Water quality and organic content from intensive system of vaname production at coastal area of Sumur, Pandeglang, Banten

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Abstract. The high stocking and proper feeding in intensive system of vaname shrimp production remain organic waste. The increase input of feed along with shrimp biomass rises accumulated organic matter. The quality of shrimp pond disposal influences water quality surround effluent area shrimp pond activities. The study aims to analyze the magnification of organic waste of the intensive shrimp pond. The research was conducted in one production cycle of four ponds, by observing condition of water quality and organic matter. The result shows that in general, the water quality parameters (temperature, dissolved oxygen, and pH), nutrient (ammonia, nitrite, and nitrate); and organic matter (COD) were suitable to the shrimp production process. There were also found four different groups of organic conditions according to the level of feeding and pond drainage periods. Group 1, 2, and 3 showed that the presence of organic matter was inversely proportional to ammonia, nitrite, and nitrate; while in Group 4, the organic matter was proportionally to nitrite and nitrate. As a whole, proper maintenance kept organic matter in a safe level to dispose into the environment.

1. Introduction
The operational of brackish shrimp pond as one of fastening ways to increase shrimp-based fishery production [1]. The increasing of shrimp production, especially white shrimp or Litopenaeus vannamei [2] is recently boosted by intensification system. This system is characterized by high stocking density, high quality, and quantity of commercial feed [3], and intensive aeration [4]. The consequence of the system is high production of organic waste from the remaining of uneaten feed and shrimp feces. The organic waste consists of high concentration of nitrogen, such as ammonia. To some extent, high ammonia concentration might have a deadly effect on the shrimp [5].

Khan [3] stated that feed input is the main supplier of organic material waste and nutrients to the aquatic environment. The waste during shrimp maintenance processes besides affects the pond waters itself also impacts the quality of the surrounding coastal waters. Pollution in the pond environment causes stunted shrimp growth, and decreases resistance to shrimp disease and leads to death.

Intensive ponds have an increase in total N-inorganic along with shrimp age [6]. In addition to an increase in total N-inorganic, pond water quality will also decrease due to the accumulation of organic matter from the rest of the feed and feces [5].

Besides providing high economic benefits, shrimp rearing activities have also potential negative impact on the aquatic environment due to discarded uneaten feed. Intensive system of pond applies a
high density of shrimp stocking and uses commercial feed during the production period. The high the stocking density will also increase the waste in the form of organic matter. Therefore, it is essential to study the impact of increasing organic matter on water quality (nitrogen dynamics) and pond waters productivity.

2. Materials and methods

The observation was conducted at four ponds of 29 shrimp ponds situated at the coast of Ujung Kulon, Pandeglang District, Banten Province. Each pond was designed with a surface area of 3600 m² and a depth of about 1 m. The bottom of the pool is covered with HDPE plastic with central drainage. The ponds were equipped with 20-24 Hp wheels capacity. Water exchange to maintain water quality started from the 30th-day.

The shrimp culture is operated intensively with the density of 125 individual/m² in 105 days. The shrimp were fed with commercial feed containing 35% protein, 6% fat, 3.5% fiber, 13% ash, and 11% moisture. Crumble-shaped commercial feed was given for the first two weeks, followed by pellets until the harvest day. The dose of feed was 8.0% at the beginning of stocking and decreased gradually to 2.5% at the end of the production period.

Data on some water quality parameters were collected in one production, i.e. dissolved oxygen (DO), pH, temperature, ammonia, nitrite, nitrate, and COD [7]. DO, pH, and temperature were measured directly in the pond twice a day. Meanwhile, ammonia, nitrite, nitrate, and COD were measured weekly in a laboratory.

Data of water quality were compared to water quality standard for aquaculture. Data of each period were analyzed statistically using linear regression analysis and Pearson’s correlation test [8, 9] to elucidate the relationship between organic material and nitrogen.

3. Results

Water quality data showed optimum conditions for the shrimp. Temperature ranged at 27.0–29.9°C in the morning and 27.5–31.7°C in the afternoon. The range of dissolved oxygen was recorded 4.0–5.5 mg/L at night and 5.0–7.6 mg/L in the morning. Furthermore, pH in the morning ranged from 7.6–8.1 and 7.9–8.5 at night.

The production period is 105 days was divided into four periods in accordance to water exchange activities. The key parameters for each period showed different patterns (see Table 1 and Figure 1). The organic material, expressed as COD exhibited an opposite pattern with nitrite and nitrate. The ammonia showed different patterns in Period 3 with the COD. It indicates that COD was decomposed into nutrients in the form of nitrogen. In the last period, the increase of COD was supposed to be correlated to water quality; in this case lower dissolved oxygen.

The COD and water quality showed different correlations with other parameters (p<0.05). COD had a high correlation to nitrite at Period 1; with ammonia, nitrite, and nitrate at Period 2 and 4; and with nitrite and nitrate at Period 3. Furthermore, temperature was significantly influenced COD, ammonia, nitrite, and nitrate at all period; pH influenced COD and nitrite at Period 1 and 3; while DO influenced different parameters of each period.

Table 1. The range of average value of water quality of each production period.

| Parameters   | Period 1 Day 1-28 | Period 2 Day 29-56 | Period 3 Day 57-84 | Period 4 Day 85-105 |
|--------------|-------------------|--------------------|--------------------|---------------------|
| COD (mg/L)   | 145-176           | 125-145            | 100-125            | 100-140             |
| Ammonia (mg/L) | 0.018-0.060     | 0.038-0.039        | 0.033-0.300        | 0.033-0.093         |
| Nitrite (mg/L) | 0.004-0.028    | 0.028-1.010        | 0.697-3.120        | 3.120-5.245         |
| Nitrate (mg/L) | 0.168-1.260    | 0.120-0.755        | 0.755-9.258        | 8.853-10.805        |
4. Discussion
During the observations, the values of temperature, dissolved oxygen, and pH were in a proper condition for the shrimp. Haliman and Adijaya [10] stated that the appropriate temperature for shrimp growth ranged from 26-32° C. Furthermore, the optimum dissolved oxygen for ponds with high density is 4-8 mg/L [11]. Meanwhile, the proper pH value of shrimp pond water ranged from 7.5 to 8.5 [12].

The accumulation of organic material in intensive ponds occurs with increasing age of shrimp and more artificial feed is given [13]. The organic matter is an accumulation of uneaten food, shrimp feces, and dead plankton [14, 15]. Furthermore, the organic material will be decomposed by bacteria [16], which can be detected from the COD concentration. Decomposition of organic matter will produce inorganic compounds such as ammonia, nitrites, and nitrates [17] with a concentration that continues to increase in line with increasing shrimp biomass and the amount of artificial feed [18, 13].

The results showed that in Periods 1, 2, and 3 there was a similar pattern between COD and inorganic nitrogen. COD concentration has decreased with increasing nitrogen concentration. It means that organic matter was well decomposed into inorganic nutrients by decomposer organisms because it was supported by suitable temperature, pH and dissolved oxygen conditions. Temperature, pH, and dissolved oxygen is believed to have a great influence on the activity of decomposing bacteria [13].

The decrease of COD concentrations might also be caused by increasingly intensive water exchange, especially at the first 2 months of culture. The process of pond bottom sludge disposal during the production process can reduce the content of organic material [14] and maintain water quality [13]. This was related to the quite high increasing concentration of ammonia on the 71st day. According to Afriansyah et al. [19], ammonia levels increase due to the ammonification processes and
decomposition runs completely. The processes can be influenced by the suitable pH conditions in ponds for the growth of ammonia-oxidizing bacteria [6].

The process occurs because water temperature influences bacterial activity in the nitrification process. Water temperature affects chemical reactions that occur in the waters as well as biochemical reactions in the body of shrimp [20]. Nitrification process takes place optimally at a temperature of 28-32°C [21]. The results showed that the water temperature ranged from 27.0 to 31.7°C. Hence it is suspected that the bacteria decompose organic matter through the process of nitrification, and stay well during maintenance.

The pH affects the chemical reaction in the waters [20], including bacterial growth. The pH value for bacterial growth, in general, is 4-9 [22]. The value is related to the enzyme activity that is used by bacteria to catalyze reactions related to bacterial growth. In conditions of suboptimal pH, enzyme work will be disrupted and bacterial growth will also be inhibited [23].

Bacteria also need oxygen in decomposing organic matter. In addition to respiration, growth, breeding, and metabolic processes by all aquatic organisms, dissolved oxygen also plays a role in the decomposition of organic matter in waters by microbes [24]. Dissolved oxygen provides sufficient oxygen to the bacteria in the decomposition process [25].

Overall, the decrease in COD concentration over the observation time indicates the decomposition of organic matter by microorganisms in the pond as stated by Marganof [26]. Besides, the decrease in COD concentration is also due to periodic water exchange. In terms of quality, the water in the ponds seemed to support good growth of the shrimps as indicated by the good harvest [27].

5. Conclusion

The organic content and nutrient condition along the shrimp production periods was influenced by the water exchange or flushing. There are four periods of water exchange which showed different relationship with observed nutrient condition during the study. In period 1, 2, and 3, COD concentration decreased along with increasing nutrient concentration, while period 4 showed the opposite.

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