Evaluation of karst water quality as an early reference of land suitability mapping for vaname shrimp (*Litopenaeusvannamei*) culture media

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Abstract. Vaname shrimp (*Litopenaeusvannamei*) is one of the excellent fishery commodities in Indonesia. Vaname shrimp farming can be conducted in low salinity water. Low salinity water sources which could be used as culture media is karst water because it has a high mineral. The research was aimedto evaluate land suitability mapping for pond as the vaname shrimpculture mediaseen from the water quality. Research was conducted in May and August 2016. Water sampling was conducted in several locations; Ancol-Jakarta (seawater), Ciseeng-Bogor (karst water salinity), Ciampea-Bogor (karst freshwater), and Situ Gede Bogor (freshwater). Evaluating the suitability of karst water quality for vaname shrimp culture media, done by the results of karst water quality analysis compared with seawater and SNI 01-7246-2006 on shrimp vaname culture media. The results showed that Karst water of Ciseeng and Ciampea could not directly use as vaname shrimp culture media. It is needed water quality treatment of ozonation and aeration of karst water to improve water quality.Ozonation and aeration treatments were able to improve the quality of karst water up to approach the living quality standard of vaname shrimp media.

1. Introduction

Vaname shrimp aquaculture activities are generally carried out in high-salinity waters such as on coastal waters. Vaname shrimp which have euryhaline properties causing this organism, in addition to be able to be cultured in high-salinity waters, it can also be cultured in low salinity waters such as lakes, rivers, wetlands and reservoirs [1].

Vaname shrimp farming activities in the waters with low salinity is not only able to increase shrimp production but also provide other benefits such as employment, reducing transport costs due to the distance between farmers and consumers are relatively close, shrimp can be served in a fresh state, and shrimp farming activities in freshwater can prevent shrimp contracts a disease. However, when vaname shrimp is cultured in low salinity waters, it will cause vaname shrimp experience stress because it cannot maintain the osmotic pressure of the body [2,3]. This is because low salinity water has lower mineral

content than the high salinity waters[4,5]. Therefore, it requires source of freshwater that has a high mineral content.
Low salinity water source that has the mineral potentials is karst water or limestone water [6]. Karst water contains minerals dominated by calcium, magnesium, and carbon. Mineral content in karst water is come from the activities of rocks dissolution by water (carstification) [7]. Abundant mineral content and availability throughout the year makes the karst water is a potensial ofvanameshrimpculture media. Limited information on this is an opportunity for the evaluation study on karst water quality conditions for vaname shrimp (*L. vannamei*) breeding media. The purpose of this study is to assessland suitability mapping for pond as the Vaname shrimp habitat seen from the water quality.

2. Material and Methods

2.1 Time and place
The study was conducted on May and August 2016. Water sampling was conducted in several locations, namely Ancol-Jakarta (sea water), Ciseeng-Bogor (karst water salinity), Ciampea-Bogor (fresh karst water), and Situ Gede Bogor (freshwater) (figure 1). sea water in the study was used as a positive control because it represents the habitat vaname shrimp, Ciseeng karst water in this study is used as a representative water karst having a value of high salinity, Ciampea karst water used in this study as a representative of the water karst not have salinits, while Situ Gedeis freshwater used as a negative control because it has a different character with shrimp habitat vaname.Water quality analysis was conducted at the Laboratory of Water Environment Productivity and the experiments were conducted in the laboratory of the Secondary Productivity, Ministry of Water Resource Management, Faculty of Fisheries and Marine Science, Bogor Agricultural University.

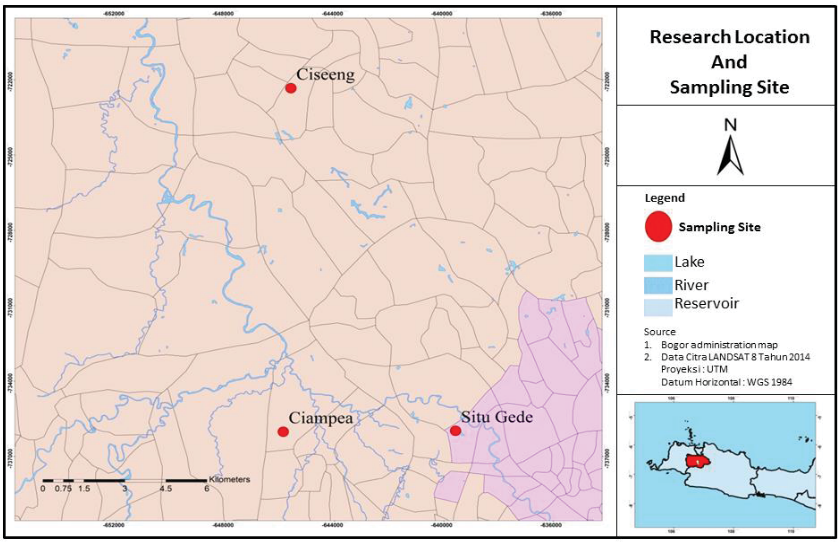

Figure 1 Research location and sampling site

2.2 Stages of Research
2.2.1 Karst water quality evaluation
Analysis was performed on each sample of the water source. Salinity and pH measurements were performed using a refractometer and pH meter. Furthermore, dissolved oxygen and temperature

measurements were performed using a DO meter, electrical conductivity (EC), total hardness, SO_4^- (sulfate), alkalinity, NH_3^- (ammonia), Ca, Mg, K, and H_2S [8].

2.2.2 Karst water quality treatment

Treatmentwascarried out by ozonation and aeration. Prior to ozonation and aeration, the water was filtered using a sieve with a mesh size of 25 microns. The water is then stored in separate containers. Water was treated with ozonation and aeration for 24 hours and left a few hours until the odor generated by ozone treatment disappeared. Analysis of water quality on the same parameters as in the evaluation phase carried [8].

2.3 Data analysis

The evaluation on the suitability of water quality conditions for vaname shrimp culture media was carried out by comparing the overall results of the analysis of quality of karst water to sea water as its natural habitat, as well as to the SNI (Standar Nasional Indonesia) 01-7246-2006 for vanameshrimp culture media. Differences in karst water quality before and after the modification were analyzed using t-test.

3. Results and Discussion

3.1 Physical and chemical conditions of the water

Results of water quality measurements Ciseeng and Ciampea karst waters that includes physics and chemistry of water compared with the seawater and Situ Gede. This is done to determine the characteristics of karst water Ciseeng and Ciampea. The results of measurements seawater quality, Ciseeng and Ciampea karst waters and water Situ Gede is presented in table 1.

Table 1. The quality of sea water, karst Ciseeng and Ciampea and water Situ Gede

Parameter	Unit	Water Source			
		Seawater	Ciseeng	Ciampea	Situ Gede
Physics					
Temperature	ºC	28,000±0,820	39,100±1,890	26,500±0,880	28,500±0,510
Conductivity	µS/cm	47740,00±1368,890	41972,500±2784,090	433,000±13,520	267,000±123,600
Chemistry					
Dissolved Oxygen	mg/l	4,400±0,320	0,275±0,150	4,500±0,260	4,050±0,240
Salinity	Ppt	33,250±0,960	33,250±0,960	0	0
pH	-	8,120±0,080	6,352±0,420	6,680±0,170	6,460±0,390
Hardness	mg/l $CaCO_3$	4103,900±622,580	8458,450±5262,32	84,080±30,840	62,560±18,590
Alkalinity	mg/l	186,00±5,160	1599,000±202,840	267,750±5,440	51,000±6,000
NH_3^-	mg/l	0,210±0,180	3,160±0,020	0,180±0,040	0,415±0,270
H_2S	mg/l	<0,001	<0,001	<0,001	<0,001
Ca	mg/l	652,460±99,470	2904,572±575,790	186,880±61,050	14,040±7,770
Mg	mg/l	907,460±78,400	354,181±9,440	3,870±1,280	2,670±0,220
K	mg$CaCO_3$/l	329,550±134,410	250,950±18,250	0,370±0,250	1,140±0,120
SO_4	mg/l	1234,620±132,920	8.360±0.26	5,270±0,760	8,470±0,520

Based on table 1 it can be seen that almost all parameters of Ciseeng karst water has higher value than the Ciampea karst water unless the value of dissolved oxygen and H_2S. Physical and chemical parameters of Ciseeng water tend to be similar to sea water, while Ciampea water tends to be similar to freshwater. This causes Ciseeng water is classified as water that has high salinity and Ciampea water is classified as freshwater or low salinity. The seawater has a salinity> 16 ppt, while freshwater has a salinity <0.5 ppt [9].

Ciampea and Ciseeng waters are potential for vanameshrimp living media. The Ciseeng water has salinity similar to salinity of vaname shrimp (*L. vannamei*) in their habitat, while Ciampea water has alkaline salinity similarity to the salinity in their habitat. However, to determine whether or the potential water of Ciseeng and Ciampea can be used as vanameshrimp (*L. vannamei*) living media, it is necessary to perform a comparison between physical and chemical water at Ciseeng and Ciampea with water quality for vanameshrimp (*L. vannamei*) by SNI 01-7246-2006.

3.2 Comparison of physical and chemical parameters of karst water with water quality for shrimp by SNI 01-7246-2006

The results of measurements of physical and chemical parameters of karst water at Ciseeng and Ciampea are compared to SNI-01-7246-2006 on quality standard of vaname shrimp living media. This is performed to determine the suitability of karst water quality at Ciseeng and Ciampea with tolerance range which is possessed by the vaname shrimp. Comparison results of karst water quality measurements of Ciseeng and Ciampea and SNI-01-7246-2006 were presented in table 2.

Table 2. Comparison of physical and chemical parameters of karstwater with water quality for shrimp by SNI 01-7246-2006

Parameter	Unit	Ciseeng karst water	Ciampea karst water	SNI 01-7246-2006
Temperature	ºC	39,100±1,890	26,500±0,880	28,500-31,500
Dissolved Oxygen	mg/l	0,275±0,150	4,500±0,260	>3,500
Salinity	ppt	33,250±0,960	0.00	15,000-25,000
pH	-	6,353±0,420	6,680±0,170	7,500-8,500
Alkalinity	mg/l	1599,000±202,840	267,750±5,440	100,000-150,000
NH_3^-	mg/l	3,160±0,020	0,180±0,040	<0,010
H_2S	mg/l	<0,001	<0,001	<0,001

Based on Table 2, it can be seen that almost all physical and chemical parameters of Ciampea and Ciseeng karst water do not correspond to the water quality for vaname shrimp (*L. vannamei*) based on SNI 01-7246-2006. This is because the karst water at Ciseeng and Ciampea is relatively poor to be uses as vaname shrimp breeding media. Therefore, Ciampea and Ciseeng karst water requires water quality modification to be used as vaname shrimp breeding media. Water quality modifications that can be performed are ozonation and aeration treatments. Ozonation treatment can decrease the value of alkalinity[10]. Other than that ozonation lowers the alkalinity value by 21.5% and increases the pH value by 5.2% [11]. While the aeration treatment can boost dissolved oxygen and lower the value of ammonia by 98% and reduce the alkalinity value of 69% on a liquid fertilizer [12,13].

3.3 Karst water quality modification

Karst water quality modification aims in order that karst water can be used for vanameshrimp (*L. vannamei*) preserving media. Modification to lower the temperature of the water is performed by placing the karst water in a room so it has room temperature. Meanwhile, modification to increase oxygen and pH and lower alkalinity and NH_3^- were performed by providing aeration and ozone for 24 hours. Comparison Results of karst water quality after the modification is presented in Table 3.

Table 3. The quality of sea water, karst water of Ciseeng and Ciampea and water of Situ Gede after modification

Parameter	Unit	Ciseeng karst water	Ciampea karst water	SNI 01-7246-2006
Temperature	ºC	27,15±0,129	27,250±0,058	28,500-31,500
Dissolved Oxygen	mg/l	5,15±0,129	5,200±0,183	>3,500
Salinity	Ppt	33,250±0,960	0.000	15,000-25,000
pH	-	8,0125±102	7,673±0,077	7,500-8,500
Alkalinity	mg/l	204,000±19,114	54,750±6,397	100,000-150,000
NH_3^-	mg/l	2,664±0,135	0,056±0,059	<0,010
H_2S	mg/l	<0,001	<0,001	<0,001

Karst water quality modification using ozonation and aeration in Table 3 indicates the change that approaches SNI 01-7246-2006 water quality standards for vanameshrimp.In karst water at Ciseeng, the parameters are changed significantly, those are temperature, dissolved oxygen salinity, pH, alkalinity, and NH 3 - ($p <0.05$). Karst water at Ciampea experiences real changes including dissolved oxygen salinity, pH, and alkalinity ($p <0.05$). However, the NH_3^- and temperature parameter decreases but is not significantly different ($p> 0.05$). Whereas H_2S parameter remains largely significantly better on Ciseeng karst water than on Ciampea karst water and still comply with the quality standards for vaname shrimp. Value of salinity, alkalinity, and NH_3^- which is possessed in Ciseeng and Ciampea karst water despite undergoing changes it remains not meet the quality standards for vaname shrimp. Salinity value that does not comply will cause the growth of shrimp to be slow because of the energy required for growth will be exclusively used for osmoregulation [14]. Meanwhile, if the value of alkalinity does not comply, it will cause disruption of the process of cells osmoregulation in the body due to lack or excess of calcium[15]. NH_3^- value that is too high can inhibit the growth of shrimp, in addition to the direct influence of NH_3^- content is high but not damaging lethal gill tissue. The sheets will swell gills (hyperplasia) so that the gills as respiratory function will be impaired in terms of the binding of oxygen from the water. High ammonia levels in the water can also increase the concentration of ammonia in the blood, thereby reducing the activity of blood (hemocyanin) in binding oxygen. Additionally, high levels of ammonia can also increase susceptibility for shrimp to get disease[16].

The high value of salinity and alkalinity on Ciseeng karst water can be lowered by way of dilution of freshwater or distilled water in order to obtain the appropriate salinity and alkalinity. Meanwhile, to increase the value of salinity and alkalinity in the Ciampea karst water to conform to the quality standards can be done by adding seawater. Ammonia values that are too high in all karst water can be reduced by performing aeration treatment.

4. Conclusion

Karst watersresources of Ciseeng and Ciampea a decent location used as a source of water for aquaculture vaname shrimp (*Litopenaeusvannamei*)development in inland areas far from the beach.

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