



Water Quality Analysis Based on Total Coliform Bacteria in Ambon Bay

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Abstract. Ambon Bay is divided into two main parts, namely the Inner Ambon Bay (IAB) and the Outer Ambon Bay (OAB). The quality of Ambon Bay waters continues to decline along with increased activity around the bay. This study aims to determine the health quality of the waters around Ambon Bay from a microbiological aspect. Determination of the number of coliform bacteria in the tested seawater samples was carried out using the Most Probable Number (MPN) method. In addition to taking seawater samples, physical and chemical parameters were measured, such as salinity, temperature, turbidity, dissolved oxygen (DO), pH, phosphate, and nitrate content at surface depth limits (0-1 meter). The study results found that station 11 was the location of the observation station with the highest total coliform, while stations 6,16,17 were areas with low total coliform values. Coliform bacteria detected the condition of the water quality of Ambon Bay as a whole. One observation station location that did not meet the requirements was found out of eighteen observation stations, namely station 11, following the Decree of the Minister of Environment No. 51 of 2004 (KepMen LH 51/2004) concerning Seawater Quality Standards for Marine Biota, Marine Tourism, and Ports. The high pollution around the bay, which comes from domestic, industrial, and market waste, is the main trigger for the high coliform bacteria in that location. Continuous monitoring is needed representing a season or per certain period to obtain more comprehensive data and mitigation measures to ensure the health of Ambon Bay in the future

Keywords: Ambon Bay, Total Coliform, Water Quality

1 Introduction

Ambon Bay waters consist of two parts, namely the Inner Ambon Bay (IAB) and the Outer Ambon Bay (OAB), both of which are separated by a narrow and shallow gap [1]. The characteristics of the IAB are that it has a relatively narrow, shallow water area and is heavily influenced by river currents, while the OAB is wider, deeper, and directly related to the Banda Sea. The area of ambon bay is around 143.5 km² and the length is around 30 km [2]. The ecosystems in these two bays are mangrove ecosystems, coral reefs, seagrass beds, sea grass and various another marine biota [2-5].

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Ambon Bay has an important role for the people of Ambon and the people of the surrounding islands. The Ambon Bay area is used as a fishing area for caught fish, boat bait fish and floating net cages (KJA), as a port for the Indonesian Navy and POLAIRUD base, the port for PT. Pelni, traditional inter-island boats and ferries, docks for repairs, mangrove forest conservation areas, places for recreation and sports, as well as places for education and research [6]. Ambon Bay consists of a conservation area and a marine tourism location in the form of diving tourism. Its waters keep the beauty of underwater ecosystems as well as historical sites such as the sinking site of the SS. Aquila which sank since May 27, 1958 [3].

Ambon Bay waters are experiencing degradation along with the increasing population and activities in the increasingly dense bay area. Physical damage to coastal ecosystems due to dredging of beach sand, increased sedimentation rates, pollution originating from residential waste, transportation, hotels, industry, and commercial activities that come into direct contact with the waters of Ambon Bay cause the water quality to decline. One indicator of decreasing water quality can be analyzed by the presence of disease-causing pathogenic bacteria such as *Escherichia coli* and coliform [7]. Coliform is a group of bacteria that is often used as an indicator of dirt pollution and unfavorable conditions in water or bodies of water [8]. This research aims to determine the health quality of the waters around Ambon Bay, both OAB and IAB from a microbiological perspective especially coliforms. It is hoped that this activity can be used as a basis for determining the direction of development policies that pay attention to health and environmental sustainability in the Ambon Bay area.

2 Methodology

2.1 Study area

The survey was conducted in the Ambon Bay area in August 2019 during the east monsoon season. Sampling was divided into two central locations: Inner Ambon Bay, consisting of 7 stations, and Outer Ambon Bay, consisting of 10 stations. Sampling was carried out using purposive sampling.



Fig. 1. Location of sea water sampling station in Ambon Bay

2.2 Seawater Sampling and Measurement of Physical and chemical Parameters

Water samples were taken from the sea vertically to a depth of 0-1 meter above sea level. 150 ml sea water was taken, put into a sterile bottle, wrapped in sterile aluminum foil, and then placed in a cool box to be taken to the laboratory. Measurement of physical parameters of the waters such as salinity, temperature, turbidity, dissolved oxygen (DO), and pH was carried out by a compact Conductivity, Temperature, Depth (CTD) (Alec ASTD 687, Kobe Japan). Water samples for nutrient analysis were collected with Niskin bottles at the surface depth (1-5 meters). Water samples (350 ml) from the Niskin bottle were put on labeled black plastic bottles. The pre-filtered water samples from the Niskin bottle were filtered immediately after sampling through a 0.45 μm pore size, 47 mm membrane filter using a vacuum pump with a maximum pressure of 0.3 bar and stored at $-20\text{ }^{\circ}\text{C}$ until the analysis. Phosphate and nitrate were measured using a spectrophotometer (UV-Vis Shimadzu 1700, Kyoto-Japan) following Strickland and Parsons (1972).

2.3 Coliform Test

Determination of the number of coliform bacteria was carried out using the Most Probable Number (MPN) method. The tube containing the Lactose Broth medium, which showed positive results, was taken one cycle, and then put into a test tube containing the Brilliant Green Lactose Broth (BGLB) medium and incubated for 1x24 hours at a temperature of 37°C [8]. Then, it is matched with the MPN series five calculation table.

3 Result and Discussion

3.1 Microbiological water conditions

Coliform bacteria were detected at all observation stations, with varying quantities between them, according to the results of the MPN analysis. The smallest Coliform populations were found in the station 6,16,17 (Halong, Tawiri, and Eri) with 16,000 cells/100 ml of seawater. Based on the decision of the Minister of Environment No. 51 of 2004 (KepMen LH 51/2004) concerning Sea Water Quality Standards for Marine Biota, Marine Tourism and Harbors for the required total Coliform of 1000 Cells/100 ml. it can be stated that among the eighteen sampling stations, one location/station does not meet the requirements, namely station 11 (Pasar Mardika), while seventeen other stations are still within the predetermined quality standard threshold.

Table 1. Total Coliform Bacteria in seawater samples from Ambon Bay

No. Sta	Station name	Total Coliform /100 ml sampel)	Status
1	Passo	20	qualify
2	Latta	20	qualify
3	Nania	45	qualify
4	Waiheru	45	qualify
5	LIPI	68	qualify
6	Halong	<18	qualify
7	UNPATTI	20	qualify
8	Galala	220	qualify
9	Tantui	700	qualify
10	Wayame	93	qualify
11	Pasar Mardika	16000	unqualified
12	Air salobar	460	qualify
13	Tengah TAL	130	qualify
14	Hatiwe besar	45	qualify
15	Tengah TAL2	45	qualify
16	Tawiri	<18	qualify
17	ERI	<18	qualify
18	Amahusu	20	qualify

(Noted: status is determined based on Sea Water Quality Standards KepMen LH No.51 of 2004)

From the provisions of the regulations regarding seawater quality standards, stations 6,16, and 17 are still relatively clean from impurities. This is reasonable because the locations of Tawiri and Eri are in the Outer Ambon Bay area, which is quite far from domestic waste sources. This water area also directly faces the Banda Sea with current dynamics, the mass of surface seawater changing relatively quickly due to crashing waves from the open sea. Meanwhile, station 6 is in the middle of Inner Ambon Bay and does not have direct contact with people's houses and the mouth of the Wairuhu River.

Referring to the regulations regarding Sea Water Quality Standards for Marine Biota, Marine Tourism, and Harbors, the condition of station 11 (Pasar Mardika) has been polluted by dirt and is in relatively high condition. The same thing was also reported [9] that the highest density of *E. coli* and coliform bacteria was found at the Floating Fish Market part of Pasar Mardika. Pollution of the aquatic environment around Pasar Mardika is relatively high. Human activity in this place is quite dense. Mardika Market is an economic center, trading area, traditional market center, and shopping area close to ship docks and terminals. Sanitation in this area has yet to be managed optimally. Visually, the seawater around the observation station looks cloudy and dirty. There is a lot of organic waste (liquid and solid) and inorganic waste (plastic bags and bottles) floating on the water's surface; oil spills look thin and almost found at the observation station, and a foul smell sting.

3.2 Physical and chemical conditions of Ambon bay

Tabel 2. Physical and chemical Parameters of seawater sample in Ambon bay

Station	pH	DO (mg/l)	[11041] (mg/L)	[N031] (mg/L)	Temp °C	Salinity (PSU)	Turbidity (FTU)
1	8.25	8.38	0.15	0.082	25.99	33.39	0.56
2	8.23	12.31	0.13	0.006	26.35	33.06	0.46
3	8.16	7.28	0.15	0.008	26.12	33.35	0.57
4	8.16	8.72	0.13	0.006	25.89	32.9	0.36
5	8.29	7.96	0.16	0.038	26.13	31.48	0.69
6	8.19	12.28	0.38	0.001	26.29	32.6	1.04
7	8.15	8.24	0.16	0.085	26.18	32.23	0.54
8	8.06	7	0.17	0.032	25.54	32.98	0.76
9	7.97	6.7	0.19	0.034	25.18	33.83	0.34
10	6.66	7.95	0.17	0.032	25.43	33.71	0.37
11	7.95	6.85	0.14	0.076	25.43	33.43	0.4
12	8.01	7.93	0.15	0.0072	25.26	33.59	0.42
13	7.18	7.58	0.14	0.0168	25.37	33.6	0.34
14	7.46	6.79	0.22	0.0256	25.4	33.94	0.23
15	7.8	7.62	0.13	0.0048	25.43	33.66	0.32
16	7.84	6.56	0.19	0.0196	25.49	33.98	0.23
17	7.97	6.39	0.16	0.0268	25.84	34.14	0.14
18	9.05	8.25	0.16	0.0304	25.75	34.04	0.17

(Noted : pH : potential of Hydrogen or acidity; DO: Dissolved Oxygen, PO4: Phospat, NO3 : Nitrate)

Waste originating from fish markets, household waste, ship waste, and other types of waste contributes to worsening water pollution conditions in the area. Even though the Mardika market is closer to the open sea, its location is in direct contact with dense human activity. Even so, the physical/chemical conditions in the area are still within the threshold of quality standards (Kep Men LH 51/2004): DO: > 5, Temperature: 28°-

30°C, pH: 7 – 8.5, Turbidity: 5 NTU; Salinity: 33 – 34 ‰). This phenomenon is believed to be caused by the significant surface water exchange. It's just that these factors do not affect the size of the source of pollutants in the form of feces from community activities in the area. Hence, the Coliform population is relatively high.

E. coli and Coliform were not detected at station 1, station 12, and station 13 observation areas [11]. This data slightly differs from the observations currently found at the same station. Because when sampling was carried out, all OAB areas had been detected to contain coliform. This result proves there has been a change in the quality of the waters in the Outer Ambon Bay area in a long time. Gradually, the extent of pollution by domestic waste in the form of sewage originating from household waste fish markets around Ambon Bay continues to increase. The same thing has been conveyed [12], stating that Ambon Bay has experienced a decline in water quality over the last thirty years. However, it is still within the seawater quality standards of the Ministry of Environment.



Fig. 2. Outer Ambon Bay (Station 11) and Inner Ambon Bay (Station 7)

When this monitoring activity was carried out, many piles of plastic, cloth, bottles, and other organic waste were found floating near the water's surface in the Outer ambon bay area (Figure 2.A). This condition must receive serious handling to maintain the quality of the waters in Ambon Bay. In monitoring Ambon Bay, data on Coliform bacteria contamination is temporal because sampling is done during the east monsoon season with only one sample. Changes in populations of organisms, especially microorganisms, can occur very quickly and are strongly influenced by physical/chemical factors and other coastal ecological factors. Surveys are needed to regularly monitor at close time intervals and represent each season so that the resulting data is more up-to-date and representative so that it can describe the health conditions of Ambon Bay more recently and accurately.

4 Conclusion

Based on the results of microbiological tests using the MPN method, it can be concluded that Ambon Bay's overall water quality conditions detect coliform bacteria. According to the Decree of the Minister of Environment No. 51 of 2004 (KepMen LH 51/2004) about Sea Water Quality Standards for Marine Biota, Marine Tourism, and Harbors (1000 cells/100 ml MPN coliform), station 11 (Pasar Mardika) does not meet the requirements of the other 18 observation stations because the amount of coliform found was higher than the required quality standard threshold of 1000 cells/100 ml. Pollution due to domestic waste in the form of animal manure, feces, and other household waste needs to be appropriately managed. A comprehensive study of the physico-chemical conditions of waters using a continuous sampling process representing certain seasons or periods must be carried out to obtain more detailed and accurate results.

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