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EFFECT OF RECIRCULATION SYSTEM ON WATER QUALITY AND SURVIVAL RATE OF BANGGAI CARDINAL FISH (*Pterapogon kauderni*)

Pengaruh Sistem Resirkulasi Terhadap Kualitas Air dan Survival Ikan Banggai Cardinal (*Pterapogon kauderni*)

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ABSTRACT

The Recirculation System is a method of raising fish in controlled containers to reuse used water after a physical and biological filtering process. One form of recirculation system is a multi layer filter. This research aims to determine water quality parameters and survival rates in the cultivation of the Banggai cardinal fish (*P. kauderni*) using a variation of a multi-layer filter recirculation system. This research activity was carried out for 1 month from February – March 2019 at the Cultivation Unit Laboratory of the Aquaculture Study Program-Pattimura University, Ambon. This research uses a recirculation container design with 2 system treatments and filter media used, namely dacron, activated charcoal, beach sand, bioball and mica ceramic. The data obtained was then analyzed using descriptive analysis, then the data was processed in Microsoft Office Excel 2010, presented in the form of tables and graphs. The results of this research show that the results of measuring the ammonia concentration obtained were that treatment B (Bioball, activated charcoal, dacron, and sand) could reduce ammonia more optimally with a concentration value in the last week of 0.3 mg/l and this treatment could maintain the survival of the fish. Banggai cardinal was around 66.67% better than the other treatments. It can be concluded that variations in the components of the multi-layer filter recirculation system in the treatment with a combination of bioball filters, activated charcoal, dacron and sand are able to reduce ammonia, as well as provide a better influence on water quality so as to increase the survival of the Banggai cardinal fish.

ABSTRAK

Sistem Resirkulasi adalah metode pemeliharaan ikan dalam wadah terkendali untuk menggunakan kembali air bekas setelah melalui proses penyaringan fisik dan biologis.

Salah satu bentuk sistem resirkulasi adalah filter multi layer. Penelitian ini bertujuan untuk mengetahui parameter kualitas air dan kelangsungan hidup pada budidaya ikan kardinal Banggai (*P. kauderni*) dengan menggunakan variasi sistem resirkulasi filter multi layer. Kegiatan penelitian ini dilaksanakan selama 1 bulan pada bulan Februari – Maret 2019 di Laboratorium Unit Budidaya Program Studi Budidaya Perairan Universitas Pattimura Ambon. Penelitian ini menggunakan desain wadah resirkulasi dengan 2 sistem perlakuan dan media filter yang digunakan yaitu dakron, arang aktif, pasir pantai, bioball dan mika keramik. Data yang diperoleh kemudian dianalisis dengan menggunakan analisis deskriptif, kemudian data tersebut diolah dalam Microsoft Office Excel 2010, disajikan dalam bentuk tabel dan grafik. Hasil penelitian menunjukkan bahwa hasil pengukuran konsentrasi amonia yang diperoleh adalah perlakuan B (Bioball, arang aktif, dakron, dan pasir) mampu mereduksi amonia lebih optimal dengan nilai konsentrasi pada minggu terakhir sebesar 0,3 mg/l dan ini Perawatan dapat mempertahankan kelangsungan hidup ikan. Banggai cardinal sekitar 66,67% lebih baik dibandingkan perlakuan lainnya. Dapat disimpulkan bahwa variasi komponen sistem resirkulasi filter multi layer pada perlakuan dengan kombinasi filter bioball, arang aktif, dacron dan pasir mampu mereduksi amonia, serta memberikan pengaruh yang lebih baik terhadap kualitas air sehingga untuk meningkatkan kelangsungan hidup ikan kardinal Banggai.

Kata Kunci	*Resirkulasi, Kelulusan hidup, Ikan Kardinal Banggai*
Keywords	*Recirculation, Life graduation, cardinal banggai fish*
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INTRODUCTION

Banggai Cardinal fish, whose scientific name is Pterapogon kauderni, is a marine fish endemic to the Banggai Islands, Central Sulawesi Province, and is not found anywhere else in the world. Local people call it "capungan" or "bibisan". However, with the booming trade in ornamental fish at quite attractive prices, these fish can also be found in other places, especially on the island of Bali (precisely around the Gilimanuk waters). Optimal/appropriate media quality or rearing environment are important factors in developing management and cultivating these species. To maintain good quality of cultivation media in ornamental fish rearing, a recirculation system is usually used so that water quality can be well maintained in cultivation activities. System recirculation is a system that reuses water that has been used by rotating the water continuously through a filter in a container (Fauzzia et al., 2013) so that this system is water efficient (Sidik, 2002; Djokosetiyanto et al., 2006; Prayogo et al. 2012), therefore this system is an alternative cultivation capital that uses water repeatedly and is useful for maintaining water quality (Djokosetiyanto et al, 2006). There are 2 types of recirculation systems, namely closed recirculation systems which recycle 100% of the water and semi-closed recirculation systems which recycle some of the water so that they still require additional water from outside (Sidik, 2002).

Some forms of simple recirculation systems are double bottom filters or now updated to become multi layer filters/filter components with more than two filter layers. This filter is generally a filter made of corrugated zinc plastic or fine wire. This filter creates a space between the filter and the bottom of the aquarium for clean water. By using materials such as sand, gravel, dacron, bioball and activated charcoal which will bind the contents of substances that are toxic to the biota inside.

Based on the results of research conducted by Sahetapy et al (2016), it was found that when keeping Blue Devil fish (*Chrysiptera cyanea*), a recirculating double bottom filter system with a composition of dacron and sand was able to reduce ammonia and increase survival by 90% compared to other compositions. It was deemed necessary to modify the filter components in the recirculation system for this reason, this research was carried out with the aim of finding out water quality parameters and survival rates when rearing Bangangan fish (P. kauderni) using variations of the multi-layer filter recirculation system.

RESEARCH METHODS

Time and Place of Research

This research activity was carried out from January - March 2019 at the Cultivation Unit Laboratory of the Aquaculture Study Program-Pattimura University, Ambon.

Research Design

This research used a Completely Randomized Design (CRD) using 2 treatments and 3 replications. The treatment of filter variations in a recirculation system is as follows:
Treatment A: No biological filter, only activated charcoal, Dacron and sand (Control)
Treatment B: Filter variations in the form of Bio ring, activated charcoal, Dacron and sand (Figure 1)
Treatment C: Filter variations in the form of Bioball, active charcoal, Dacron and sand

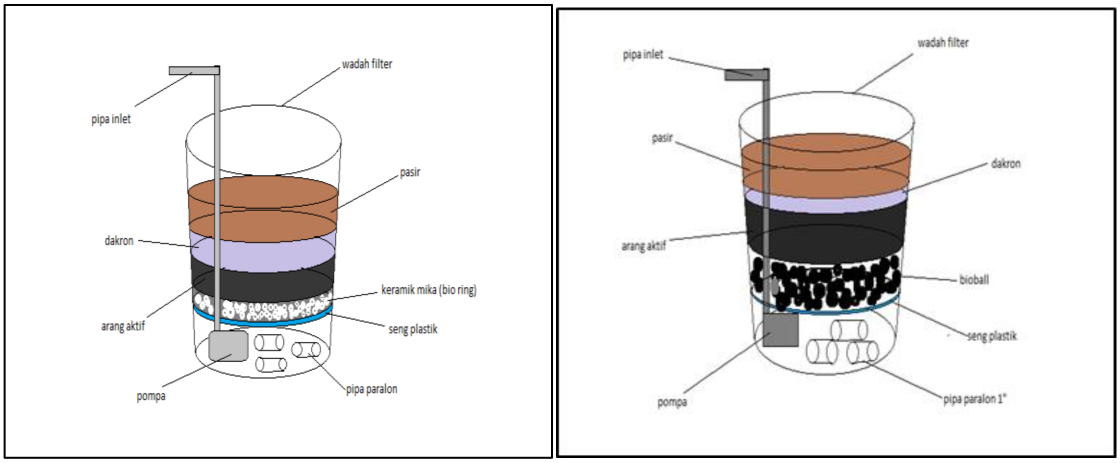


Figure 1. Variations in filter components in the recirculation system for treatments B and C

Materials and tools

The materials used in this research were Banggai Cardinal fish seeds, sea water, fresh water, Dacron, activated charcoal, bioball, bio ring (mica ceramic). The tools used are aquariums, buckets, paralon pipes, plastic zinc, aeration hoses, submersible pumps, thermometers, refractometers, DO meters, digital scales and writing instruments.

Research procedure

Container Preparation

The research container used was an aquarium measuring 30x30x30 cm, totaling 9 pieces, followed by assembling the recirculation system and arranging the filter media components in the container.

Test Fish Preparation

The Banggai Cardinal fish (P. kauderni) (Figure 2) was obtained from the Ambon Marine Cultivation Fisheries Center and 180 individuals were used, containing 20 individuals in each aquarium totaling 9 rearing containers. The fish were adapted to the containers for 1 week until their condition was stable and ready for use in research.

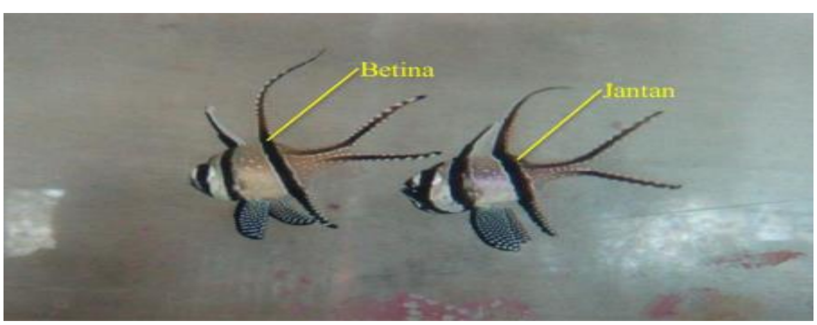


Figure 2. Banggai Cardinal Fish (*P. kauderni*)

Maintenance

The maintenance period is 1 month after previously carrying out acclimatization for 1 week. The fish were given food in the form of otohime pellets which were given for 4 weeks with a frequency of 2 times a day at ad satiation.

Observed Parameters

The parameters observed were ammonia concentration, survival rate and water quality parameters (temperature, salinity, pH and dissolved oxygen). The ammonia concentration was analyzed at the Ambon health laboratory

Survival Rate

Calculation of fish survival using the formula according to (Effendie, 1997):

$$SR = \frac{Nt}{No} \times 100$$

Information :

SR = Survival Rate (%)

Nt = Number of live fish at the end of rearing (ekor)

No = Number of fish at the start of rearing (ekor)

Data analysis

Data on ammonia concentration and survival rate of Banggai Cardinal Fish (P. kauderni) obtained were then analyzed using descriptive analysis, then these data were processed in Microsoft Office Excel 2010, presented in the form of tables and graphs.

RESULTS AND DISCUSSION

Ammonia

Ammonia is the main end product of protein breakdown in fish. Fish will digest the protein in the feed and excrete ammonia through their gills and feces. Ammonia in the cultivation environment also comes from the decomposition process of organic materials such as food waste, dead algae and aquatic plants (Duborow et al., 1997). The results of the research showed that measurements of ammonia concentration were carried out thoroughly in each treatment with 3 measurements in one month between the beginning, middle and end weeks where each treatment used a different multi-layer filter variation. From the measurement results it could be shown that treatment C (Bio ring, activated charcoal, dacron and sand) can reduce ammonia well, with a range between 0.3 mg/l in the first week, then 0.9 mg/l in the second week and 0.2 mg/l in the final week. Meanwhile, the results of measuring the ammonia concentration in treatment B (bioball, activated charcoal, dacron, and sand) ranged from 0.3 mg/l in the first week, 0.6 mg/l in the second week, and in the final week the results were 0.3 mg/l. Then in treatment A (control) the results ranged between the first week of 0.4 mg/l, the second week of 0.5 mg/l, and the last week of 0.4 mg/l (Figure 3).

From the results of measuring the ammonia concentration with variations in the multi layer filter components, it can be explained that treatment C had the lowest ammonia concentration results in the last week but this is not a determinant that treatment C can reduce ammonia optimally, this is because the ammonia concentration was measured in the second week. The concentration results obtained were very high with the number of deaths increasing. This can be indicated that the results of measuring the ammonia concentration in the last week had a low value because the number of fish had greatly reduced from the previous number due to death and the feed given was very small and resulted in a lack of metabolic product residues and leftover feed that had accumulated in the rearing container. Meanwhile, treatments A and B have different ammonia concentration values and the results show that treatment B can reduce ammonia to a concentration of 0.3 mg/l and this treatment can maintain the survival rate of Banggai Cardinal fish better than treatments A and C. This means that it can be explained that the absorption of ammonia content is better in the filtration treatment that uses bioball, namely treatment B with the following filter variations, namely bioball at the bottom, then the next layer is activated charcoal, dacron, and sand on the last or top layer.

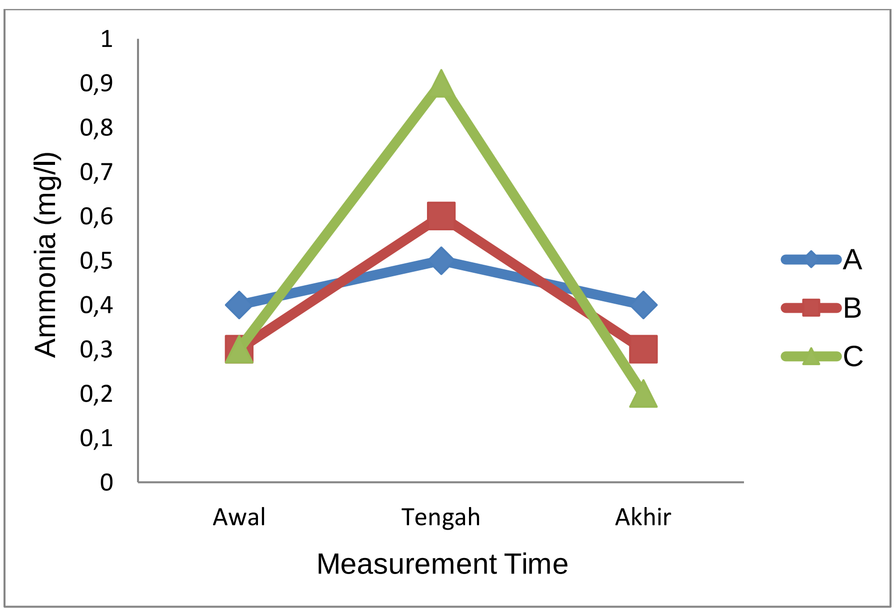


Figure 3. Ammonia concentration during the study

There are 2 forms of ammonia in water, namely ionized (ammonium, NH_4^+) and non-ionized (ammonia, NH_3). Unionized ammonia is dangerous for aquatic organisms, because it is toxic (Masser et al., 1999). The NH_3 value depends on the pH value and temperature of the water. The higher the temperature and pH of the water, the higher the NH_3 percentage (Boyd, 1990).

High concentrations of ammonia in the water will affect the permeability of fish by water and reduce ion concentrations in the body. Ammonia also increases oxygen consumption in tissues, damages gills, and reduces the blood's ability to transport oxygen (Boyd, 1982). The level of free, non-ionized ammonia (NH_3) in water media should be no more than 1 mg/l.

Bioball is a biological filter media whose working system uses microorganisms/bacteria that work simultaneously, that is, it not only acts as a filter but also as a medium or living place for microorganisms/bacteria (O-Fish, 2012). According to Cahyo (2011) Bioball is a very efficient ammonia absorber and also provides space for nitrification in the recirculation system. The point is that bioball functions to reduce ammonia and nitrogen with the help of nitrobacter so that bioball is able to filter small particles that dissolve in water. Meanwhile in variations other filters in treatment design B also help reduce ammonia according to their respective functions. For example, using activated charcoal / activated carbon which functions to absorb toxic substances in water or separate the ammonia content in water by absorbing these toxic substances. These toxic substances will be trapped in the charcoal pores and then the charcoal pores will absorb these substances until the amount of toxic substances will decrease (Ristiana et al, 2009). Activated charcoal works by absorption, which means that when a material passes through the activated charcoal, the material contained in that substance will be absorbed. So this activated charcoal is able to remove some of the bad content from polluted water with the function of simultaneously purifying the water, removing odors from the water, absorbing chlorine or chlorine in the water, and creating a fresh taste in the water.

Other filter variations such as dacron / polyethylene have very small and dense pores, this is because the material used to make dacron is made from synthetic fiber. Dacron has the function of filtering particles that dissolve in water. The advantage of Dacron is that it is known as a strainer or filter for aquariums, the material does not break down quickly, and is easy to wash. Then there is the final filter variation used in this research, namely sand. Sand is a filter media that is often used in cultivation water media. Sand functions as a water filter because sand is very effective in purifying water that is cloudy by substances dissolved in the water, filtering mud, sediment and other foreign particles, so sand can help reduce the ammonia levels in the water.

Of the several variations of filters used, each has its own function but can help reduce ammonia concentrations. The presence of high concentrations of ammonia in water can affect fish growth and can cause death of fish being kept. The range of ammonia obtained during the research for each treatment ranged between 0.2-0.9 mg/l, this shows that the various components of the multi layer filter recirculation system have proven to be quite effective in reducing nitrogen waste, in this case ammonia and the results obtained show that in the treatment B can reduce ammonia with results that are still within a reasonable range for the growth and survival of the test fish. According to Kordi (2004), a good water medium for fish cultivation is one that contains less than 1 ppm ammonia.

Water Quality Parameters

Water quality parameters during the maintenance period can be seen in table 1 below. It can be seen that the water quality parameters, including temperature, salinity, pH and DO, show values that are still within optimal limits for the life of the Bangangi cardinal fish in the aquarium. Temperature range values are 27.8-29ºC, salinity 33-35 ppt, pH 7.5-7.9 and DO 4.9-6.2 mg/l.

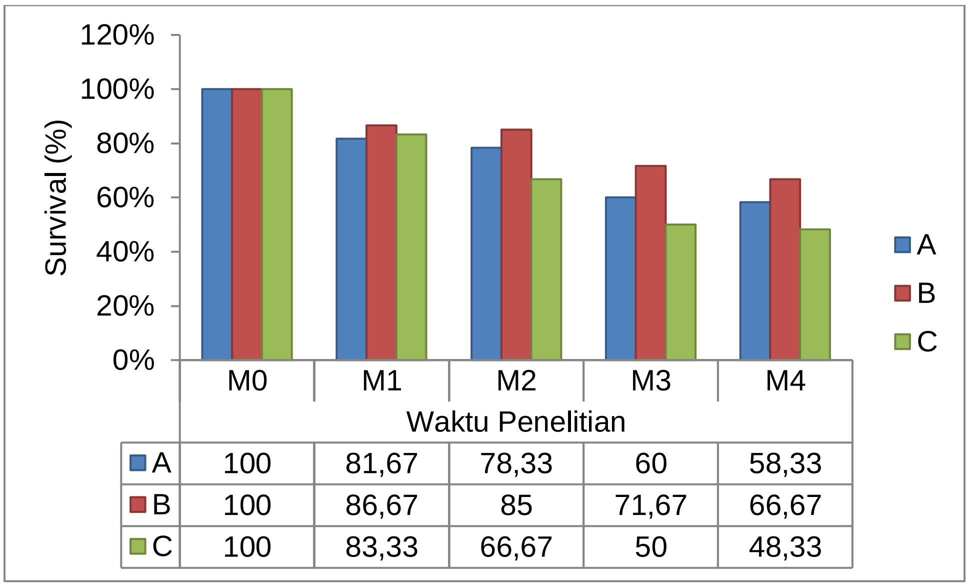
Table 1. Range of water quality parameters during the study

Parameter	Optimum	Treatment			Reference Source
		A	B	C	
Temperatur (^{0}C)	25 – 29	27.8 – 29	27.8 – 28.7	27.8 – 28.6	Boyd, 1991
pH	6 – 9	7.5 – 7.9	7.5 – 7.9	7.6 – 7.8	Wedemeyer, 1996
Disolved Oxygen (mg/l)	> 4, > 3	4.9 – 5.9	5.0 – 6.2	5.1 – 5.9	Boyd, 1991
Salinity (ppt)	30-35	33 – 35	33 – 35	33 – 35	Boyd, 1991

Based on the results of observations of the temperature in the rearing container using a multi-layer filter, it was found that it was still within the optimal value for the growth and survival of the Banggai cardinal fish. This is in accordance with Brotowidjoyo's (1995) statement that a good temperature range for cultivation is between 20 - 30°C. The same thing is also recommended by Boyd (1991) that a good temperature for keeping fish is between 25 - 290C. The average salinity measurement results during the maintenance period ranged from 33-39 ppt, this salinity range was still within optimal limits. According to Fujaya (2008), the salinity range for carrying out cultivation activities is around 24-40 ppt, for this reason, especially in the cultivation of the Bangai cardinal fish, it is able to survive at high salinity and According to Boyd (1991), seawater ornamental fish have an optimum salinity, namely at a salinity of 30 -35 ppt. Likewise, the pH range in this study is still within the tolerance limits for the growth and survival of the Banggai Cardinal fish. This condition is in accordance with Boyd's statement (1991), that normal water that meets the requirements for the life of aquatic organisms has a pH ranging between 6-9. Meanwhile, the measured dissolved oxygen value was 4.9-6.2, supported by Boyd (1991) recommending a good DO value for fish cultivation, namely □ 4 ppm, while Wedemeyer (1996) stated that a DO value of □ 3 ppm is good for growth and survival. live farmed fish. If we look at the DO value obtained during the research, it can be said that it is suitable to support the growth and survival of the test fish.

Survival Rate

One important factor in cultivation activities is survival. Survival or what is usually called by another name, namely survival, is the number of living organisms at the end of maintenance expressed as a percentage. The following are the survival results for rearing Banggai Cardinal Fish (P. kauderni) using a variety of multi-layer filter systems during the research period, which are shown in graphical form in Figure 4. During the period of rearing Banggai cardinal fish, it shows that the highest survival percentage at the end of the research was represented by treatment B, namely 66.67%. Fertility or survival will be high if the quality and quantity of feed and environmental quality are supportive. Factors that influence the survival rate of an organism include water quality, stocking density, nutrition and ability to adapt to the environment.



	M0	M1	M2	M3	M4
A	100	81,67	78,33	60	58,33
B	100	86,67	85	71,67	66,67
C	100	83,33	66,67	50	48,33

Figure 4. Survival of Bangi cardinal fish during rearing

CONCLUSION

Variations in the components of the multi-layer filter recirculation system with the composition of bioball, activated charcoal, dacron and sand (Treatment B) in the rearing of Bangangi cardinal fish (P. kauderni) are the best treatment in reducing the ammonia concentration to 0.3 mg/l until the end of the study so that it can increase maintenance media water quality. The application of variations in the multi-layer filter recirculation system in the rearing of the Banggai cardinal fish (P. kauderni) had a better effect on water quality so that treatment B was able to increase survival to around 66.67%.

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