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Filtration Systems in Fishery Aquaculture

Sistem Filtrasi Pada Budidaya Perikanan

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ABSTRACT

The fisheries cultivation process requires carrying capacity to maintain water quality in order to produce maximum results in the cultivation process. Fisheries cultivation is starting to spread on a small scale (urban farming) with the aim of independent food security. This requires a solution to maintain water quality which aims to increase growth, survival and prevent unpleasant aromas from emerging from cultivation activities. Maintaining water quality can be done by using filtration or recirculation systems in cultivation activities. This scientific article uses a library research method with a qualitative descriptive approach, namely using a content analysis method. Filter media is divided into mechanical (cotton, Dacron), biological (bio ball, ceramic ring), and chemical (activated carbon, zeolite stone). The use of various types of filter media affects water quality, growth and survival of fish. Using vegetables as additional filtration also affects water quality.

ABSTRAK

Proses budidaya perikanan memerlukan daya dukung untuk menjaga kualitas air agar menghasilkan hasil yang maksimal dalam proses budidaya. Budidaya perikanan mulai berkembang pada skala kecil (urban farming) yang dimana bertujuan untuk ketahanan pangan mandiri. Hal tersebut memerlukan solusi untuk menjaga kualitas air yang bertujuan meningkatkan pertumbuhan, kelangsungan hidup dan mencegah aroma yang tidak sedap muncul dari kegiatan budidaya. Menjaga kualitas air bisa dengan penggunaan filtrasi atau sistem resirkulasi pada kegiatan budidaya. Artikel ilmiah ini menggunakan metode studi kepustakaan (library research) dengan pendekatan deskriptif kualitatif yaitu dengan menggunakan metode analisis isi. Media filter terbagi dalam mekanis (kapas, dacron), biologis (bio ball, ceramic ring), dan kimiawi (karbon aktif, batu zeolite). Penggunaan berbagai jenis media filter berpengaruh terhadap kualitas air, pertumbuhan, dan kelangsungan hidup ikan. Penggunaan sayur sebagai filtrasi tambahan juga berpengaruh terhadap kualitas air.

Kata Kunci	*Kualitas air, Resirkulasi, Filter, Limbah, Budidaya*
Keywords	*Water quality, Recirculation, Filters, Waste, Aquaculture*
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INTRODUCTION

Limited land and water availability are problems in aquaculture activities, various cultivation systems have been developed to solve these problems by applying filtration systems using plants or other filter media to maintain the quality of cultivation water. Intensive fish farming can reduce water quality which affects physiological processes, including the growth and survival of farmed fish as a result of the accumulation of feed waste and metabolic products (Effendi et al., 2015). The accumulation of ammonia compounds from feed waste and metabolic products can be toxic, reducing the productivity and survival of farmed fish (Effendi et al., 2015; Marlina and Rakhmawati, 2016). Various metabolic processes that occur in the fish body play an important role in productivity and survival, influenced by various physical factors of water quality (Dauhan et al., 2014). Several physical factors that are water quality parameters in freshwater fish cultivation are pH (power of Hydrogen), DO (Dissolve Oxygen), ammonia, nitrate (Marlina & Rakhmawati, 2016).

In line with growth and survival, environmental factors can determine the rate of conversion of feed to biomass. Good water quality will increase appetite and feed intake (Setiawati et al., 2008). Good water quality will also influence the metabolic rate and energy assimilation for growth (Putra et al., 2011). In line with the research results obtained, it is that good water quality can increase growth through high conversion of feed into body biomass which overall affects the survival of farmed fish.

Recirculation is a system that uses water continuously by rotating it to be cleaned in the filter and then flowing back, so that this system is effective in using water (Prayogo, 2012). The success of a recirculation system depends on the effectiveness of the system in handling or processing cultivation waste, especially organic waste (Sasongko in Prayogo & Manan, 2012). Syafriadi Mann et al., (2005) stated that filter materials commonly used to improve water quality include sand, gravel, shell charcoal, palm fiber, lime slurry, alum, stone. Zeolite is the filter media most often used in recirculation systems. According to Silaban et al., (2012), zeolite is an aluminosilicate mineral compound which is known to have good adsorption capacity and has a cation exchange capacity of 200-300 cmolc/100 grams. There are various types of zeolites and one of them is the natural zeolite type clinoptilolite which has a high affinity for ammonia and has been successfully used as an ammonia cleaner in freshwater aquaculture systems.

The aquaponics system is one way to improve water quality and reduce water use for fish cultivation, so it is hoped that it can become an alternative method for controlling water quality so that it can increase the growth and survival of cultivated fish. In principle, the aquaponics system is an integrated system of plant cultivation systems (hydroponics) and aquaculture (Nugroho et al., 2012; (Wijaya et al., 2014; Hermawan, 2015). The main function of this system is to optimize water functions and water bioremediation using plants in fish farming systems (Nugroho et al., 2012).

Differences in filter systems, filter types and filter volumes will certainly influence water quality conditions during cultivation activities, which will influence the growth and survival of fish. Based on the description presented above, a comprehensive study was carried out to discuss various filtration systems in maintaining stable water quality in aquaculture activities.

METHODS

The writing and study method used in this research is a type of library research with a qualitative descriptive approach, namely using a content analysis method, which explains, compares and describes research results regarding filtration systems, water quality and fish farming activities. refers to scientific manuscripts in the form of journals, proceeding articles and books that have been analyzed. The data source used is a secondary data source, the extracted data is grouped appropriately to be compiled and displayed in a table to be discussed descriptively in the discussion section. The criteria for selecting articles and journals that will be reviewed are research articles in English and Indonesian, with the keywords recirculation, filtration system, water quality, fish cultivation, growth, survival. Articles that are appropriate and meet the criteria related to the theme to be reviewed.

RESULT AND DISCUSSION

The development of the aquaculture industry to increase production is limited by several factors, including limited water, land and environmental pollution. Water as a medium for raising fish must always pay attention to its quality. Intensification of cultivation through stocking densities and high feeding rates can cause water quality problems. Although fish eat most of the feed given, the largest percentage is excreted as metabolic waste (nitrogen). Efforts that can be made to overcome the above problems are to apply a recirculating aquaculture system.

Suraya et al., (2011) conducted research to measure the relationship between water quality and catfish growth in the budikdamber system. concluded that pH, Do, Temperature, Nitrate and phosphate simultaneously influence the dependent variables length and weight. Apart from that, based on the partial test (T test), it is known that all the variables pH, Do, temperature, nitrate and phosphate also partially influence the weight and length of the fish.

The filtration system is a technology that can be applied to improve water quality or maintain its carrying capacity so that fish continue to grow normally. Various filtration systems and innovations have been developed, below we discuss several journals and articles that discuss filtration systems in cultivation activities. This information is used to draw conclusions and suggestions regarding the most ideal filtration system applied to the budikdamber system. Below are summarized in table 1 several research results discussing filtration in fish farming activities

Table 1. Table of treatments, parameters and results of filtration system research activities in cultivation activities discussed in the review journal.

No	Writer	Treatment	Parameter	Results
1	Maksum	The use of different biofilter media a. bioring b. bioball c. bamboo	a. Survival rate (SR) b. Spesific Grouth Rate (SGR) c. Feed Convertion Ratio (FCR). d. Suhu e. pH f. DO	The use of different biofilter media had an effect on survival with the highest value in treatment C with the use of a bio ring filter of 86.67%, the specific growth rate was 1.15%. Treatment had no effect on the feed conversion ratio.

No	Writer	Treatment	Parameter	Results
2	Sari *et al*	Differences in filter media a. poribioball foam, activated carbon b. Dacron cotton, pumice stone, zeolite stone	a. growth b. total bacterial abundance c. survival rate. d. temperature e. pH f. TDS g. TSS	Different types of filters influence water quality and length growth of Siamese catfish seeds, while stocking density factors influence water quality, namely total ammonia. The best type of filter is a combination of pore foam-bioball-activated carbon
3	Wahbi *et al*	Differences in filter media a. without filters b. bioball, sand, charcoal c. zeolite, sand, charcoal d. gravel, sand, charcoal	a. Survival Rate b. Daily Growth Rate c. Absolute Weight Growth d. Temperature e. pH f. DO g. Salinity h. NH3	Differences in the use of different filters affect the survival and growth rate of vaname shrimp. Using bioball, sand and charcoal filters gives the best results.
4	Pratama *et al*	Differences in the percentage of zeolite filter media a. 25% zeolite and sand b. 50% zeolite and palm fiber c. zeolite 75% sand and palm fiber	a. Temperature b. pH value c. Dissolved oxygen d. Ammonia	The zeolite treatment of 75% sand and palm fiber had a real effect on survival rate, length growth and average weight gain. However, for the quality of the filtration water, there was no real difference between the three treatments applied
5	Prasetyo *et al*	Comparison of filter media a. gravel, palm fiber, sand b. zeolite, palm fiber, sand c. charcoal, palm fiber, sand d. bioball, palm fiber, sand	a. Temperature b. pH value c. Dissolved Oxygen d. Salinity e. NH3 f. NO2 g. NO3	The use of filter media with a recirculation system had a real influence on the growth of absolute weight, absolute length and survival but had no real influence on the daily growth rate.
6	Marsono *et al*	Comparison of a pool without a filter with a pool with a filter in an Arduino-based recirculation system	a. Do b. pH c. Ammonia d. Total bacteria	Pools that use ultraviolet filtration and sterilization are better than pools without using ultraviolet filtration and sterilization
7	Seran *at al*	Comparison of filters in the budikdamber system	a. Water physics (temperature, dissolved oxygen, turbidity, odor).	The addition of activated charcoal can help reduce ammonia levels and improve the quality of water for

No	Writer	Treatment	Parameter	Results
		a. kangkong and activated charcoal b. kale c. kangkong and filter	b. Water chemistry (pH value, Ammonia)	cultivating catfish in budikdamber media
8	Suraya *et al*	Comparison of catfish and ember farming	a. Water physics (temperature, Dissolved oxygen) b. Water chemistry (pH, Nitrate, Phosphate) c. Growth (length, weight) d. Life sustainability	pH, Do, temperature, nitrate and phosphate simultaneously influence the dependent variables of fish length and weight
9	Arya susatyo nugroho, Endah rita sulistya dewi, Maria ulfa	Development of recirculation and bioremediation system design with bioballs	-	Accelerate the nitrification process in bioremediation installations to support the fulfillment of vegetable nutritional needs

a. Various Filtration Systems

Various filtration systems can be used in cultivation activities, Pratama et al., (2020) regarding the differences in the influence of different filter media in recirculation on water quality, growth and survival of goldfish (*Cyprinus carpio*) stated that the ammonia value during the research showed optimal values for the growth of goldfish (*Cyprinus carpio*) where the ammonia value in each treatment ranged from 0.08 to 0.10. According to Syaifudin et al., (2004) in Hafiz, (2020); Effendi, (2003)in Arianto, (2019), the concentration of dissolved ammonia that can be tolerated well for fish survival is in the range of 0.04-3.01 ppm. Apart from that, Nurhidayat (2009) in Suandi (2019) also added that zeolite has the property of being able to absorb ammonia waste with a regular cavity structure and as a medium for attaching microorganisms (biofilm) which can utilize various elements suspended in water and be absorbed together as food for the organisms.

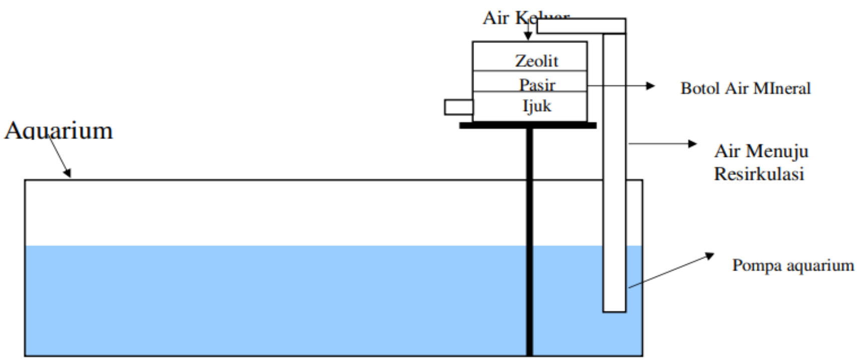

Figure 1. Recirculation System Construction (Pratama et al., 2020)

Marsono et al., (2023) in their research on the design of an ultraviolet filtration and sterilization system with an Arduino-based automatic control system said that efforts to improve water quality by adding UV-C light were considered quite effective. This can be proven by the fact that during the research several values were obtained. water quality such as the range of DO values during observations between 5.05 -6.73 mg/L, the DO value increases for each observation in pools that use ultraviolet filtration and sterilization equipment due to the recirculation system, namely the dropping of water from the filter produced by the installed pump machine in cultivation ponds. The value of ammonia content at the time of the study was 0.31 mg/L. Generally, an NH3 content of 0.05-0.20 mg/L can inhibit the growth of aquatic organisms.

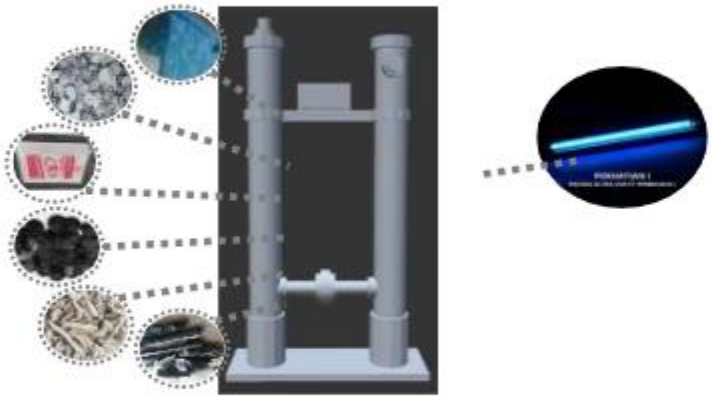

Figure 2. Design of an ultraviolet filtration system (Marsono et al., 2023)

The hardware for pond water filtration and sterilization tools with an Arduino-based automatic control system consists of 2 main chambers, where the first chamber is filled with filtration materials such as filters, coarse matt, zeolite rock, fine matt filter, bioball, rock. coral, and charcoal as active carbon, while in the second chamber there is an ultraviolet lamp with UV-C type light which is intended for sterilizing pond water. This filtration design system seeks to reduce residues from fish metabolism and disease. Disease is one of the obstacles in developing fish farming businesses and can cause economic losses for farmers. Poor water quality, excessive fish feeding and the content of bacteria, viruses and microorganisms in the water are factors that cause disease in fish. It can be concluded that on average Indonesian fish farmers still underestimate water quality. In fact, by maintaining water quality, farmers are able to reduce the death rate of fish due to water containing bacteria, germs, viruses and microorganisms that cause disease in fish, so that farmers' profits will increase. This problem can be overcome by implementing a recirculation system with the addition of filters and UV light. -C to filter and sterilize water with the aim of improving the water quality so that it can be reused.

Nugroho et al., (2022) in a monograph entitled circulation and bioremediation systems in environmentally based aquaponic technology, designed two filtration systems in aquaponics by utilizing a bioremediation process using bioballs, so that the nitrification process becomes more efficient and effective so that it is able to provide nutrients for cultivated plants, and is able to maintain water quality.

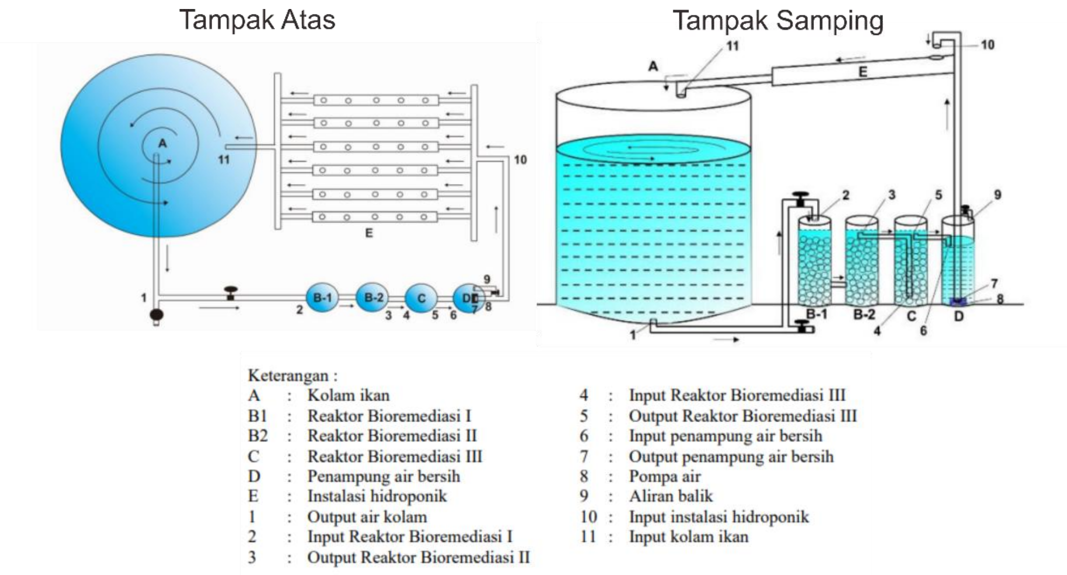

Figure 3. 1st Design of Aquaponic Technology (Nugroho et al., 2022)

Nugroho et al., (2022), stated that in this bioball there are millions of decomposer microorganisms, especially microorganisms that play a role in the nitrification process. Organic waste dissolved in the pool water will flow along the bioreactor tube and pass through the bioball which is full of decomposer microorganisms. When water flows through the bioball, the decomposer microorganisms work to break down organic waste that dissolves in water into simple inorganic materials, so that the water becomes clean again.

The main process that occurs is the nitrification process, namely the conversion of ammonia into nitrite, and then the nitrite is converted into nitrate. This process where water containing toxic organic waste is cleaned to become non-toxic again is called the bioremediation process. After the water undergoes bioremediation and becomes clean, the water will then flow into the output tube and then continue to the sump tank.

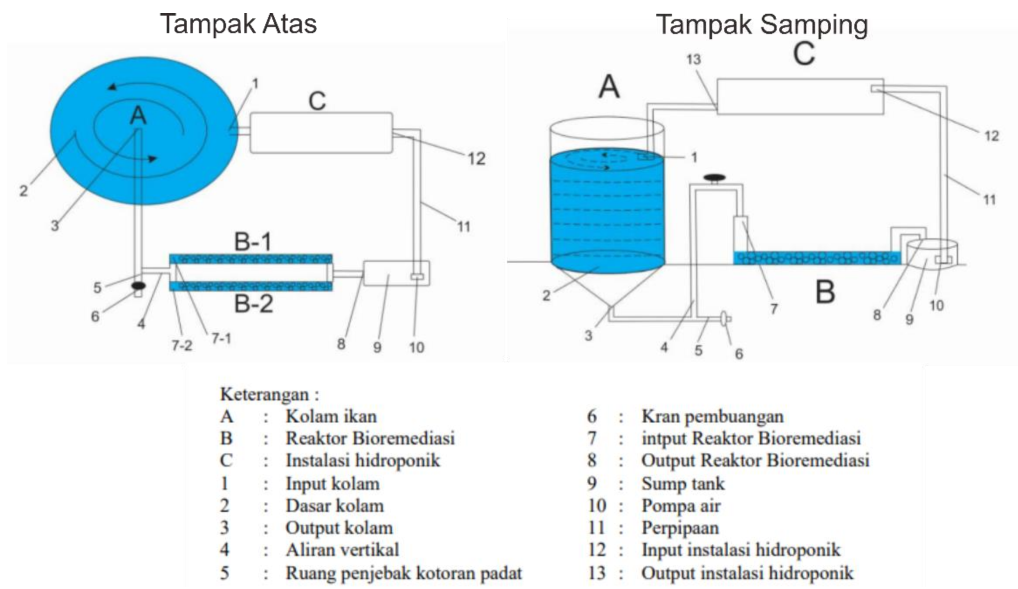

Figure 4. 2nd Design of Aquaponic Technology (Nugroho et al., 2023)

The aquaponic installations in the 1st design are arranged in series, while in the 2nd design they are installed in parallel. The development of an aquaponic circulation system includes the shape of the pond, the shape of the pond bottom, the direction of the flow of the pond input, the solid waste trapping space, and the solid waste disposal faucet. The development of the circulation system is as follows. Water enters the aquaculture pond through the pond input pipe. After some time, the water from the pool will come out through the pool output. The water that comes out of the pool output then enters the solid waste trapping chamber. From the dirt trapping room, water will flow vertically to the bioremediation installation, leaving solid dirt in the trapping room. After nitrification occurs in the bioremediation installation, the water then enters the sump tank. Water circulation from the pool input to the sump tank all relies on gravity. Next, from the sump tank, the water will be pumped to the hydroponic installation. From the hydroponic installation, the water will return to the pond through the pond input with the help of gravity.

b. Factors Affecting Filtration

The filtration process using sand and palm fiber provides optimal results, resulting in good water quality in the rearing media and feeding in quantities appropriate to fish growth. According to Mujiman (2002), growth rate is influenced by water temperature, feed supply, food composition, movement space, oxygen supply and metabolic waste products. This is thought to be an optimal filtering process that produces good water quality in the goldfish seed rearing media and with the increase in the amount of zeolite, the absorption of ammonia content decreases. This was confirmed by Mulyadi et al., (2014) who stated that the recirculation system can improve the quality of water in the rearing media which is very influential on fish life. Apart from water quality, there are other factors that support survival such as feeding.

Filtration is a system built to maintain optimal water quality during fish rearing in cultivation containers. Filtration works by separating a mixture of solids and liquids by passing bait (solids + liquids) through a filter medium, the bait flows due to a pushing force in the form of a pressure difference, for example, due to gravity or rotational force. In general, filtration is carried out when the amount of solids in the suspension is relatively smaller than the liquid (Oxtovy, 2016). To reduce the concentration of ammonia in water, the step taken is to add biofiltration to the recirculation system. A recirculation system is the most effective option for maintaining water quality by recirculating water that has been used continuously (Fauzia et al., 2013).

c. Filtration on Water Quality

Water quality is the main parameter as an indicator of the carrying capacity of water in carrying out fish rearing activities which is related to the growth rate and survival of fish. The larger the size of the fish, the higher the dissolved organic content in the waters which has a significant effect on the growth rate of the fish.

Marsono et al., (2023) stated that if the NH3 content is more than 0.2 mg/L, the water is toxic to several types of fish. The toxic level of ammonia (NH3) in pond water can kill fish at a limit of 0.1-0.3 mg/l, while at a concentration level of ammonia (NH3) between 0.6-2.0 mg/L it can only poison fish if brief contact occurs. From the results of tests carried out on ammonia (NH3) levels and bacterial content in water, the supporting water quality parameters observed include DO (Dissolved Oxygen), temperature, brightness, salinity and pH of the water, using a comparison method between pools without using filtration. and ultraviolet sterilization with pools that use ultraviolet filtration and sterilization, it can be concluded that the results obtained by pools that use ultraviolet filtration and sterilization are better than pools that do not use ultraviolet filtration and sterilization.

In the research of Prasetyo et al. 2018 stated that by using filter substrates of sand, palm fiber, gravel, zeolite, coconut charcoal and bioball. It was found that the range of ammonia values during the study was between 0.06-0.66 mg/L. The results of ammonia measurements in this study show that each filter material has its own performance in reducing ammonia levels originating from fecal waste and red tilapia feed residue. Where there are filter materials that are able to work optimally, but there are also filter materials that are not optimally capable. At low pH most of the ammonia will be ionized, while the higher the pH causes the ammonia to increase, because the ammonium compounds formed are not ionized and will be toxic to fish (Widayat et al., 2010). According to Boyd (1979) in (Manurung, 2018), the ammonia concentration that is safe for fish and aquatic organisms is less than 1 mg/L.

The range of nitrite values during observations was between 0.56-0.140 mg/L, the nitrite value for waters required in Government Regulation no. 82 of 2001 is < 1 mg/l. The range of nitrate values during observations was between 0.28-1.90 mg/L. From the results of nitrate measurements, it was found that the nitrate levels obtained during the research were still in accordance with standards referring to Government Regulation no. 82 of 2001, namely < 20 mg/L. Nitrate compounds, the final result of the nitrification process, are utilized by organisms and aquatic plants in the biosynthesis process which produces organic nitrogen. The nitrification process is greatly influenced by the parameters of temperature, dissolved oxygen, and pH, where high temperatures can affect the nitrification process (Widayat et al., 2010).

Serena et al., (2023) conducted research on the effectiveness of adding activated charcoal on the quality of catfish cultivation media in the budikdamber system. The research was carried out by adding 50 grams of charcoal to the bottom of the cultivation container (bucket).

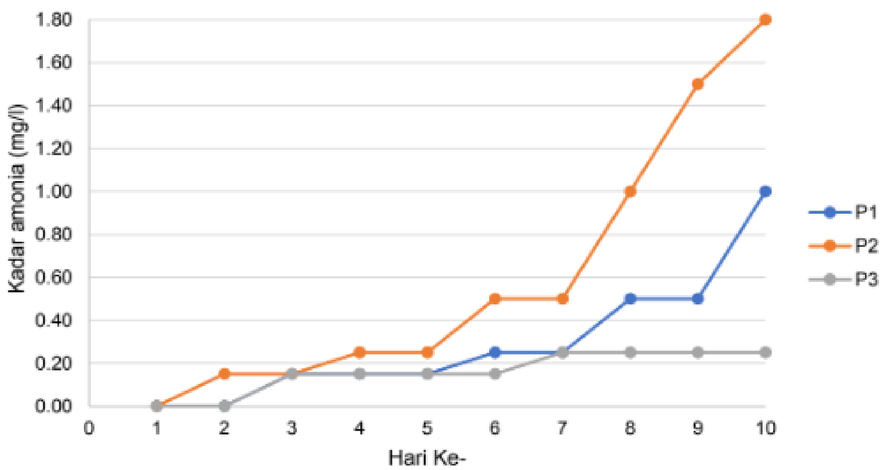

Figure 5. Graph of the results of measuring ammonia levels in the first 10 days before water changes (Seran & Salu, 2023).

The graphic image above shows that the Budikdamber + water spinach treatment with the addition of a filter (P3) can reduce ammonia levels in fish rearing water media until the day of the water change (day 10), while the use of activated carbon alone cannot reduce ammonia levels in fish rearing water media. fish.

d. Filtration on Cultivation Productivity

The use of various types of biological filters in the shrimp rearing system using bio balls, bio rings, and bamboo shows that the results obtained from using different biofilter media have an effect on the survival of giant prawns with the use of bio ring filters of 86.67%, and a specific growth rate of 1 .15% (Maximum, 2018). This is because the bioring treatment can reduce ammonia levels better than other treatments (bio ball and bamboo).

The recirculation system has three filtration systems, namely: mechanical, biological, and mechanical. Like research conducted by Sari et al., (2022) who used fish in this experiment were Siamese catfish which were tested with different filtration systems and different stocking densities (10 and 12 fish/L). Treatment: no filter (K), both porous foam filters-bioball-activated carbon (R1), and dacron cotton-pumice-zeolite filter (R2). The results obtained showed that the different filter types had an effect on the total ammonia content, the total reduction value of bacterial abundance, the growth in total length and standard length of Siamese catfish seeds, as well as the specific growth rate. The lowest TSS value was found in the R1 recirculation system. The best total ammonia reduction value was 0.14 ± 0.00% (R1.12) and the best total bacteria reduction value was 0.90 ± 0.09% (R1.12). The best specific length growth rate parameter was shown in the R1.12 treatment, both total length (2.97 ± 0.19%) and standard length (3.11 ± 0.21%) had better performance compared to the control aquarium. Water quality conditions, especially DO, support the survival of Siamese catfish seeds with the highest survival (95.25%) in the R1.10 treatment. Based on this, the best and most effective combination of filter types is pore foam-bioball-activated carbon (R1).

Vaname shrimp rearing has problems in its maintenance, such as decreasing water quality which has an impact on decreasing production results caused by leftover feed. Research conducted by Wahbi et al., (2022) examines how the combination and influence of different biological filtration systems has on the water quality of vaname shrimp rearing media. In treatment P1 without filter, P2 bioball, sand, charcoal, P3 zeolite, sand, charcoal and P4 gravel, sand, charcoal. The research results obtained were that the highest survival rate in the P2 treatment reached 78.66% and the lowest in the P1 treatment was 43.33%. The P2 growth rate provided the best daily growth rate compared to other treatments, namely 0.2117 g. In absolute weight, P2 got the highest weight, namely 6.35 g and had the lowest ammonia content, namely 0.10 mg/L.

CONCLUSSION AND SUGGESTION

The recirculation system with the application of filters is considered as a solution for sustainable and environmentally friendly cultivation activities. This system can be applied to various cultivation containers and locations. The filtration system is more often applied to cultivation systems with an urban farming concept on narrow land. Research regarding the most optimum, effective and efficient filtration system must continue to be studied in order to obtain a clear and measurable relationship between the filtration media used to maintain water quality in cultivation activities. In this literature review journal, the author only limits the study of the relationship between water quality and filter media on aquaculture activities. It is hoped that future research will be able to research further and specifically regarding the type, quantity and method of applying filter media in maintaining water quality in cultivation activities.

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