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Utilization of ciseeng karst water as vaname shrimp (*Litopenaeus vannamei*) culture media

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Abstract

Ciseeng karst water contains high mineral, it was potentially to be used as culture media of shrimp vaname (*Litopenaeus vannamei*). The aim of this study is to assess the feasibility of Ciseeng karst water as a vaname shrimp (L. *vannamei*) culture media. This research was conducted from September to October 2016. This research applied a complete randomized design with the water salinity as the treatments. There are 3 different Ciseeng water salinity values (10, 15, and 20 ppt) and a salinity control value (25 ppt) with 4 replications in every treatment. The shrimp vanname postlarva (0,01 grams) was used as experimental animal. The result shows that the medium salinity of 15 ppt gives the best result in vaname shrimp maintenance, with the survival rate accounting for 81,25 ± 17,97%, the specific growth rate of 8,93 ± 0,41%, and the production of shrimp by 18,26 ± 6,17 grams.

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Introduction

Indonesia is a country that has large water resources. Aquatic resources in Indonesia are not only marine waters but also inland waters. Inland waters are all water bodies located in the mainland (Suwignyo 2003). The inland waters in Indonesia is approximately 13.58 million ha which includes lakes, reservoirs, swamps, and rivers. In general, the utilization of inland waters by the community for the source of clean water, transportation activities, and fishery activities. The inland waters which have not been widely used for fishery activities are karst waters (Sukadi and Kartamihardja 1995).

The waters of karst are waters in the karst ecosystem or limestone areas. The karst waters have mineral content dominated by calcium (Ca), magnesium (Mg), and carbon (C). The mineral comes from the water-solubility activity (Karstifikasi) (Ekmekci 2005). One of karst waters located in Indonesia is Ciseeng karst waters located in Kec. Ciseeng, Kab. Bogor, West Java. Utilization of Ciseeng karst water by the community is still limited in the form of ecotourism activities. Ciseeng karst waters according to Wildan *et al.* (2017) have salinity, alkalinity and mineral values close to sea water. The waters which have many mineral contents can be used as a medium for bivalve and shrimp culture (Anacleto *et al.* 2016). One kind of shrimp that is used for the utilization of Ciseeng karst water is vaname shrimp (*Litopenaeus vannamei*).

Vaname shrimp by Bray *et al.* (1994) is a biota that has euryhaline properties that can be culture in high and low salinity waters such as lakes, rivers, swamps, and reservoirs. In addition, based on Ministerial Decree No. 78 of 2009, shrimp vaname (*Litopenaeus vannamei*) is designated as one of the leading fishery commodities in Indonesia. Vaname shrimp become superior commodity of fishery because it has several advantages such as: resistant to environmental change, disease resistance, high survival, faster growth, shorter maintenance time which is about 90-100 days per cycle, and feed saving and can be cultivated with a high dense stocking. Inland water shrimp cultivation activities can not only increase shrimp production but also provide other benefits such as opening employment, reducing transportation costs, due to the distance between farmers and consumers relatively close, shrimp can be presented in a fresh condition, and cultivation activities shrimp in fresh water can prevent shrimp from contracting the disease.

Vaname shrimp culture in low salinity waters with additions 50 ppm potassium (KCl) could increase the survival to 18.50% and growth value to 2,6% (Davis et.al. 2005). In Kaligis (2010), salinity decrease from 25 to 0 ppt resulted in total mortality, but with the additions 50 ppm calcium carbonate ($CaCO_3$) the survival of vaname shrimp reached 100% and addition of 41 ppm potassium carbonate (K_2CO_3) vaname shrimp had survival to 83% and specific growth rate to 11.24%. This proves that minerals, especially calcium and potassium are minerals needed by vaname shrimp (*Litopenaeus vannamei*), but if the results of research Davis *et.al.* (2005) and Kaligis (2010) applied for cultivation activities in low salinity waters, will require a large cost to meet the needs of minerals in shrimp. Therefore, it is necessary for water source which has mineral contents near high salinity water so that shrimp can live and grow well and its production cost becomes low.

Limited information on the utilization of Ciseeng karst water as a medium for shrimp culture causes a need for a review of it. This study aims to analyze the feasibility of Ciseeng karst water as a medium for shrimp vaname (*Litopenaeus vannamei*).

Materials and methods

Experimental design

The experimental design used in this study was a complete randomized design (CRD) with 4 treatments ie Ciseeng water salinity difference (10 ppt, 15 ppt, and 20 ppt) and control of 25 ppt sea water with each treatment having 4 replications.

Research Stages

Preparation Container

The container used is a glass aquarium measuring 30x30x30cm of 16 units, equipped with a thermometer and aerator.

In each experimental container, there was installed 1 unit of container where water for the treated medium was placed higher than the culture medium in order to facilitate the flowing of the treated water into each treatment container. Before use, all containers are washed with detergent, then disinfected with methylene blue. The container is then placed randomly according to the unit of experiment.

Media Preparation

Sea water and Ciseeng karst water prior to use as a vaname shrimp maintenance medium, filtered first by using sieve with 25-micron size. Then each of the 145 liters were put into a 70x50x40cm container. Furthermore, the water in each container was subjected to ozone and aeration treatment for 1.5 hours and allowed for several hours until the odor generated from the ozone treatment disappeared. After that the water is ready for use as a medium for the maintenance of vaname shrimp.

Test Animal Preparation

Postlarva 10 day old of vaname shrimp obtained from PT. Suri Tani Pemuka, Banten. The shrimp from spawning one parent to minimize the variation of the experimental unit. Prior to use, postlarva was acclimatized to laboratory conditions for 10 days from PL 10 to PL 20. Postlarva stocks of about 10000 individuals were incorporated into 2 60 × 30 × 40cm aquarium containers equipped with an aerator. Maintenance media in the form of salinity sea water 25 ppt. Feeding is done 3 times per day, the feed used in this study is commercial food shaped crumble brand Feng-Li with protein content to 40%.

Acclimatization

Acclimatization of vaname shrimp seeds in many media of karst water is done by each container in the form of aquarium size 30x30x30cm filled with sea water 25 ppt as much as 1 liter. Then postlarva shrimp vaname aged 20 days (PL20) included to the container as much as 20 individuals. After that addition of water. Addition of water for treatment A (water karst Ciseeng 10 ppt) is done by inserting water of Ciseeng karst with salinity of 9 ppt as much as 12,5 liter into container so water volume become 13,5 liter, then for treatment B (water karst Ciseeng 15 ppt) Was carried out by introducing Ciseeng karst water with salinity of 14 ppt as much as 12.5 liters into container so that water volume became 13.5 liters, and C treatment (Ciseeng 20 ppt karst water) was done by introducing Ciseeng karst water with salinity 20 ppt As much as 12.5 liters into the container so that the volume of water to be 13.5 liters, while for the K (25 ppt sea water) done by entering the sea water with salinity 25 ppt as much as 12.5 liters into the container so the volume of water becomes 13, 5 liters. The addition of water according to the treatment done gradually lasts for 4 days, by way of flowing water debit media according to treatment.

At the acclimatization stage for 4 days, vaname shrimp seeds were fed in the form of commercial food shaped crumble brand Feng-Li with protein content of about 40%. Feed is given 3 times a day.

Data retrieval

The parameters observed in this study include water quality (temperature, DHL, dissolved oxygen, salinity, pH, hardness, alkalinity, and ammonia) and vaname shrimp biology (survival, growth, and biomass production). Measurements of temperature, salinity, dissolved oxygen, and pH are carried out in situ every day. While the measurements of DHL, hardness, and alkalinity as well as ammonia are done in the laboratory and measured once a week. The measurements of all water quality parameters were performed according to the method of analysis according to APHA (2012). While taking data to determine the survival rate (SR) by shrimp observation every day during the experiment. Meanwhile, shrimp weight data was collected to calculate the specific growth rate (SGR) by weighing at the beginning and end of the experiment.

Data analysis

Data of parameters physical and chemical water and biology of vaname shrimp were analyzed statistically using a complete randomized complete ANOVA (RAL) design processed with SPSS (Statistical Product and Service Solutions) and Excel 2010 for Windows programs.

Then the data is analyzed further with Tukey test with the aim of knowing the difference between the middle variable value (Steel & Torrie 1991).

Determination of the best salinity was analyzed using matrix method. Matrix value obtained by multiplying weight value with score value. The acknowledgment that has the highest total matrix value is set as the appropriate treatment with the vaname shrimp culture media.

The weighting of each parameter is based on its effect on vaname shrimp. The parameters of survival, growth rate, and production are an indicator of the success of shrimp farming activities. The alkalinity, hardness and DHL parameters are included in the limiting factor (Davis *et al.* 2005), while the temperature, oxygen, pH, and ammonia parameters are included in the control factor.

Indicator of success is a marker that the activity is successfully implemented, while the limiting factor is the limiting factor in the life of the vaname shrimp, and the controlling factor is the factor affecting shrimp metabolism (Affandi & Tang 2003). Therefore the survival, growth rate, and production have a proportion of 13.3% each, while the alkalinity, hardness, and DHL each have 10% and the temperature, oxygen, pH, and ammonia have a proportion of 20 %. In order to get the whole value for easy calculation, the total weight of 100 is determined. Thus, the survival, growth rate, and production each weigh 13.3, while the alkalinity, hardness, and DHL each have a weight of 10, and temperature, oxygen, pH, and ammonia, each weighing 7.5. Scoring on each parameter are based on their authenticity with the vaname shrimp tolerance range based on SNI 01-7246-2006 (Indonesia National Standard).

A value of 3 is assigned to a parameter that has a value in the range of vaname shrimp tolerance based on SNI 01-7246-2006 (Indonesia National Standard) and value 1 for parameters having values outside the tolerance range.

Results and discussion

Results

Physics-Chemical Parameters of Water and Biology of Vaname Shrimp (L. vannamei)

Water quality has a huge contribution to vaname shrimp. The quality of water that is not in accordance with the needs of shrimp will cause its growth disturbed and even death. The results of observation of water quality in the form of physical and chemical parameters of water and shrimp biology in this study are presented in Table 1.

The results of observation physical-chemical water and biology of shrimp (Table 1) showed that salinity treatment had an effect on physical and chemical parameters of water and shrimp biology.

Physical and chemical parameters of water affected by salinity include DHL, pH, hardness, alkalinity, and ammonia (NH_3^-). Increased salinity in karst water treatment results in an increase in the value of DHL, pH, hardness, alkalinity, and ammonia. While on biological parameters, salinity increase is not accompanied by increased survival value, specific growth rate, and production.

Determination of Best Treatment

The best treatment as a vaname shrimp maintenance medium is determined by scoring method. The highest score total score is the best treatment. The results of different scores of salinities treatment are presented in Table 2.

Table 1. Results of observation of physical-chemical parameters of water and shrimp biology.

Parameter	Unit	Treatment			
		A*	B*	C*	K*
Physics water					
Temperature	°C	27,3^b±0,3	27,2^a ±0,2	27,20^a±0,2	27,3^b±0,3
Conductivity	µS/cm	17567^a±385	22079^b±440	26095^c±1660	33033^d±1925
Chemical water					
Oxygent	mg/L	4,4^a±0,4	4,4^a±0,4	4,4^a±0,3	4,4^a±0,1

Parameter	Unit	Treatment			
		A*	B*	C*	K*
pH	-	7,40^{a}±0,12	7,43^{b}±0,09	7,57^{c}±0,12	7,99^{d}±0,13
Hardness	mg/l $CaCO_3$	5880^{a}±796	6089^{a}±760	7048^{b}±912	8258^{c}±993
Alkalinity	mg/l $CaCO_3$	54^{a}±6	91^{b}±5	115^{c}±8	113^{c}±9
NH_3^-	mg/L	0,35^{a}±0,17	0,47^{b}±0,14	0,55^{b}±0,17	0,27^{a}±0,21
Biology of vaname shrimp					
Survival Rate	%	62,5^{a}±17,1	81,3^{a}±17,9	66,3^{a}±7,5	83,8^{a}±7,5
Specific Growth Rate	%	8,3^{ab}±0,5	9,00^{b}±0,9	7,3^{a}±0,4	9,1^{b}±0,5
Production	%	9,6^{a}±3,3	18,3^{b}±6,2	7,4^{a}±2,6	19,3^{b}±1,8

*Information: A = Ciseeng karst water 10 ppt, B = Ciseeng karst water 15 ppt, C = Ciseeng karst water 20 ppt, K = Seawater 25ppt.

Table 2. Results of differential scores of salinities treatment.

Parameter	Perlakuan			
	A*	B*	C*	K *
Temperature	22,5	22,5	22,5	22,5
Oxygen	22,5	22,5	22,5	22,5
pH	22,5	22,5	22,5	22,5
Alkalinity	20	30	30	30
Ammonia	22,5	22,5	22,5	22,5
Total Hardness	30	30	30	30
Conductivity	30	30	30	30
Survival Rate	13,3	39,9	13,3	39,9
Specific Growth Rate	26,6	39,9	13,3	39,9
Production	13,3	39,9	13,3	39,9
Total	223,2	292.2	204,9	299,7
Rank	2	1	3	

*Information: A = Ciseeng karst water 10 ppt, B = Ciseeng karst water 15 ppt, C = Ciseeng karst water 20 ppt, K = Seawater 25ppt.

Result of scoring based on Table 2 is known that treatment B (Air Ciseeng 15 ppt) becomes the treatment which has the biggest total value with value 292,2 and become the 1st rank. Treatment A (Air Ciseeng 10 ppt) has the second largest value with a value of 223,2 and becomes the 2nd rank. Furthermore, treatment C (Air Ciseeng 20 ppt) has the third largest value with a value of 204,9 and ranked 3rd.

Discussion

Effect of Treatment on Physical and Chemical Water Parameters

Treatments of different salinity cause some of physical and chemical parameters of water (conductivity, pH, alkalinity, and hardness) have different values. The differences in the values of some of the physical and chemical parameters of water caused by salinity are descriptions of the amount of salts dissolved in the water, whereas conductivity, hardness, and alkalinity are the parameters used to calculate the amount of minerals in some waters, thus increasing the value of the parameters as the salinity value increases. According to the statement (Stickney 1979; Boyd 1982), that salinity describes the number of solids in grams of salts dissolved in one kilogram of sea water and expressed in units of g / kg or ‰. There are 7 ions that are very influential in determining the salinity of waters, namely Na, K, Mg, Ca, Cl, sulfate and bicarbonate. Salinity causes a difference in pH value at each treatment because an increase in salinity value leads to an increase in the value of the alkalinity thus increasing the value of CaCO3 acting as a buffer or buffer, in accordance with Wheaton(1977) statement that alkalinity is the water's ability to support acid or aquatic capacity to receive Proton in natural waters, related to carbonate concentration (CO_3^{2-}), bicarbonate (HCO_3^-) and hydroxide (OH^-). The value of physical and chemical parameters of water although there are differences in values on some parameters between treatments, but still in the tolerance range for vaname shrimp except the parameters of alkalinity in treatment A (water karst Ciseeng 10 ppt) (Van Wyk and Scarpa 1999; Prapaiwong 2011; Suprapto 2005, Scarpa and Vaughan 1998; Adiwidjaya *et al.* 2008). The low alkalinity value of treatment A (Ciseeng 10 ppt karst water) is due to the dilution of Ciseeng karst water with fresh water, thereby reducing the Ca's mineral content held by karst water, in accordance with Kaligis (2010) stating that dilution aimed at decreasing salinity will cause the value of alkalinity decreases as a result of a decrease in the amount of miineral Ca.

Effect of Treatment on Biological Parameters of Vaname Shrimp (L. vannamei)

The biological parameters of vaname shrimp that include survival (SR), specific growth rate (SGR), and production, illustrate the ability of shrimp adaptation to environmental conditions. The best biological shrimp treatment is B treatment (Ciseeng 15 ppt karst water), because the water quality value is close to the control water quality value, although it has a lower salinity than the C treatment (Ciseeng 20 ppt karst). The lowest karst water treatment was a treatment (Ciseeng 10 ppt karst water), the condition was caused by water chemical parameters (alkalinity) that did not match the requirement of vaname shrimp. The value of alkalinity in this treatment is lower than the quality standard.

Adiwidjaya *et al.* (2008) states that the vaname shrimp tolerance range for alkalinity is about 90-150mg/L. The low alkalinity in treatment A (water karst Ciseeng 10 ppt) is caused by dilution with fresh water to obtain 10 ppt salinity. Dilutions aimed at decreasing salinity will cause the value of alkalinity to decrease as a result of a decrease in the amount miineral of Ca (Kaligis 2010). Low alkalinity values will affect the activity of osmoregulation and the replacement of the skin (molting) due to calcium for shrimp body osmoregulation needs reduced. In accordance with the study of Davis *et al.* (2005) who found that with the addition of calcium in the process of acclimatization of vaname shrimp seeds to low salinity can improve the survival of vaname shrimp seeds. The disruption of the osmoregulation system will affect the growth of vaname shrimp, since the energy required for growth will be used for osmoregulation activity so growth is slow (Affandi and Tang 2002). This condition is evidenced by the value of specific growth rate owned by treatment A is lower than other treatment (Table 1). Treatment C (water karst Ciseeng 20 ppt) has physical and chemical parameters of water that suits the needs of vaname shrimp, but has a lower biological parameter value than treatment B (water karst Ciseeng 15 ppt). The low value of biological parameters is due to the ammonia value of this treatment is greater than other treatments. Thus, it causes increased ammonia concentration in the blood and then decreases blood activity (hemocyanin) in oxygen binding (Tsai 2002). In addition, high levels of ammonia can also increase the vulnerability of shrimp to disease. Concentrations of ammonia in ponds that exceed 0.45 ppm can inhibit shrimp growth by up to 50%, while at levels of 1.29mg / L cause death (Tsai 2002). This is evidenced by the low survival rate and specific growth rate of vaname shrimp on the treatment.

Determination of Best Treatment

Matrix calculations give the result that treatment B (water karst Ciseeng 15 ppt) is the best treatment in life support and growth of vaname shrimp. This is because the biological value of treatment B approaches the control value so that treatment B has the greatest value. While the treatment is less appropriate as a medium for maintenance of vaname shrimp is treatment C (Ciseeng karst water 20 ppt), because it has a biological parameter value that is far from the control.

Conclusion

Ciseeng karst water can be used as a vaname shrimp (*Litopenaeus vannamei*) culture medium with culture media has salinity of 15 ppt.

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