prawn Bodyweight (g) | Amphipod consumption (%) | Percent of Bodyweight |
|----------------------|--------------------------|-----------------------|
| 0.5-1.0              | 88.95±3.33a              | 68.29±3.33a           |
| 2.0-3.0              | 96.67±1.67a              | 23.61±1.67a           |
| 4.0-5.0              | 100.00±0.00a             | 15.48±0.00a           |

Different superscript letters in the same column at different amphipod densities indicate significant differences between treatments ($P < 0.05$).
Figure 2. The consumption rate of swimmer tiger prawn *Penaeus monodon* at a different stocking density of Amphipod-crustacean in controlled conditions.

From the quadratic line equation (Figure 2) the optimum density of amphipod is 954.7 ind. L$^{-1}$ when the highest consumption rate reached at 459.6 ind. The amphipod consumption rate changes with the amphipod density. This may be related to the ability of the prawn to catch amphipod. It is easy to catch amphipod in dense compared to scarce conditions. The maximum consumption of tiger prawn (459.6 ind.) is equivalent to the food dosage of 42% of prawn body weight. Based on the ability of tiger prawn to prey on amphipod, it becomes a supporter of the reality in the field where the success of the harvest of the pond is very dependent on the amphipod availability [13]. Aside from its freshness, there is no adverse impact on the environment [11] and has a high and comprehensive nutritional value [18], perhaps another reason why amphipod can support shrimp life on the farm. The problem then is how to meet the needs of shrimp to amphipod, which is high density in ponds. One thing that should be noted from the author's experience is that this amphipod can breed throughout the year with a relatively high density and likes moss as shelter and maybe as food. While aquaculture activity expected to feed people more than fishery can, it is necessary to investigate new marine feed sources to be used in aquaculture. Previous works have explored the use of alternative prey, like copepods, and traditional prey, like Artemia and rotifers. Amphipods from marsh ponds could also be an alternative source. To date, amphipods have been used in meals for finfish with different results. *Themisto libellula* (Amphipoda: Hyperiidae) has been used to improve salmon growth with a total substitution of fish meal for amphipod meal [19]. The amphipod does not only contain micronutrients but also macronutrients including protein, lipid, and especially high content of n-3 PUFA [10, 11, 19]. Related to the opportunities for future development, studies on the biological aspects also need attention. The techniques of cultivation, domestication and other aspects [15-17] have been initiated by several researchers and are expected to be used for the revival of tiger shrimp culture in South Sulawesi as has been declared by the provincial government.

No mortality was found for the prawn during the experiment, but few were found for amphipod at different treatments. No clear pattern of the mortality rate occurred at different stocking densities of the amphipod during the experiment. This may indicate that the cause of death was not related to the stocking density of the animal but may have been killed by prawn or some other reasons. The good thing is the prawn could feed on alive or death amphipod. However, it is important to notice here that live food is more attractive compare to dead food.
4. Conclusions
Based on the consumption rate of tiger prawn juvenile against amphipod, it can be concluded that the amphipod-crustacean is suitable as a live food during the growing phase of tiger prawn. The optimum stocking density of amphipod for maximum consumption is 29 ind./0.5 L at a consumption rate of 11.47. However, more detail about the effect of amphipod on the growth rate of swimming crab and the biological aspect still needs more detail elucidation.

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