Evaluation of physiological responses and production performance of spiny lobster with different density treatments in floating net cage

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Abstract. The weak in survival rates and low productivity of spiny lobster are influenced by stock density. Thus it is necessary to find the optimum stock density to minimize stress levels and increase productivity. This study was consisted of 2 treatments, consisting of a 25 individuals/m² and 50 individuals/m² with a sheltered environment. The research analysis used descriptive analysis. The lowest stress levels was found in treatment of 25 lobsters/m² (cortisol 1.17±0.14 nmol/L and glucose level 8.34±0.5 mg/dL) and the highest weight gain (26.29±1.69%) as well as the specific growth rate (0.77±0.014%). However, the highest value of survival rate of spiny lobsters (95±0.03%) with lowest specific growth and weight gain was found in 50 lobsters/m² treatments.

Keywords: growth, shelter, spiny lobster, stress levels

1. Introduction

Spiny lobster is an export commodity with high economic value and widely caught in Indonesian oceans market demand. This increase market demand which has an impact on increasing exploitation of lobsters in oceans. In the long run without good management can lead to overfishing of lobsters. To avoid this overfishing, some fishermen began to cultivate of lobsters in floating net cages. Lobster culture activities in floating net cages (KJA) began to develop both in Indonesia and other countries, such as New Zealand. The effort to grow lobster in Lombok District using KJA still has weaknesses, while it is not equipped with shelters and the survival rate achieved is still low (40-50%) (Suastika et al 2008).
The low of lobster productivity influenced by environmental factors such as the level of stress and cannibalism caused from the culture media used such as the maintenance of spiny lobster in the floating net without shelter. Unsupportive environmental factors such as inappropriate cages and density, not using shelter, are thought to cause stress which induces high levels of physiological respond such as cortisol and glucose. Increased cortisol has an effect on growth, physiological conditions and stress response (Barton et al 1987). The necessary development innovation of lobster container that can minimalized of stress levels and increase productivity such as making special compartment equipped with shelter (Pratiwi et al 2016, Supriyono et al 2016, and Djai et al 2017). The aim of this research was to evaluate the application of the compartment within the floating net cage with different density of spiny lobster.

2. Material and methods

The materials used in this study were juvenile of spiny lobster with size of ±50 g/lobsters and tembang fish as feed. The preparation stages included the design of research and the manufacture of specially for lobster enlargement (compartment) design and the placement of shelters. The general specifications of these compartments and shelters included compartment material made of cube-shaped fiber with a size of 1 m³, while the shelter used was a pipe with a diameter of 15-20 cm with a pipe length of 50 cm.

The study design consisted of 2 treatments with A (with a density of 25 lobsters/m²) and B (with a density of 50 lobsters/m²). Measurement of glucose (following the method of Supriyono et al 2017) and cortisol levels (following the method of Blahova et al 2007) was done 4 times, namely on days 0, 7, 14, and 30th. Retrieval of hemolim lobster taken in the morning by taking hemolim at the point of the swimming foot (pleopod) at the back near the abdomen. The research analysis uses descriptive analysis

3. Results

3.1. Stress response

The lowest cortisol level was found in the treatment with a density of 25 lobsters/m² of 1.17 nmol/L (figure1). Figure 2 shows that the lowest glucose level was observed in treatment with a density of 25 lobsters/m² (8.34 mg/dL).

![Cortisol level in each treatment.](image)

3.2. The weight gain and Specific growth rate

The highest of weight gain rate was in the B treatment with a density of 25 lobsters/m² of 26.29% while the lowest was in the C treatment with a density of 50 lobsters/m² of 13.51% (figure 3). The highest specific growth rate was in the treatment of B with a density of 25 lobsters/m² of 0.75% while the lowest was in the treatment of C with a density of 50 lobsters/m² of 0.33% (figure 4).
3.3. Survival rate
The highest survival rate was in the B treatment with a density of 50 lobsters/m² (95%). The survival rate in 25 lobster/m² only 84% (figure 5).
4. Discussion

The highest cortisol and glucose levels of spiny lobster was observed in a density of 50 lobsters/m². This condition is caused by the space competition between lobsters.

The higher glucose level in hemolym indicates an increase in stress level due to high density. At very high stress levels, a rapid increase in glucose and survival at high levels will be followed by death (Brown 1993).

Several studies have shown that cortisol and glucose levels increase after being treated. Woodward and Strange (1987) observed that rainbow trout cortisol increased 3 times more than hatchery fish when exposed to clean container treatment and electric shocks. On the other hand as stated earlier, stress hormones such as catecholamines, cortisol and others can be influenced by internal factors or external conditions (Anoxia, pollution, nutritional stress, physical stress). Meanwhile, according to Pickering (1981), causes stress or stressor caused by changes in the environment (changes in temperature, density, salinity, changes in water pressure, pollution, pH, disease, changes in water flow, sediment loads, DO concentrations and food availability, handling / handling (tank maintenance, transportation and removal fish with a scoop or bucket) and capture (catch) with a trawler, trammel net, and gill net, and also by Aeration method (Supriyono et al 2016) as well as by an appropriate shelter type (Adiyana et al 2014), the ratio of shelter to cultured organism (Djai et al 2017), and the density of cultured organism (Supriyono et al 2017, Subhan et al 2018).

Besides the stock density, another requirement that must be met in order to minimize stress levels is the nutritional value of feed and the appropriate environmental factors during maintenance. According to Barton et al (1987) completeness of nutritional status can influence stress and glucose responses and finally to the production of cultured organism (Effendi et al 2016). Diet intake with different lipids and protein levels results in various glucose responses (Cheng et al 2006). Glucose level in the blood is one of the parameters used to evaluate the stress status of a cultured organism both on freshwater, brackishwater and marine organism. The glucose level of the some cultured organisms tend to increase by increasing of the stressor, such as temperature (Hastuti et al 2003), salinity (Taqwa et al 2018), fish density (Subhan et al 2018). Glucose level of this research also tend to increase by increasing of lobster density.

In lobster cultivated with a fairly high density (intensive), an increase in stocking density will be followed by an increase in the need for feed, oxygen, and impurities (metabolites and feed residue), so that the growth of spiny lobsters tends to decrease with high density. It was seen that the growth of spiny lobster in the C treatment tended to be lower than the B treatment. The rate of growth also
depends on the frequency of moulting and changes in size per moulting. Periodically lobster will change in moulting, which is the old skin will be removed and replaced with a new skin. At the time of skin replacement is usually followed by growth and weight gain. According to Quackenbush (1986), it is known that there are 2 factors that affect moulting in crustaceans, namely external and internal factors. External factors include; the presence of stressors, nutrition, photoperiod and temperature while internal factors are related to the production of ecdysteroid hormones and Molt Inhibiting Hormone (MIH).

The relative growth rate has a strong relationship with cortisol and glucose levels, meaning that the increase in growth is caused by a decrease in stress levels (cortisol and glucose levels). Cortisol and glucose levels have a positive relationship, meaning that an increase in cortisol levels is followed by an increase in glucose levels, this is in accordance with the opinion of Hemre and Krogdahl (1996) and Falahatkar and Barton (2007) that cortisol can increase glucose levels in hemolim, disturbance in cortisol secretion can change the response of glucose values and increase in glucose can be associated with differences in the mechanism of action of cortisol.

The success of the spiny lobster cultivated in floating net cages cannot be separated from the optimum stock density and the water quality. The dissolved oxygen content (DO) measured during the study ranged from 5.24 to 6.74 mg/L. Dissolved oxygen levels in the culture media in this study were due to lobster being kept in open water as well as seaweed culture (Rosyida et al 2015) and vaname shrimp cultured in floating net cage (Effendi et al 2016) . This value was still in a good range, the range of optimum dissolved oxygen value for crustacean growth is 5 mg/L. Nevertheless, the dissolved oxygen content of 4.21 to 5.43 mg/L can still provide good growth and survival (Boyd 1982). Lobster oxygen demand will also increase when consuming food and oxygen demand at night is much higher than during the day. However, low oxygen levels (0.5 and 3.0 mg/L) can kill lobsters (Philips and Kiitaka 2000).

Growth rates among lobster species vary, water temperature greatly influences juvenile of lobster growth. In general lobster in warm water can grow at the fastest rate. A variety of temperatures have been tolerated by lobsters. Temperatures above ambient (but up to maximum) usually produce faster growth, greater than those seen in the wild. Faster growth mainly comes from high moulting frequency. Seawater temperature measured during the study ranged between 27.79-29.67°C, this value is still in a good range. Optimal growth in juveniles occurs around 18-20°C (for J. edwardsii from Australia) to 29-30°C (P.argus from Antigua). The salinity of the waters during the study ranged from 32.57-34.09 ppt, still in a good range, spiny lobster can still tolerate salinity value, because spiny lobster is a poikilosmotik palinurid species that is still able to tolerate salinity in sea waters to 20% below sea salinity for several days. Salinity of sea water can affect the taste of thorny lobster meat (Philips and Kiitaka 2000).

5. Conclusion

The stress levels of spiny lobsters that were maintained in floating net cages with 25 lobster/m² was lower than that of 50 lobster/m².

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