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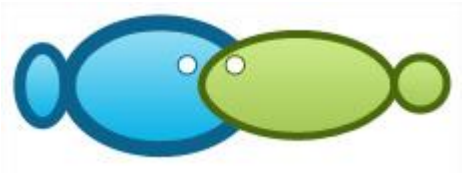

Effect of the feeding rate practice on the white shrimp (*Litopenaeus vannamei*) cultivation activities

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Abstract. Feeding rate is based on the estimated percent of feed per shrimp weight. The purpose of this study was to determine the effect of the used feeding rate on the water quality profile and on the biological growth of white shrimp (*Litopenaeus vannamei*). This research was conducted using an ex-post facto causal design concept in an intensive shrimp pond with a size of 2,000 m^2. The indicators observed in this study were the water quality parameters and the biological indicators of shrimp, as well as the percentage of feed rate used in ponds during the cultivation cycle. The results showed that the water quality parameter values remained stable, with a pH value of 8.2 (±0.15), a salinity of 17‰ (±6.50), a dissolved oxygen of 5.87 mg L^{-1} (±0.51), a green water color, a temperature of 28.59°C (±1.19), an organic matter concentration of 93.48 mg L^{-1} (±17.02), a brightness of 36 cm (±24.75). The organic matter content in ponds has a positive correlation with the brightness value, which is described by the equation Y=144.20+1.16x. The shrimp growth rate is positively correlated with the shrimp weight, which is described by the equation Y=5.98+79.58x. The feed rate in ponds has a correlation value of 0.725 with the shrimp weight and of 0.587 with the brightness. The feed rate also has a relationship with the shrimp biomass, which is described by the equation model Y=43.26+0.01x. Based on the results of this study, it can be concluded that the use of feeding rate during the cultivation cycle has a significant effect on the shrimp weight and on the value of pond water brightness.
Key Words: biomass, pond, productivity, shrimp culture, water quality.

Introduction. White shrimp (*Litopenaeus vannamei*) cultivation is a productive aquaculture activity that is widely developed in coastal areas (Ray et al 2021). In Indonesia, white shrimp cultivation began to be popular in 2001, after the failure of tiger shrimp cultivation (Ariadi et al 2019b). *L. vannamei* is widely favored as a cultivation commodity, due to its relatively fast biological growth rate, feed conversion ratio, survival rate and tolerance of water quality fluctuations in environmental habitats (Addo et al 2021). Many *L. vannamei* cultivation farms in Indonesia have used the concept of intensive and sustainable cultivation (Ariadi et al 2019a).

Intensive shrimp farming activities have the potential to produce waste accumulation in the surrounding environment (Piotrowska-Kirschling et al 2021). The accumulation of waste will cause the surrounding aquatic ecosystem to become eutrophic (Yang et al 2017). The accumulation of shrimp culture waste comes from a combination of suspended solid, solid waste and liquid waste originating mainly from the aquaculture activities input (Leong et al 2021). One source of waste in the shrimp farming ecosystem comes from the quantity of feed waste (Ariadi et al 2020). The wasted feed contributes with 17% to the total waste in the pond ecosystem (Burford & Williams 2001). The rest of the waste comes from fecals, suspended solids and other particles. The feeding management procedures during the cultivation cycle play a crucial role in the presence of waste loads in ponds (Ullman et al 2019). One of the feeding techniques in white shrimp culture is using the percentage feeding rate, a method of feeding in aquaculture activities based on the body weight and on the estimated percentage of feed levels (Kaya et al

2020). The purpose of this study was to determine the effect of the feeding rate use on the water quality profile and biological growth of *L. vannamei*.

Material and Method

Description of the study sites. The current research was conducted in the shrimp ponds of Sidomulyo Village, Pekalongan City, Central Java, from August to October 2021 during the shrimp cultivation cycle. The research method used is an *ex-post facto* causal design or analysis based on real conditions in the field. The study was conducted on a pond with a size of 2,000 m^2, with a stocking density of 100 fry m^{-2}. The research indicators observed were water quality parameters which included: pH, salinity, dissolved oxygen, temperature, brightness, water color and organic matter. Other indicators observed were shrimp average body weight, shrimp average daily gain and feeding rate data used for feeding. All research parameters were measured every seven days during the cultivation period.

Water quality measurement. The dissolved oxygen concentration and water temperature values were measured using a DO Meter type YSI 550i, while the water pH was measured using a pH meter Merck Eutech Eco-pH; the salinity was measured using a Master ATAGO S10 refractometer, the brightness was measured using a secchi disk, the water color was visually evaluated, and the organic matter was analyzed using the titrimetric method. The measurements of shrimp average body weight and shrimp average daily gain were weighed using an analytical digital scale and the average daily growth rate value was obtained by subtracting the current shrimp sampling weight from the previous shrimp sampling weight and then by dividing it with the time period (days) of rearing.

Statistical analysis. The data were collected according to the sampling time or every seven days in 11.00 AM, then the data were analyzed descriptively using Microsoft Excel. Furthermore, data were analyzed statistically by using the SPSS software, version 16.

Results and Discussion

Water quality parameters. The water quality parameters at the research pond location is still quite good for white shrimp cultivation activities (Table 1). During the shrimp culture period, the average pH value was between 7.9-8.4, the salinity was 9-27‰, dissolved oxygen was 5.28-7.18 mg L^{-1}, the water color was green, the pond water temperature was 26.20-30.50°C, the organic matter was 51.82-115.02 mg L^{-1} and the brightness value was 36 cm. The water quality parameter values were admissible for white shrimp farming activities: the pH range value should range between 7.5-8.5 and the dissolved oxygen concentration should be >4 mg L^{-1} (Ariadi et al 2021a), with concentration fluctuations (in intensive ponds) expected to stabilize, over time (Wafi et al 2021).

Table 1

Pond water quality parameters

	Water quality parameters						
	pH	*Salinity*	*Dissolved oxygen*	*Water color*	*Temperature*	*Organic matter*	*Brightness*
Mean	8.2 (±0.15)	17 (±6.50)	5.87 (±0.51)	Green	28.59 (±1.19)	93.48 (±17.02)	36 (±24.75)
Range	7.9-8.4	9-27	5.28-7.18		26.20-30.50	51.82-115.02	10-100

The water quality parameters in intensive white shrimp culture fluctuate continuously (Ariadi et al 2021c). White shrimp are very sensitive organisms to the water quality

fluctuations in their habitat (Ma et al 2013) and must be monitored. Poor water quality conditions will make pathogenic infections in the pond environment even more dangerous (Shekhar et al 2019).

Organic matter in pond. Crucial for the water quality parameters of concern is the total organic matter. During the shrimp culture period, the concentration of organic matter in the pond fluctuated against the value of water brightness (Figure 1). The brightness value will decrease when the organic matter concentration in the pond waters increases. This condition is caused by the high organic matter solubility which will affect the turbidity level in the water column (Torun et al 2022).

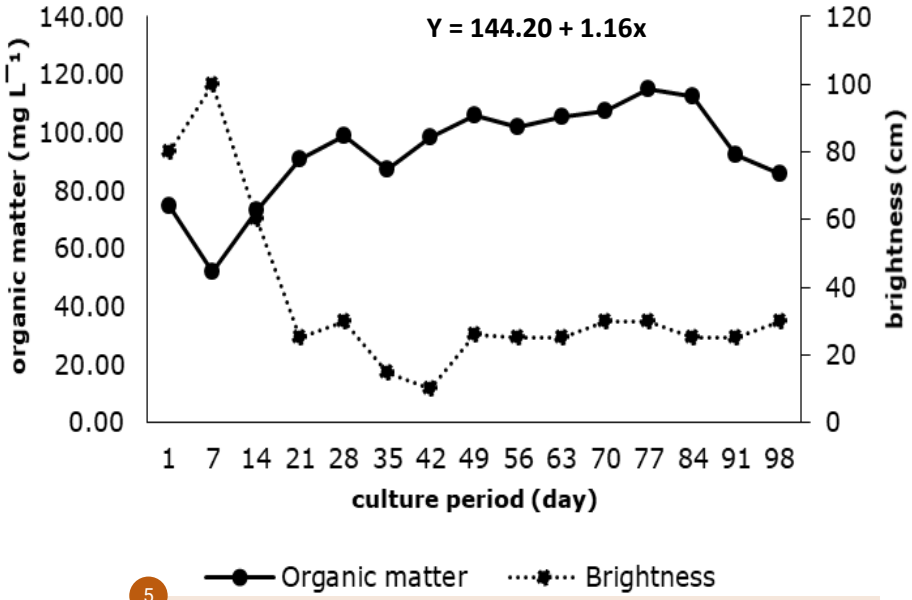

Figure 1. Organic matter in ponds during shrimp culture periods.

The relationship between the organic matter concentration and the brightness of the waters is described by the equation Y=144.20+1.16x, which means that every increase in the concentration of organic matter by 1 mg L^{-1}, will affect the increase of turbidity level in the waters by 1.16 cm. White shrimp are organisms that tend to prefer cloudy water conditions, compared to clear ones (Ariadi 2020), because in turbid waters, the plankton abundance is more diverse than in clear waters (Permatasari et al 2021). Organic matter in pond waters comes from feed waste, feces, shrimp moulting and various other dissolved particles (Torun et al 2022).

Shrimp growth rate. The shrimp growth rate in ponds continues to increase with the shrimp culture period (Figure 2). The increase in growth rate followed by an increase in the average shrimp body weight was explained by the equation Y=5.98+79.58x. The culture period increase requires more feed inputs, positively affecting the growth rate of shrimp in pond ecosystems (Ariadi et al 2021b). White shrimp is a type of crustacean that has a faster average growth rate than other types of crustaceans (Anand et al 2019).

Besides being influenced by feed factors, the shrimp optimal growth rate in ponds is also influenced by the water quality conditions, which play an important role in the aquaculture operational cycle (Addo et al 2021). The shrimp productivity will increase if throughout the cultivation period the water quality history is good (Ariadi et al 2019c). Water quality is driven by biochemical processes in the aquatic ecosystems.

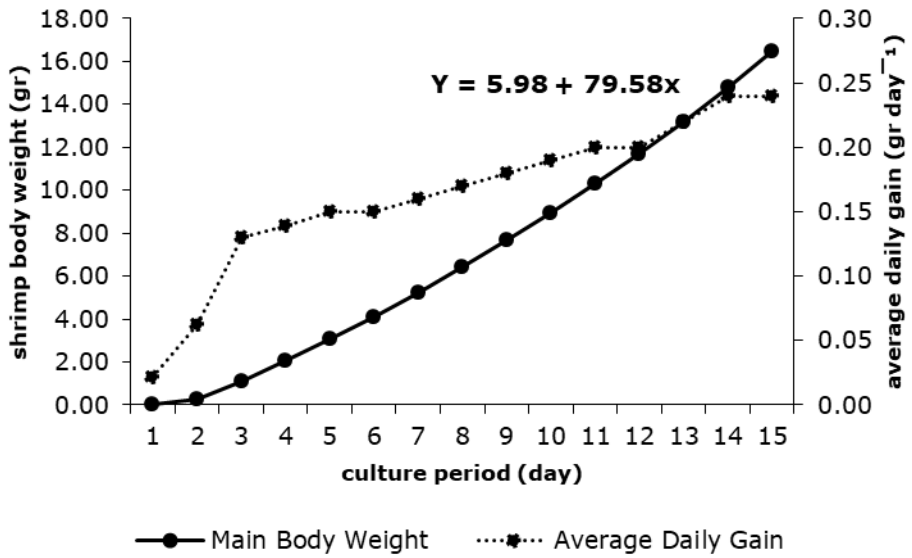

Figure 2. Shrimp growth rate during cultivation periods.

Feeding rate practice. The feeding rate calculation in the research ponds is based on the estimation of the shrimp weight increase, ranging from 2.33 to 174.41% (Figure 3). The feeding rate in ponds decreases with the average shrimp weight increase. The higher the feed conversion rate, the smaller the required feed rate (Antunes et al 2018).

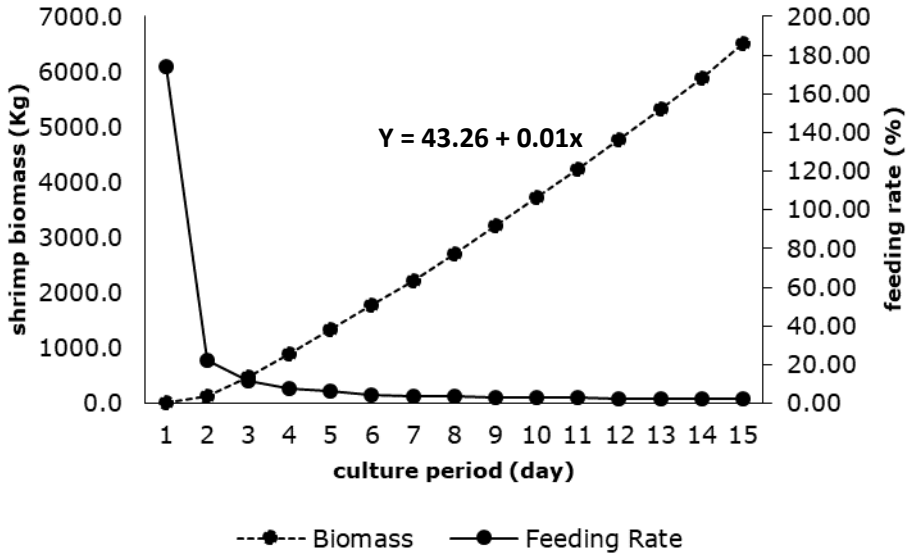

Figure 3. Correlation of the shrimp biomass with the feed rate during the cultivation.

The feeding rate will have a negative correlation with the shrimp weight, as shown by the equation Y=43.26-0.01x (Figure 3). This means that every 1% of decrease in the value of the feeding rate will increase the shrimp cultured biomass by 1 g. There are many factors that affect the effectiveness of the feeding rates in ponds, such as the feeding management or the quality of the feed products used in the shrimp culture (Ullman et al 2019). Shrimp is a continuous feeder organism, which biases the indicators for assessing the effectiveness of the feeding in ponds (Wafi et al 2020).

The relationship between the feeding rate with the water quality and the shrimp biological factors. Based on the test results, the feeding rate in ponds correlates to the shrimp body weight and to the level of water brightness (Table 2). The feeding rate kept constant affects the shrimp body weight that and also the feed conversion rate (Nair &

Sridhar 1994). In addition, a constant feeding rate generates excess feed, which affects the level of turbidity in the pond waters, due to the wasted feed and shrimp feces (Ariadi et al 2021a).

Table 2

The relationship of the feeding rate practice with the water quality and shrimp biological factors

Indicators		*MBW*	*ABW*	*pH*	*Salinity*	*DO*	*T*	*TOM*	*Brightness*
FR	Pearson correlation	-0.434	-0.725”	0.183	-0.045	-0.038	0.436	-0.398	0.587’
	Sig. (2-tailed)	0.106	0.002	0.515	0.874	0.894	0.105	0.142	0.021
	N	15	15	15	15	15	15	15	15

FR-Feed Rate; MBW-Main Body Weight; ABW-Average Body Weight; DO-Dissolved Oxygen; T-Temperature; TOM-Total Organic Matter.

Overall, based on the results of this research, it is shown that the feeding rate in the shrimp culture will have an impact on the shrimp body weight gain and on other parameters such as brightness. The brightness value is one of the physical indicators that will determine the level of suitability of the aquaculture water quality (Erawan et al 2021). In addition, the use of feeding rates in ponds is also influenced by the estimated biomass weight and by the size of reared shrimp (Nair & Sridhar 1994). The larger the shrimp, the more complex the feeding rate adjustment to the metabolic rate and biological conditions of the shrimp (Ariadi et al 2019c).

Conclusions. From the results of this study, it can be concluded that the choice of the feeding rate during the cultivation cycle has a very significant effect on the shrimp weight and on the pond water brightness, as well as the shrimp crop productivity rate.

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Conflict of interest. The authors declare no conflict of interest.

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