Minireview Article

The Effectiveness of the Red Water System (RWS) Technique in Cultivating African Catfish (*Clarias gariepinus*): A Minireview

ABSTRACT

This article aims to analyzed the effectiveness of the Red Water System Technique on the survival and growth of cultivated catfish from the conclusions of several previous researchers. The method used in this literature study is to review several research articles on the success of catfish farming using the red water system technique. The collected review data is then compiled into a manuscript. The result is that probiotics in the red water system technique can maintain water quality according to quality standards by utilizing nutrient levels in waters as a food source for bacteria *L.casei* and catfish have high growth rates due to the addition of probiotics to the waters, which makes them resistant to disease. In conclusion, the Red Water System technique has proven better growth performance, survival, digestibility, immunity, and disease resistance in the African catfish, compared to African catfish farming without using the RWS.

Keywords: African Catfish, Growth, Probiotics, Red Water System, Water quality

1. INTRODUCTION

The African catfish has the Latin name *Clarias gariepinus*. According to the database of introduced aquatic species at FAO and FishBase, African catfish was introduced to Indonesia in 1985 [1]. It has body characteristics that are smooth, slimy, without scales, and has extra arborescent respiratory organs. Catfish has a Blackish gray, depressed body, flat head, and four pairs of whiskers. Not only are African catfish included in the catfish group, but some fish are still in the catfish or grunt fish category, such as catfish, bass fish, and so on. Catfish can live in all freshwater waters with calm streams and are classified as omnivorous fish [2]. Data on the total production of catfish aquaculture in Indonesia in 2022 has estimated 343,414 tonnes, which has increased by 0,14% from 2021 [3]. With the increase in catfish production per year, that means catfish is a fish in great demand by the people of Indonesia. The nutritional content contained in 100 g of catfish is 78,5 grams of water, 90 grams of calories, 18,7 grams of protein, 1,1 grams of fat, 15 grams of calcium, 260 grams of phosphorus, 2 grams of iron (Fe), 150 grams of sodium, 0 g thiamin, 10 g, and niashin 2 g [4]. Apart from its high nutritional content, catfish is easy to process, has a delicious taste, and has a relatively affordable price [5]. Due to high consumer interest, there are more and more catfish cultivators to meet the needs of the Indonesian people. The local catfish species in Indonesia is *Clarias batrachus*, but those commonly cultivated are African catfish (*Clarias gariepinus*), Sangkuriang catfish, and Paiton catfish (*Clarias* sp.) [6]. The specific growth rate of African catfish is affected by the genetics and physiology of African catfish, also a supportive environment, water quality, and feed used. Certain growth limits (carrying capacity) of fish be affected by water quality, fish feed, and the size of African catfish [7].

Several ways of cultivating catfish that are applied in Indonesia are the biofloc system, aquaponics, booster, Recirculating Aquaculture System (RAS), Green Water System (GWS), and Red Water System (RWS). The RWS is a catfish farming technology that utilizes the fermentation of *L. casei* bacteria and the fungus *Saccharomyces cerevisiae* during rearing. RWS is an application of adding probiotics to intensive catfish farming [8]. This addition causes the decomposition of organic matter in ponds resulting in lower ammonia concentrations than in ponds without probiotics [9]. Giving probiotics also has a positive effect on water quality (Dissolved Oxygen (DO), ammonia (NH_3), nitrite (NO_2^-), and nitrate (NO_3^-)) so that it can support the survival of catfish. Probiotic microorganisms can also oxidize ammonia thereby reducing the amount of ammonia in aquaculture ponds [10]. Probiotics have beneficial properties to improve the microbial balance in the intestinal tract of African catfish which can facilitate the digestion of fish [11].

The advantages of this system are that there is no need for water changes during cultivation activities, high stocking density, easy maintenance of aquaculture, cost-effective feed, and increased resistance of catfish to disease, probiotics in this system also increase fish response to disease, and improve the quality environment [12], utilizing bacteria to increase fish digestibility, inhibiting the growth of pathogenic bacteria until satisfactory results are obtained [13]. Some of the weaknesses of the RWS technique are the need to wait several days for probiotic fermentation, the possibility of failure of probiotic fermentation, uneven spread of bacteria, and rainwater that goes directly into the pond causing an acidic pH. These deficiencies can be anticipated by ensuring the ingredients in the manufacture of probiotics are following the dosage and type, followed by adding aerators to the aquaculture ponds. This article aims to look at the effectiveness of the Red Water System Technique for the survival of cultivated catfish.

2. METHODOLOGY

The analysis was carried out in 2023. The analytical method used was in the form of literature studies both domestically and abroad related to catfish farming using the Red Water System technique. Use relevant search keywords such as "cultivation"; "catfish"; "fish probiotics"; "catfish growth"; "red water systems". As well as collecting literature from various sources such as Google Scholar, Elsevier, ScienceDirect, and Research Gate. With a systematic review method, which combines several previous primary research results to obtain accurate and clear facts.

3. RESULTS AND DISCUSSION

3.1 CATFISH WATER QUALITY

The quality standards for catfish farming water according to Government Regulations number 22 of 2021 [14] and the National Standardization Agency (SNI) 6484.3: 2014 [15] can be seen in Table 1.

Table 1. Aquaculture water quality for catfish

According	Parameter	Unit	Range
fNational Standardization Agency 6484.3:2014	Brightness	cm	25-30
	Ammonia (NH_3)	mg/L	Maximum 0,1
	Dissolved Oxygen (DO)	mg/L	Minimun 3

Government Regulations number 22 of 2021	Temperature	℃	25-30
	pH	-	6,5-8
	Ammonia (NH_3)	mg/L	0,2-0,5
	Dissolved Oxygen	mg/L	3-4
	Temperature	℃	26-30
	pH	-	6-9

3.2 RED WATER SYSTEM (RWS)

The quality of the red water system meets the standard requirements for fish culture water quality in PP number 22 of 2021 and can be seen in Table 2.

Table 2. Water quality standards for catfish farming with RWS*

No	Parameter	Unit	Range
1	Brightness	cm	27-30
2	Ammonia	mg/L	0,5-5
3	*Dissolved Oxygen*	mg/L	0,3-4,7
4	Temperature	℃	25,1-30,2
5	pH	-	7,1-9,2

***[16]**

3.3 PREVIOUS RESEARCH

Several researchers have conducted research on catfish (*Clarias* sp.) farming using the Red Water System (RWS) technique and different treatments with various catfish growth results. The following results from various studies can be seen in Table 3.

Table 3. Cultivating catfish using RWS techniques and different treatments

No	Type of Catfish	Treatment	Result	Reference
1.	*Clarias* sp.	A: RWS 7,5 µl/L/week no probiotic. B: no probiotic RWS. C: with probiotic RWS 7,5 µL/L/week. D: with probiotic RWS 10 µL/L/week. E: with probiotic RWS 12,8 µL/L/week.	The lowest ammonia, nitrate and phosphate values were obtained in the aquaponic experimental group with RWS 10 µL/l/week (Treatment D). Treatment D had the lowest average ammonia of 0,50 ppm, nitrate reduction of up to 60,78% and temperature and pH remained relatively unchanged.	[8]
2.	Channel Catfish *(Ictalurus punctatus)*	A = no probiotic *Bacillus velezensis.* B = with strain *B. velezensis* AB01. C = with strain *B. velezensis* AP79. D = with strain *B. velezensis* AP143.	Catfish fed *B. velezensis* AP193 experienced a growth increase of 40,4% compared to the control feed on catfish fry, each of which came from aquariums or raceways. Water quality was improved where fish were treatment fed with probiotic modified feeds, as reductions in total	[17]

		E = with strain *B. velezensis* AP193	phosphorus / TP (19%), total nitrogen / TN (43%) and nitrate (75%).	
3.	African Catfish (*Clarias gariepinus*)	Observation of average survival with stocking density: A = 250 head/m^3 B = 500 head/m^3, and C = 750 head/m^3	The best treatment was a stocking density of 250 head/m^3 with an average survival rate of 88,5% (B=74,3% and C=82,9%) and a daily growth rate of 7,25% body weight/day (B= 7,15% and C = 6,91%). Water quality is still in the temperature tolerance range of 27,3-30,9 °C, pH 8,28-8,61, DO 1,41-5,68 mg/L, ammonia 0,3-3,5 mg/L. However, from an economic point of view, it is better to use a stocking density of 750 individuals/m^3 because each treatment has slight differences.	[18]
4.	African Catfish *(Clarias gariepinus)*	Capacity density: A = 250 head/m^3 B = 500 head/m^3, and C = 750 head/m^3 Look for the highest protein retention and energy retention	The results obtained did not have a significant effect on protein retention and fish energy retention. The highest yields were in treatment B (500 individuals/m^3) of 44,94% and 39,70%, the lowest yields were in treatment C (750 individuals/m^3) namely 37,72% and 33,03%. Water quality is quite optimal. The temperature range of all rearing ponds in this study was 26,5-28 °C. Dissolved oxygen (DO) is between 0,2-6,5 mg/L in the morning and 0,3-10 mg/L in the afternoon. The average pH is 7,5 – 9.	[19]
5.	African Catfish *(Clarias gariepinus)*	Treatment A = 250 head/m^3 Treatment B = 500 head/m^3 Treatment C = 750 head/m^3	The higher the stocking density, the lower the total bacterial density. The water quality during the study was still in the tolerance level for catfish. However, from an economic point of view, it is better to use a stocking density of 750 individuals/m^3 because each treatment has slight differences.	[20]
6.	African Catfish *(Clarias gariepinus)*	Treatment A = 250 head/m^3 Treatment B = 500 head/m^3 Treatment C = 750 head/m^3	The highest protease activity was in treatment C, but inversely proportional to the highest growth rate in treatment A. Treatment A had a growth rate of 7,23% body weight/day and protease enzyme activity of 55,93 U/mL. treatment B = 7,14% body weight/day and 60,08 U/mL. treatment C = 6,89% body weight/day and 75,15 U/mL. The water quality during the study was still within the tolerance limits of catfish. However, from an economic point of view, it is better to use a stocking density of 750 individuals/m^3 because each treatment has slight differences.	[21]
7.	Basa (*Pangasius bocourti*)	Probiotic diet for 60 days without probiotics and with a mixture of 6 strains of *Bacillus* spp. different:	A significant increase in body weight, growth rate and feed conversion ratio compared to without probiotics. Humoral & cellular immunity was higher in the probiotic-treated fish. Has a higher survival rate than control fish	[22]

	S.lutetiensis L7c, *L. paraplantarum* L34b-2, *L. plantarum* L42g, *B. amyloliquefaciens* B44v, *Bacillus* sp. B51f, and *B. aerius* B81e	after injection with virulent *A. hydrophila*. *B. aerius* strain B81e and *L. paraplantarum* strain L34b-2 significantly increased innate immunity, growth performance, and disease resistance of *P. bocourti*.

After some of the research results of previous researchers were obtained, three types of fish were still classified as catfish as a comparison with one another, namely African catfish (*Clarias gariepinus*), Basa (*Pangasius bocourti)*, and American catfish *(Ictalurus punctatus)*. Using the RWS technique with various additional treatments such as catfish stocking density, probiotic composition given, and the type of catfish strain used.

Probiotics are one of the solutions to maintain water quality by cultivation standards because they contain bacteria that can increase the conversion of nitrite to nitrate [23]. Probiotics can regulate the microbial environment in the fish gut and inhibit pathogenic microbes in the gut and can increase feed efficiency in fish [24]. Probiotics that are commonly used in the Red Water System Technique for African catfish cultivation are Bacillus, Lactobacillus, Streptococcus, and Nitrosomonas types.

Cultivating catfish using the RWS technique can also reduce the nutrient content in aquaculture waters, namely the average ammonia level is 1,43 mg/L, it can reduce nitrate by 67,89%, it can reduce Total Phosphate by 19%, and Total Nitrogen by 43%. Bacillus and Nitrosomonas bacteria in decomposing organic matter in waters are said to be very effective so that they can produce water quality in African catfish cultivation that remains stable. Bacillus is used to improve water quality in cultivation media [25]. High survival rates and growth rates are due to good water quality and are suitable for fish life so that fish will grow and develop optimally. Water quality greatly affects the survival and growth of fish [26]. Continuous provision of probiotics can help provide suitable aquatic ecosystem conditions in terms of efficient absorption of fish feed and nitrification processes in the waters [10]. The average survival of African catfish with the RWS technique was 81,9%, the growth rate was 7,1% body weight/day and experienced a relative growth increase of 40,4% compared to not using the RWS technique.

The use of probiotics can reduce toxic levels in water and can reduce diseases caused by pathogenic bacteria [27]. Large microorganisms from probiotics can oxidize ammonia. Bacteria in carrying out the process of photosynthesis also use ammonia as a nitrogen source for the decomposition process of organic matter as well as its growth and development. The water quality results obtained from several previous studies were still at a fairly good quality standard by the specified catfish cultures' water quality standards, such as an average temperature of 26 °C, pH 8, and Dissolved Oxygen (DO) obtained between 1-6 mg/L. Cultivating African catfish without the RWS system and probiotics produces African catfish that increase in length and gain in weight slower or smaller. This is presumably due to the low levels of DO in aquaculture waters. Low DO levels can cause stress on African catfish. So that catfish appetite will decrease. The probiotic solution contains lactic acid bacteria namely *Lactobacillus* sp. so the pH in RWS technique cultivation starts from acidic or low [28].

From the presentation of the table above it can be seen that catfish farming using the RWS technique can improve growth performance, increase fish survival, increase fish digestibility, and increase immunity and disease resistance in African catfish. This does not only apply to

one species of catfish, but applies to all groups of catfish, both American catfish, African catfish, and sea bass which are relatives of catfish.

4. CONCLUSION

Based on the results obtained from various literature regarding catfish farming using the RWS technique, the Red Water System technique has proven better growth performance, survival, digestibility, immunity, and disease resistance in the catfish, compared to catfish farming without using the RWS. The successful application of the RWS technique must also be equal to the success of the fermentation process in making probiotics and supported by water quality that is still within the tolerance limits of catfish. It is recommended in future research to focus on research on differences in the immune system of African catfish cultivated with the RWS system and not, as well as ways to prevent and deal with failed probiotic fermentation.

REFERENCES

[1] FAO. Database on Introduction of Aquatic Species. 2013. Accessed on the 9th May 2023. Available: http://www.fao.org/fishery/introsp/search/en

[2] Manik RR, Handoco E, Tambunan LO, Tambunan J, Sitompul S. Socialization of Catfish (*Clarias* sp.) Using Semi-Artificial Spawning in Aras Village, Batu Bara Regency. Mattawang: Jurnal Pengabdian Masyarakat. 2022 Mar 20;3(1):47-51.

[3] Asianto AD, Wulansari RE, Malika R, Rahadian R, Pribadi DM. R Release of Marine and Fisheries Data for Quarter I – 2022. Directorate of Conservation and Marine Biodiversity, Directorate General of Marine Spatial Management. 2022

[4] Apriyana I. Effect of adding catfish head flour (*Clarias* sp) in making cilok on protein content and organoleptic properties. Unnes Journal of Public Health. 2014;3(2).

[5] Wiryati G, Tsalasa IN, Danapraja S. Increasing Income from Catfish Growing Business Through Application of Probiotics in Pellet Feed in Pagelaran District, Malang Regency, East Java Province. In Proceeding Of Indonesian Fishery National Seminar 2022 Dec 27 (pp. 267-280).

[6] Farikhah. Types of Catfish Cultivated in Indonesia. University of Muhammadiyah Gresik. 2016

[7] Maryam S. Super Intensive Cultivation of Red Tilapia *Oreochromis* sp. with Biofloc Technology: Water Quality, Survival and Growth Profiles. 2010

[8] Zahidah, Dhahiyat Y, Andriani Y, Sahidin A, Farizi I. Impact of Red Water System (RWS) Application on Water Quality of Catfish Culture Using Aquaponics. In IOP Conference Series: Earth and Environmental Science 2018 Mar 1 (Vol. 139, No. 1, p. 012009). IOP Publishing.

[9] Aquarista F, Subhan U. Administration of Probiotics With Zeolite Carrier on African Catfish (*Clarias gariepinus)* Rearing. Journal of Marine Fisheries. 2012 Dec 1;3(4).

[10] Hartini S, Sasanti AD, Taqwa FH. Water Quality, Survival Rate and Growth of Snakehead *Channa striata* Maintained In Media With Addition of Probiotics. Jurnal Akuakultur Rawa Indonesia. 2013;1(2):192-202.

[11] Fuller, R. A Review, Probiotics In Man and Animals. J Appl Bacterial, 1987;66:355-37

[12] Verschuere L, Rombaut G, Sorgeloos P, Verstraete W. Probiotic bacteria as biological control agents in aquaculture. Microbiology and molecular biology reviews. 2000 Dec 1;64(4):655-71.

[13] Yulvizar C, Dewiyanti I, Devira CN. Selection Of Bacteria With Probiotic Potential From Indigenous Jantho Goldfish (*Cyprinus carpio*) Based on In Vitro Antibacterial Activity. Jurnal Teknologi dan Industri Pertanian Indonesia. 2014 Jun 1;6(2).

[14] Regulation of the Government of the Republic of Indonesia Number 22 of 2021 About Implementation of Environmental Protection and Management.
[15] National Standardization Agency of Indonesia. African Catfish (*Clarias* sp.) Part 3: Mother Fish Production. 2014
[16] Febrianto S. The Effect of Using the Red Water System RWS Technique on Water Quality in Dumbo Catfish (*C. gariepinus)* Seeds with Different Stocking Densities (Doctoral dissertation, Universitas Brawijaya). 2015
[17] Thurlow CM, Williams MA, Carrias A, Ran C, Newman M, Tweedie J, Allison E, Jescovitch LN, Wilson AE, Terhune JS, Liles MR. *Bacillus velezensis* AP193 Exerts Probiotic Effects In Channel Catfish (*Ictalurus punctatus*) and Reduces Aquaculture Pond Eutrophication. Aquaculture. 2019 Mar 30;503:347-56.
[18] Wijaya, H. Effect of Different Stocking Densities on Survival and Growth Rate of Dumbo Catfish (*Clarias gariepinus*) using the Red Water System technique (Doctoral dissertation, Universitas Brawijaya). 2015
[19] Merdekawati, S. The Effect of Using the Red Water System (Rws) Technique on Protein Retention and Energy Retention in Dumbo Catfish Seed (*Clarias gariepinus*) With Different Stocking Densities (Doctoral dissertation, Universitas Brawijaya). 2015
[20] Irfandi, Y. Identification of Bacterial Density in Dumbo Catfish (*Clarias gariepinus*) Seed Cultivation Media Using the Red Water System RWS Technique at Different Stocking Densities (Doctoral dissertation, Universitas Brawijaya). 2015
[21] Siskharini, D. The Effect of Using the Red Water System (RWS) Technique on Protease Enzyme Activity in Dumbo Catfish (*C. gariepinus*) Seeds with Different Stocking Densities (Doctoral dissertation, Universitas Brawijaya). 2015
[22] Meidong R, Buatong A, Nakao M, Sakai K, Tongpim S. Mixed Culture of *Bacillus aerius* B81e and *Lactiplantibacillus paraplantarum* L34b-2 Derived From In Vivo Screening Using Hybrid Catfish Exhibits High Probiotic Effects on *Pangasius bocourti*. Journal of bioscience and bioengineering. 2021 Oct 1;132(4):423-8.
[23] Ghouse, M. Use of Probiotics as Biological Control Agents in Aquaculture For Suistanable Development. Departement of Zoology. Osmania College. India. 2015;pp 112-119
[24] Faizullah M, Rajagopalsamy CB. Ahilan. B and Francis, T. Impact of Bofloc Technology on The Growth of Goldfish Young Ones. Indian Journal of Science and Technology. 2015;8(13).
[25] Pitrianingsih C. Effect of Probiotic Candidate Bacteria on Changes in Nutrient Content C, N, P and K of African Catfish (*Clarias gariepinus*) Culture Media. Journal of Aquaculture Management And Technology. 2014 Oct 29;3(4):247-56.
[26] Lisna I. Potential of Fm Probiotic Microbes in Improving Pond Water Quality and Growth Rate of Dumbo Catfish Seeds *Clarias gariepinus*. Jurnal Penelitian Universitas Jambi Seri Sains. 2015;17(2):18-25.
[27] Radhiyufa M. Dynamics of Phosphate and Chlorophyll with Distribution of Tilapia (*Oreochromis* sp) in Catfish Culture Ponds (*Clarias* sp) Heterotrophic System. Thesis. Program Studi Biologi. Fakultas Sains dan Teknologi. UIN Syarif Hidayatullah. Jakarta. 2011;70.
[28] Pratama FA, Afiati N, Djunaedi A. Water Quality Conditions For Aquaculture Ponds With The Use of Probiotics and Without Probiotics on The Growth of The Sangkuriang Catfish (*Clarias* sp) in Cirebon, West Java. Management of Aquatic Resources Journal (MAQUARES). 2016 Jan 29;5(1):38-45.