

# Water Quality Parameter Analysis for the Feasibility of Shrimp Culture in Takalar Regency, Indonesia

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## Abstract

The physicochemical studies were carried out to assess water resource in Mangara Bombang District, South Sulawesi in relation to their potential for shrimp aquaculture use. Water samples were collected from pond, coastal area and river and analyzed for pH, TSS, salinity, dissolved oxygen (DO), biodegradable organic matter (BOD), Ammonia (NH<sub>3</sub>-N), Nitrate (NO<sub>2</sub>-N), Nitrite (NO<sub>3</sub>-N), and Orthophosphate (PO<sub>4</sub>-P). The results revealed that Mangara Bombang District is suitable for the development of pond shrimp farm with values obtained for pH, Temperature, TSS, salinity, dissolved oxygen (DO), biodegradable organic matter (BOD), Ammonia (NH<sub>3</sub>-N), Nitrate (NO<sub>2</sub>-N), Nitrite (NO<sub>3</sub>-N), and orthophosphate (PO<sub>4</sub><sup>3--</sup>-P) were 8.17 ± 0.38, 29.56 ± 0.75°C, 37.73 ± 12.44 mg/l, 30.01 ± 3.77, 17, 5.89-6.02 mg/l, 1.16 ± 0.53 mg/l, 0.02614 ± 0.3355 mg/l, 0.0115 ± 0.0104 mg/l, 0.0555 ± 0.0956 mg/l, and 0.0201 ± 0.0051, respectively for pond water source, 8.06 ± 0.40, 28.56 ± 2.72°C, 58.17 ± 22.18 mg/l, 30.90 ± 4.01°/oo, 5.88 ± 1.42 mg/l, 0.74 ± 0.27 mg/l, 0.2636 ± 0.3303, 0.0110 ± 0.0141 mg/l, 0.2483 ± 0.5690 mg/l, and 0.0583 ± 0.0648, respectively for the coastal water source, and 7.77 ± 0.42, 26.77 ± 19.94°C, 60.13 ± 15.45 mg/l, 17.95 ± 3.79°/oo, 6.02 ± 0.86, 1.32 ± 0.80 mg/l, 0.1101 ± 0.0812 mg/l, 0.0924 ± 0.1241 mg/l, 0.0250 ± 0.0074 mg/l, and 0.0051 ± 0.0037 mg/l, respectively for river water source.

**Keywords:** Aquaculture; Water quality; Feasibility

## Introduction

Tiger shrimp production in South Sulawesi amounted to about 12599.50 tons in 2007. Nationally, its production was at the fourth ranking after Riau Islands, North Sumatra and West Java [1]. The tiger shrimp production number was the aggregates production in several Regencies which have the coastal area in South Sulawesi Province. One of them is Takalar Regency particularly, in Mangara Bombang District. The potential of culture fishery which can be developed in coastal area of Mangara Bombang is shrimp culture in ponds. Shrimp culture in ponds has been expanded to be a bio-food industry proved to yield foreign exchange and provide job opportunities besides animal protein source. The existence of a wide market support, stable price, technology support in the production process, commercial akuinput, the potential land availability, and the Government's policy support has led to shrimp commodity to continually grow being the excellent fishery and continue to be developed as the excellent commodity to increase foreign exchange [2-4]. Nevertheless, the sustainability pond aquaculture in highly is depended on the dynamic aspects of coastal environment quality as a result of any interaction among users in the coastal area besides pond aquaculture activity itself.

Mangara Bombang is one of Districts located in coastal area of Takalar Regency which has a developed aquaculture potential. Therefore, it has been selected as one of the aquaculture development area centers by the Government of Takalar Regency. Seaweed and shrimp aquaculture have been the aquaculture activities developed in the current time in this District. The whole pond wide in the coastal area of Mangara Bombang is 863.097 ha. From that, there has been 35.98 ha and 827.117 ha managed by using an intensive technology and traditional intensive, respectively [5].

Government's Takalar through its Marine and Fishery Service in 2008 arranged aquaculture development program plans and one of them is the pond aquaculture development. Special in Mangara Bombang District, 1851 ha and 335 ha of its coastal area have been used for shrimp monoculture and shrimp-fish milk polyculture

development with a production target of 2696.13 tons and 125.10 tons, respectively [5].

The pond shrimp culture activity in the coastal area of Mangara Bombang District in this current time and its development to the future will result in damages on the aquatic environment in someday if there is no any good management. The existence of damaged aquatic environment will finally threaten the sustainability of pond shrimp culture fishery resource. Therefore, this study aims to determine the water quality condition for the sustainability of pond shrimp culture in the coastal area of Mangara Bombang District. This study is expected to give the information to pond shrimp farmers to increase their production. In addition, the data obtained can be used as the supporting data in the formulating of Government's policies for the planning and managing of shrimp pond area.

## Research Methods

### Location and research time

This study was done in a shrimp farm area in the coastal area of Mangara Bombang District, Takalar Regency, South Sulawesi, Indonesia started from June 2010 to July 2010.

### Research method

The collection of biophysical data and waters quality was consisted

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of pond soil quality, water quality, oceanography (tide, current speed and depth), shrimp farm sediment quality, and coastal waters base land substrate data. Pond soil quality data was collected from 10 stations in several pond compartments. Meanwhile, for the coastal waters water quality data was collected from 6 stations consisted of 2 stations of river, 2 stations of pond and 2 stations of outlets. Moreover, shrimp farm sediment quality and coastal waters base substrate quality data were collected from 2 stations and 13 sampling points, respectively.

### Data and data source

Primary and secondary data were used in this study. Primary data was collected through observation and direct interview in the research location whilst, secondary data was obtained through the searching of various references to the several Agencies of Government and non Government that are related to this study. Several water quality parameters as listed in Table 1 which were the important parameters in the shrimp aquaculture success. The monitoring and sample collection of water quality were directly carried out (*in situ*). Water quality analysis was directly done in the field and laboratory and the results can be seen in Table 1.

### Results and Discussions

Water quality is one of the important factors in the determination of shrimp farm culture activity success. The result analysis of the water quality in several stations of river and coastal was shown in Tables 2 and 3.

Source : Boyd, Poernomo, Widigdo, Soewardi, and Environment Ministry (2004) From the Tables 2 and 3, it can be explained as followed:

#### Waters temperature

The temperature measurement of traditional shrimp farm

No	Water quality parameter	Equipment/Method	Note
1	Temperature	YSI	<i>In situ</i>
2	Kekeruhan	Turbidimeter	<i>In situ</i>
3	Total suspended solid (TSS)	Gravimetri	Laboratory
4	pH	YSI	<i>In situ</i>
5	Salinity	YSI	<i>In situ</i>
6	Dissolved oxygen	YSI	<i>In situ</i>
7	Ammonia(NH <sub>3</sub> -N)	Spectrophotometer	Laboratory
8	Nitrate (NO <sub>2</sub> -N)	Spectrophotometer	Laboratory
9	Nitrite (NO <sub>3</sub> -N)	Spectrophotometer	Laboratory
10	Orthophosphate PO <sub>4</sub> -P)	Spectrophotometer	Laboratory
11	BOD	Titrimetric	Laboratory

Table 1: Water quality parameters observed.

Water quality parameter	Location/Measurement station		Tolerance value
	River	Coastal	
Temperature (°C)	26.77 ± 17.94	28.56 ± 2.72	20-32
Salinity (o/oo)	17.95 ± 3.79	30.90 ± 4.01	5-34
DO (mg/l)	6.02 ± 0.86	5.89 ± 1.41	≥ 3
pH	7.77 ± 0.42	8.06 ± 0.40	6.5-8.5
BOD <sub>5</sub> (mg/l)	1.32 ± 0.80	0.74 ± 0.27	< 25
TSS (mg/l)	60.44 ± 9.35	58.17 ± 22.18	25-80
BOT (mg/l)	26.04 ± 5.73	18.77 ± 5.64	-
Turbidity (NTU)	21.41 ± 4.41	14.42 ± 17.63	≤ 30
NH <sub>3</sub> -N (mg/l)	0.1101 ± 0.0812	0.2636 ± 0.3303	≤ 1.0
NO <sub>2</sub> -N (mg/l)	0.0251 ± 0.0073	0.2483 ± 0.5690	0.25
NO <sub>3</sub> -N (mg/l)	0.0924 ± 0.1241	0.0111 ± 0.0140	-
PO <sub>4</sub> -P (mg/l)	0.0053 ± 0.0036	0.0582 ± 0.0647	0.05-0.50

Table 2: Analysis data of water quality parameters measurement in several stations of river and coastal.

Water quality parameter	Location/Measurement Station		Tolerance value
	In farm	Outlet	
Temperature (°C)	29.56 ± 0.75	30.00 ± 2.03	20-32
Salinity (o/oo)	31.46 ± 1.37	31.03 ± 6.64	5-34
DO (mg/l)	6.65 ± 1.08	4.41 ± 0.53	≥ 3
pH	8.17 ± 0.38	8.06 ± 0.42	6.5-8.5
BOD <sub>5</sub> (mg/l)	1.16 ± 0.53	1.07 ± 0.51	< 25
TSS (mg/l)	37.73 ± 12.44	55.20 ± 10.54	25-80
BOT (mg/l)	22.83 ± 12.47	25.13 ± 6.92	-
Turbidity (NTU)	9.64 ± 3.43	19.23 ± 2.80	≤ 30
NH <sub>3</sub> -N (mg/l)	0.2614 ± 0.3355	0.0982 ± 0.0033	≤ 1.0
NO <sub>2</sub> -N (mg/l)	0.0555 ± 0.0956	0.1021 ± 0.1493	0.25
NO <sub>3</sub> -N (mg/l)	0.0115 ± 0.0104	0.0023 ± 0.0003	-
PO <sub>4</sub> -P (mg/l)	0.0201 ± 0.0051	0.0422 ± 0.0273	0.05-0.50

Table 3: Analysis data of water quality parameters measurement in several stations of shrimp farm and outlet.

waters was obtained the temperature of 29.56 ± 0.75°C. Meanwhile, temperature of pond waters found of temperature measurement result in the coastal waters and river was 28.56 ± 2.72°C and 26.77 ± 19.94°C, respectively. The temperatures observed were still suitable for shrimp culture. As reported by Boyd, Poernomo, Widigdo, Soewardi Temperature with range from 20-32°C was temperature values recommended for shrimp culture and 29-30°C were the optimum temperature for cultured shrimp growth.

#### Salinity

The salinity measurement result showed that the salinity obtained in the river and coastal waters was still in the values recommended namely 17.95 ± 3.79‰ and 30.90 ± 4.01‰, respectively. Boyd, Poernomo, Widigdo, Soewardi recommended that Salinity of 5-35‰ are suitable for shrimp culture and the salinity of 15-25‰ are salinity suggested for the optimum growth of shrimp.

#### pH

The shrimp waters pH measurement result for 24 hours was 8.17 ± 0.38. pH of pond waters obtained was range from 8.06-8.17 with the highest pH (8.17) at 12.00-13.00 and the lowest at 01.30 and 03.30-04.00. pH measurement result in the river and coastal waters was 7.77 ± 0.42 and 8.06 ± 0.40, respectively. These pH values were still in the range of pH which is suitable for shrimp culture namely 6.5-8.5 with the optimum pH of 8.0-8.5 [6-9].

#### Dissolved oxygen

Maintenance of an adequate level of DO in pond water is very important for shrimp survival and prolonged exposure to the stress of low concentration of oxygen can inhibit shrimp growth. DO concentration in this study was considered normal and acceptable for a shrimp pond. Over the observation period, mean dissolved oxygen concentrations found in the waters was 6.65 ± 1.08 mg/l. Meanwhile, dissolved oxygen concentrations in shrimp farm for 24 hours of the observation ranged from 5.89-6.02 mg/l with the highest dissolved oxygen (6.02 mg/l) at 12.00 and the lowest (5.89 mg/l) at 20.00. In addition, mean dissolved oxygen concentration in the river and coastal waters was 6.02 ± 0.86 and 5.88 ± 1.42 mg/l, respectively. These values are still suitable for shrimp culture as reported by Boyd, Poernomo, Widigdo, the tolerance dissolved oxygen for shrimp culture is ≥ 3 mg/l (3 -10 mg/l) and the optimum dissolved oxygen ranges from 4-7 mg/l. Cheng et al., [10] reported that DO values higher than 5 mg/l have often been recommended for intensive culture practices.

## Total Suspended Solid (TSS)

Total suspended solid (TSS) measurement result exhibited that TSS value in shrimp farm was  $37.73 \pm 12.44$  mg/l whilst, TSS value in outlet of traditional shrimp farm was  $55.20 \pm 10.54$  mg/l. Moreover, this value for coastal waters and river was  $58.17 \pm 22.18$  mg/l and  $60.13 \pm 15.45$  mg/l, respectively. These TSS content were still in the tolerance limit for shrimp pond culture according to the tolerance value reported by Widigdo, Environment Ministry for shrimp farm namely 25-80 mg/l.

## Biochemical Oxygen Demand/BOD<sub>5</sub>

Biochemical Oxygen Demand (BOD<sub>5</sub>) measurement obtained BOD<sub>5</sub> value was  $1.16 \pm 0.53$  mg/l whilst, the BOD<sub>5</sub> value for coastal waters and river was  $0.74 \pm 0.27$  mg/l and  $1.32 \pm 0.80$  mg/l, respectively. These BOD<sub>5</sub> values are still suitable for shrimp culture based on the BOD<sub>5</sub> value recommended by Environment Ministry (2004) namely < 25 mg/l. According to the pollution level, coastal waters of Mangara Bombang District is in unpolluted waters category indicating that it is suitable for shrimp culture.

## Ammonia (NH<sub>3</sub>-N)

Ammonia (NH<sub>3</sub>-N) content observed in shrimp farm waters was  $0.02614 \pm 0.3355$  mg/l. Meanwhile, ammoniac (NH<sub>3</sub>-N) content obtained in coastal waters and river was  $0.2636 \pm 0.3303$  mg/l and  $0.1101 \pm 0.0812$  mg/l, respectively. These ammonia contents found are still in the save limit for shrimp culture based on the ammonia (NH<sub>3</sub>-N) content suggested by Boyd, Poernomo, Widigdo, Environment Ministry namely <1.0 mg/l.

## Nitrite (NO<sub>2</sub>)

Nitrite (NO<sub>2</sub>) content observed in shrimp farm waters was  $0.0555 \pm 0.0956$  mg/l whilst, nitrite (NO<sub>2</sub>-N) content in coastal waters and rivers was  $0.2483 \pm 0.5690$  mg/l and  $0.0250 \pm 0.0074$  mg/l, respectively. These values are still in the save limit for shrimp farm based on the tolerance value recommended for shrimp culture namely <0.25 mg/l [11-14].

## Nitrate (NO<sub>3</sub>-N)

Nitrate (NO<sub>3</sub>-N) content in shrimp farm waters was  $0.0115 \pm 0.0104$  mg/l. Meanwhile, Nitrate (NO<sub>3</sub>-N) content in the coastal waters and river was  $0.0110 \pm 0.0141$  mg/l and  $0.0924 \pm 0.1241$  mg/l, respectively. Nitrate (NO<sub>3</sub>-N) content obtained also indicates that Mangara Bombang is suitable for shrimp culture.

## Orthophosphate (PO<sub>4</sub><sup>3-</sup>-P)

Phosphate (PO<sub>4</sub>-P) content obtained in the shrimp pond waters, coastal waters and river was still in the recommended value limit for shrimp culture activity namely;  $0.0201 \pm 0.0051$ ,  $0.0583 \pm 0.0648$  and  $0.0051 \pm 0.0037$  mg/l, respectively. As reported by Boyd; Poernomo; Widigdo; Environment Ministry, the value limit of Phosphate (PO<sub>4</sub>-P) content which is suitable for shrimp culture activity is 0.05-0.5 mg/l.

## Turbidity

The turbidity value observed in the shrimp pond was  $9.69 \pm 3.41$  NTU whilst, that obtained in the coastal waters and river was  $14.44 \pm 17.65$  NTU and  $21.42 \pm 4.43$ , respectively. These turbidity values were still in the tolerance limit for shrimp farm culture. In general, the water quality in the coastal area of Mangara Bombang District is suitable or supporting for shrimp farm culture activity based on the criteria recommended by Boyd, Poernomo, Widigdo, Soewardi and Environment Ministry.

## Conclusion and Suggestion

### Conclusion

The study has provided the information about the water quality status of Mangara Bombang District and its suitability for pond shrimp farm. The field and laboratory observations on the water quality revealed that the study area have high potential for pond shrimp culture development based on values obtained which were in conformity with recommended values for shrimp culture,

### Suggestion

It is suggested to further study on the water quality feasibility for the development of shrimp culture for intensive and semi intensive culture technology so it can be obtained the picture of water quality feasibility for shrimp culture development in the various culture technology.

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