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Abstract. Lake Toba is designated as a National Tourism destination in North Sumatra. Lake Toba also used as a domestic water source for the surrounding communities, so that studies on water quality especially bacteriological condition need to be carried out. Theaims of this study was to analysis heterotrophic bacteria, *E. coli* ,and total coliform bacteria. In addition, somephysico-chemicalparameters were also studied. Water samples were taken from ten different sampling stations from the eastern, western, northern and southern sides of Lake Toba. Heterotrophic bacteria was analyzed using the spread plate method, the total number count of *E.coli* and coliform were analyzed using the filtration method.The results showed that physico-chemicalparameters meet the Indonesian water quality criteria of raw materials for drinking water and recreation except the COD. None of samples conformed to Indonesian water standard for sanitation hygiene needs for *E. coli* densities should not exceed 0 colonies / 100 mL and the total coliform not exceed 50 colonies / 100 mL.The highload of COD, *E.coli* and total coliform indicated severe contamination of lake with domestic sewage and human excreta. Thus we assumed that water from Lake Toba is not safe for domestic water sources.

1. Introduction

Lake Toba is an important lake in terms of ecological, hydrological and economic aspects. The lake has variety of functions, including the habitat of various aquatic organisms, water sources for domestic use (sanitary hygiene), as an area of fishing and fish culture in floating net cages, water transportation activities, and providing raw water for regional drinking water companies (PDAM; Perusahaan Daerah Air Minum). Besides that Lake Toba landscape present scenic value that has made the surrounding area as a priority object and tourist destination in North Sumatra (North Sumatra Culture and Tourism Office, 2007) in [1].

The increasing of Lake Toba waters utilization with various activities is feared to affect the water quality of the lake. For this reason, monitoring the water quality of Lake Toba is very important relate to the important values of the lake. Research on water quality Lake Toba has been carried out physically and chemically [2-6], but there is still little information about water quality in terms of its bacteriological side.

The presence of coliform and heterotrophic bacteria can be used as parameters to measure bacteriological quality in the aquatic environment, even are often used as indicators of water pollution. Heterotrophic bacteria can also indicate the presence of pathogenic bacteria such as Escherichia, Klebsiella, Enterobacter, Citrobacter, Serratia, Helicobacter etc. which can causing disruption to human health (Camper, 2004; Regan *et al*., 2003; Beech and Sunner, 2004; Emtiazi *et al.*, 2004) *in* [7]. In natural condition, although, heterotrophic bacteria play an important role in the recycling of substances, especially degrade various types of organic compounds.

Coliform bacteria commonly used as indicators of food and water sanitation quality. Coliform bacteria can be found in aquatic, soil and vegetation environments. These bacteria can enter into the aquatic environment through waste either with or without processing, surface run off, and soil leaching. Coliform bacteria in the waters is divided into two groups, namely fecal (*E.coli)* and non fecal (*Enterobacter aerogenus*). Coliform bacteria is environmental contamination or poor sanitation indicators, while *E. coli* as an indicator of fecal contamination from humans and warm-blooded animals [8].

E.coli bacteria are found commonly on the intestinal track of warm-blooded animals and their presence in the environment indicates of the fecal contamination. Most *E.coli* are non-pathogenic strains, although some can cause diarrhea, respiratory and urinary tract infections. It should be noted that the presence of enteric bacteria can cause infectious disease, if the water is used for drinking, recreation and irrigation [9-12]. The purpose of this study is to determine the bacteriological quality conditions of Lake Toba.

2.Materials and Methods

Bacteriological quality condition studies in Lake Toba were carried out in Oktober 2017, water samples were taken from ten sites (i.e. Pangururan, Tuk-tuk, Simanindo, Ambarita, Bakara, Balige, Porsea, Paropo, Silintong and Sipolha) (Figure 1). Sampling was done by purposive sampling. A sample of 100 mL of water is put into a sterile bottle and placed in a cool box for further analysis.

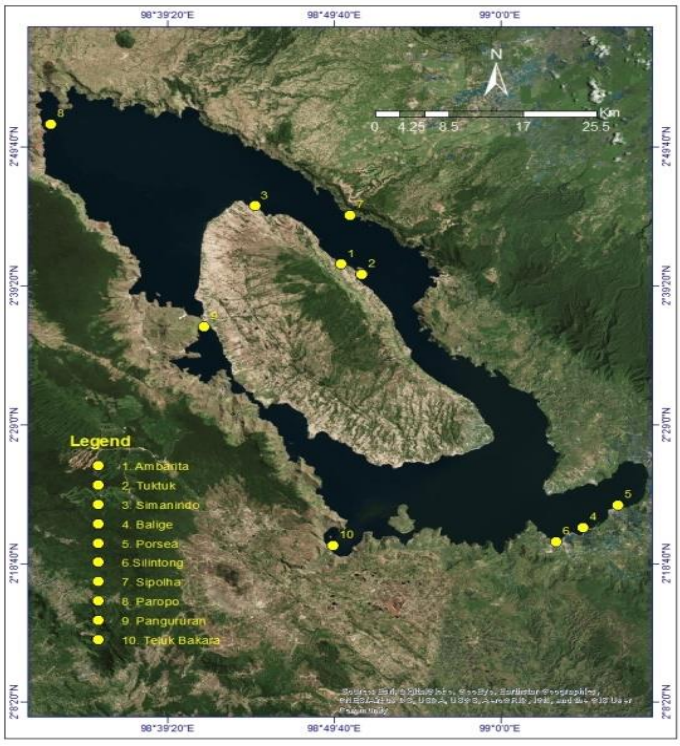

Figure 1. Map of bacteriological condition sampling location in Lake Toba

2.1 Analysis of total coliform and E..coli bacteria

The Analysis of total coliform and *E.coli* bacteria was carried out by filtration method. Water samples as much as 25 mL were filtered using a cellulose nitrate filter (porosity 0.45 µm; 47 mm diameter). Membrane filters were placed in a petri dish in the form of compact dry containing the media ChromoCult® Coliform Agar ES (PT. Merck tbk.) and incubated in an incubator at 35°C for 24 hours. *E.coli* and Total coliform bacteria were calculated by the following equation:

$$E.coli = \frac{Number\ of\ dark\ blue\ to\ violet\ colonies}{Volume\ of\ sample\ filtered\ (mL)} x\ 100 \quad (1)$$

$$Total\ coliforms = \frac{Number\ of\ blue\ to\ violet\ colonies + salmon\ to\ red\ colonies}{Volume\ of\ sample\ filtered\ (mL)}\ x\ 100 \quad (2)$$

2.2. Analysis of Heterotrophic Bacteria

The Analysis of heterotrophic bacteria using Spread plate and dilution method. Water samples were taken with a 100 mL sterile sample bottle then dilution using sterile aqudest to 10^{-4} level. Each of the product of dilution process was taken as much as 100 microliters for further plate to Triptone Glucose Yeast (TGY) media and incubated for 24-48 hours.

2.3. Analysis of Physico-chemical

The physico-chemical test included the determination of Temparature, pH, total dissolved solids (TDS) and conductivity with water quality checker (YSI professional series), dissolved oksigen (DO) with DO meter (YSI pro0DO series) and chemical oxygen demand (COD) was determined using APHA closed reflux colimetric method [13].

3.Results and Discussion

3.1Total coliforms (TC) andE.coli.

The distribution of TC in ten locations on Lake Toba is quiet varied (Figure 2). The highest densities of TC was 892 CFU/100 mL recorded in Bakara and the lowest was 8 CFU/100 mL recorded in Balige area.

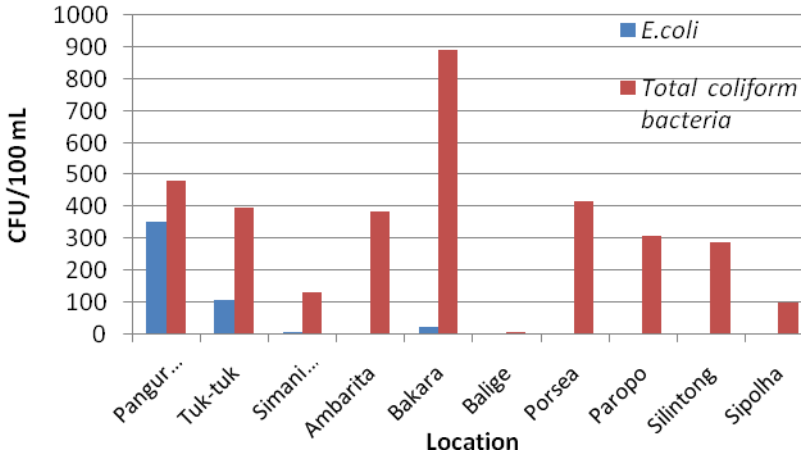

Figure 2.*E.coli* and TC densities from ten located in Lake Toba

The different results were from the total coliforms, the highest densities*E.coli* bacteria were found in Pangururan area which was 352 colonies / 100 mL. *E. coli* bacteria is one type of coliform bacteria found in many waters. The high total coliform and *E.coli* bacteria at several sampling points in Lake Toba are more influenced by the high human activity in those region. Coliform bacteria are indicators of environmental contamination or poor sanitation, while *E. coli* as an indicator of fecal contamination from humans and warm-blooded animals [8].

Pangururan is the city known as capital of Samosir regency with a densely population. The sampling locations in those area is near the harbour and in surrounding areas there were also floating net cages for aquaculture. It is not surprising that the densities of *E.coli* in this area is high. Likewise, in Tuk-tuk, known as a tourism area, there are many villa buildings or restaurants along the beach of lake. One Interesting were found in Bakara area, although the densities of *E.coli* bacteria was not high enough but the densities of total coliforms was very high. In the Bakara area there is a large river

which allegedly brought domestic waste to the Lake. Based on interviews to some residents in this region it is known that most of the family already has septic tank, but for wastewater from domestic activity were still disposed directly into the ditch which will eventually lead to Lake Toba waters.

E. coli are very dangerous for health including can cause diarrhea, intestine inflammation and tractusurainarius infection [14]. *E.coli* is opportunistic bacteria, both pathogenic and enteropathogenic [15]. The suitability of waters as domestic water source (hygiene sanitation) is if the densities of *E. coli* is 0 colonies / 100 mL and densities of total coliforms not more than 50 colonies / 100 mL [16]. Based on the data above, it can be concluded that all areas in Lake Toba that were sampled were not suitable for domestic water sources**.**

3.2 Densities of Heterotrophic Bacteria

Densities of heterotrophic bacteria in several area of Lake Toba ranges between 14-91 x 103 CFU / mL. The highest densities was obtained in the Ambarita area and the lowest in the Balige area (Figure 3).

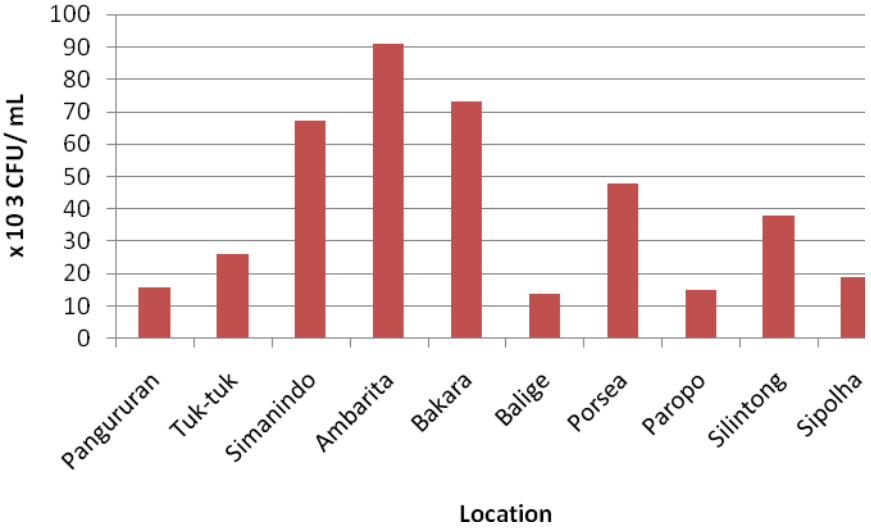

Figure 3. Densities of heterotrofic bacteria from ten locationin Lake Toba

Higher densities of heterotrofic bacteria in Lake Toba (3,04 – 30,6 x10^6 CFU/mL) has been reported [17]. This can be due to different sampling locations where the highest densities of haterophic bacteria was found in the Haranggaol area which is known as the floating net cage area. The excess of fish feed contributes to increasing of organic matter in the waters.It is importance to note that 35%-75% of the fish feed N was discharged to the environment [18-20]. In aquatic ecosystem heterotrophic bacteria are known as decomposers and have an important role in the purification process for waters contaminated with organic matter [21]. The high protein content in heterotrophic bacteria makes it a food source for zooplankton, especially the type of copepods, shrimp and insect larvae [22]. Different function the heterotrophic bacteria in water distribution systems, are used in measuring water quality in drinking water storage tanks and water distribution networks. Heterotrophic bacteria can indicate the presence of pathogenic bacteria such as Escherichia, Klebsiella, Enterobacter, Citrobacter, Serratia, Helicobacter etc. which can cause influence to human health (Camper, 2004; Regan et al., 2003; Beech and Sunner, 2004; Emtiazi et al., 2004) in [7].

In water distribution system, the presence of heterotrophic bacteria can be harmful because these bacteria are associated with decreasing of drinking water aesthetic quality (problems of taste and color, and turbidity), filter clogging, bio-fouling and bio corrotion[23-26]. Heterotrophic bacteria can form biofilms that can act as a shelter for pathogenic bacteria and be protected from the desinfecting processes [7]. Biofilms can ensnare nutrients that can lead to increased survival for non-endemic bacteria [27-28].

The densities of heterotrophic bacteria in drinking water ranged from 1-10000 CFU / mL that depend on temperature, residual chlorine, and organic matter content. In distribution system of drinking water the maximum allowable density of heterotrophic bacteria is 500 CFU / mL(Dobaradaran et al. (2006)) *in*[29] . The permissible maximum densities of heterotrophic bacteria for swimming pools is 100 CFU / 100 mL [16]. The densities of heterotrophic bacteria in all Lake Toba area which were sampled, based on Figure 3, showed were above the quality standards for both drinking water and for swimming needs. This condition must be concerned relate the extent use of Lake Toba water by the people in surrounding area of the lake.

3.3. Physico-chemical parameters

The measured parameters and their units in water samples at different location are shown ini Table 1. Water temperatures at different locations ranged from 26-28 ^{0}C, respectively (Figure 4a). The pH Values of the water samples collected ranged from 7.6-8.85 respectively (Fig.4b). The data indicates that the lake water was moderately alkaline and the values were within the desirable limit (6.5-8.5) of the Indonesian water standard for sanitation hygiene needs [16] except Balige where the pH was 8.85.This pH is unsave for human and animal who use the water because it can cause irritation and imflammation of the mucous membrane [30]. It can also to be dangerous to fish through accumulation of the unionized ammonia on the gill surface [31].The conductivity value ranged from 0.011 – 0.110mS/cm (Fig.4c). The TDSvalues ranged from 70-108 mg/L(Fig.4d) and the values were within the desirable limit (1000 mg/L) of the Indonesian water standard for sanitation hygiene needs [16]. In the case of DO the values ranged from 7-11 (Figure 4e) and the values were within the desirable limit (min.4 and 6) of Indonesian water quality criteria for raw materials of drinking water and recreation [32]. For COD, the values ranged from 58.4 – 75.87 mg/L. These values were foundto be much higher than the permissible limit (10 mg/L & 25 mg/L)of Indonesian water quality criteria for raw materials of drinking water and recreation [32]. The data indicate the occurance of sewage pollution due to convergence of untreated domestic sewage and solid waste containing oxidizable organic matter into the lake water (Usrani et al .2010) in [33].

Table 1. Physiochemical parameters of Lake Toba

Location	Parameter					
	Temperature (^{o}C)	pH	Conductivity (mS/cm)	Disolved Oxygen (mg/L)	TDS (mg/L)	COD (mg/L)
Ambarita	27	8.09	0.166	7.8	108	71.24
Balige	29	8.85	0.109	8.7	71	63.29
Tuktuk	27	8.08	0.108	8.5	70	76.6
Porsea	27	8.69	0.108	11.3	70	75.87
Simanindo	27	8.41	0.108	11.0	70	62.44
Silintong	25	8.09	0.109	7.5	71	58.4
Sipolha	27	7.94	0.108	8.0	70	60.12
Paropo	26	7.99	0.110	8.4	73	63.34
Pangururan	28	8.09	0.109	7.7	70	66.04
Bakara	26	7.60	0.100	8.6	104	69.73

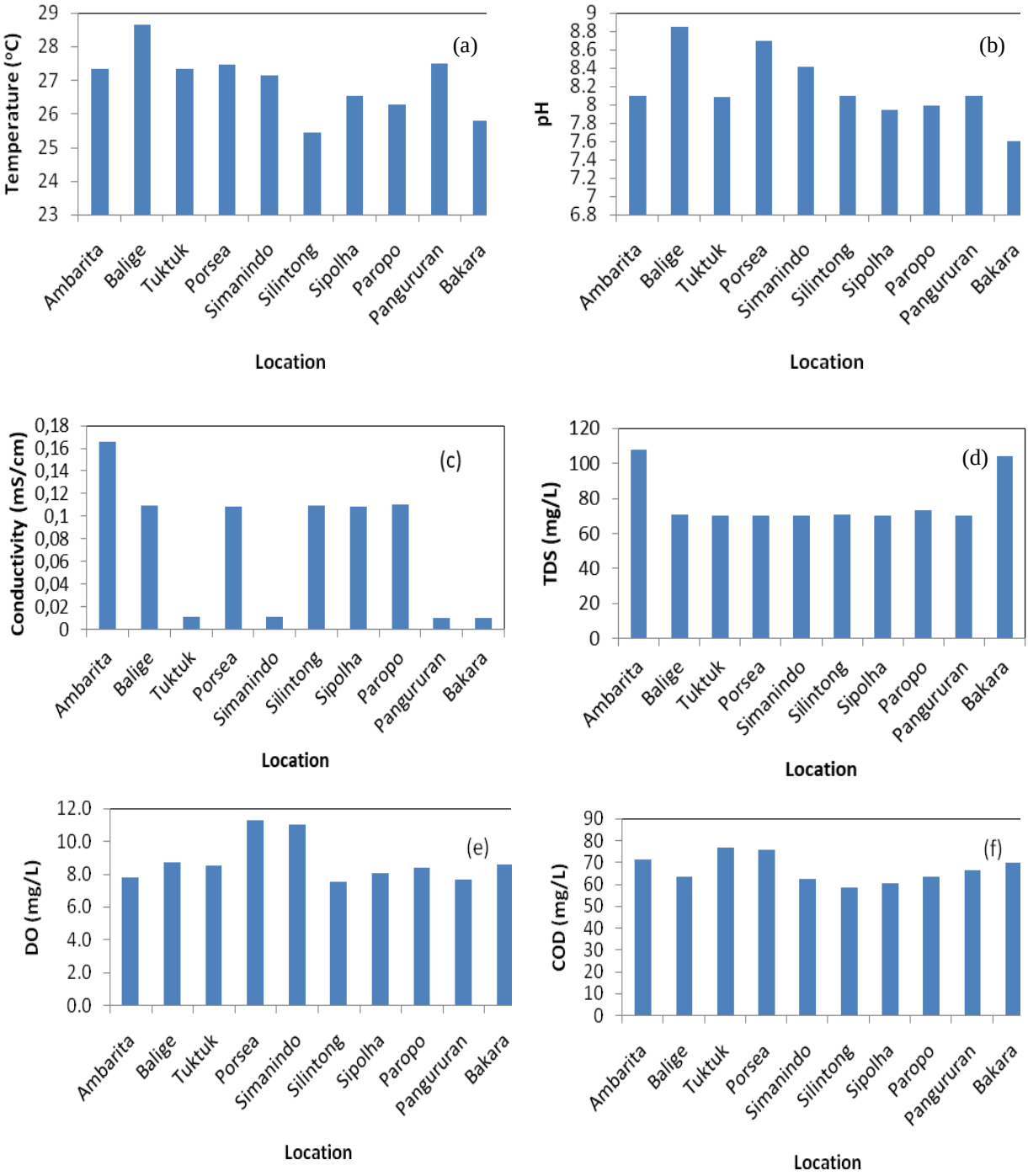

Figure 4. Physio-chemical parameters of Lake Toba . (a) Temperature, (b) pH, (c) conductivity, (d) total dissolved solids (TDS), (e) dissolved oxygen (DO) and (f) chemical oxygen demand (COD).

4.Conclusion

Base on the results obtained from this study, it can be concluded that the lake water is contaminated with organic matter though the inclusion of domestic sewage. The densities of *E.coli*, coliform and heterotrofic bacteria on several Lake Toba locations show that domestic activity significantly influence to Lake Toba ecosystem. We assummed that water from Lake Toba is not safe for domestic water sources, and also unsafe for the other direct uses such as swimming activity. The presence of *E.coli*, coliform and heterotrofic bacteria in water lake poses a significant potential health risk to the people who use the Lake Toba water.

5.References

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