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Health Risk Assessment of Coliform Bacteria Contamination in the Dug Well Water with Qmra to Predict Public Health Risk in Small Island, Makassar

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ABSTRACT

Dug wells become the main choice for small islanders because dug wells are easier to obtain than other clean air. Coliform bacteria is an indicator of pathogenic bacteria in airborne microbial contamination. The problem of pollution of the island is growing with the increasing of population density on a small island. Quantitative Microbial Risk Assessment (QMRA) has been widely used in several studies to estimate health impacts associated with water use in coastal areas. This research was conducted in Bonetambung Island Makassar City. Examination of concentration levels of coliform bacteria using MPN method with health risk assessment to predict public health risk using QMRA. Bonetambung Island Makassar City obtained the result that from 10 points of water sampling dug well, only 1 point that meet the limits of coliform bacteria contamination, which is 4 MPN. That means, there are 4 coliform bacterial colonies in every 100 ml of well water. While 9 sampling points are not eligible. The result is using QMRA got final result that 3 point of sample of water taker indicated low risk, and 7 of them high risk.

Keywords: QMRA, Coliform, dug well water

INTRODUCTION

Water and health is a very related thing. The quality of water consumed can determine the degree of public health¹. Water wells become a major source of clean water for coastal communities. This is similar to a study conducted on Lae-lae Island, it is known that 58.7% of respondents use unprotected dug wells as a means of clean water for washing and cooking².

Dug wells become the main choice for small islanders because dug wells are easier to obtain than other clean air. However, household income can not be processed and reduced by people who can be a source of bacterial originating from stool^{3,4,5}. Coliform is an indicator of pathogenic bacteria in airborne microbial contamination⁶. Research showed that 74.5% of households in Bonetambung island do not have latrines

and 53.3% of respondents doing bowel movements at sea^{7,8}

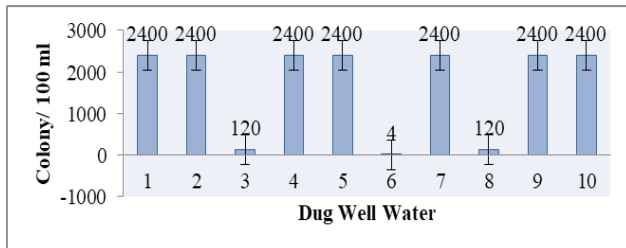
It is a threat to coliform bacteria contamination and will greatly affect the quality of water sources, both marine waters and shallow groundwater. These pathogenic bacteria cause major public health problems caused by contaminated water^{9,10}. A study on Kodingareng Island conducted by Andriyani, showed that of 87 diarrhea sufferers diagnosed by puskesmas, 35 respondents did not have latrines, and the average family members of respondents did bowel movement in the sea (71.4%)¹¹. In addition, Soller et al reported an increased health risk due to coastal waters affected by runoff containing impurities¹³. Quantitative Microbial Risk Assessment (QMRA) has been widely used in several studies to estimate health impacts associated with water use in coastal areas. The risk of disease / pathogen infection of a bacterium can be calculated using QMRA and can be used in predicting public health risks^{13,14,15}.

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From the results of research conducted in Bonetambung Island Makassar City obtained the result that from 10 points of water sampling dug well, only 1 point that meet the limits of coliform bacteria contamination, which is 4 MPN. That means, there are 4 coliform bacterial colonies in every 100 ml of well water. While 9 sampling points are not eligible (**Graph 1**).



Graph 1. Concentration of Coliform Bacteria

The presence of Coliform bacteria in the air allows and introduces enteropathogenic micro that can include health. Possible factors that can lead to positive results and the MPN persudative test are airborne contamination of the treatment method, particularly in raw air reservoirs, disinfection, and filtration. Other factors affecting production quality are air, type of equipment used, equipment maintenance and water handling¹⁷.

Based on the observations made there are several factors that cause the high concentration of Coliform bacteria in the well water in the island are as follows:

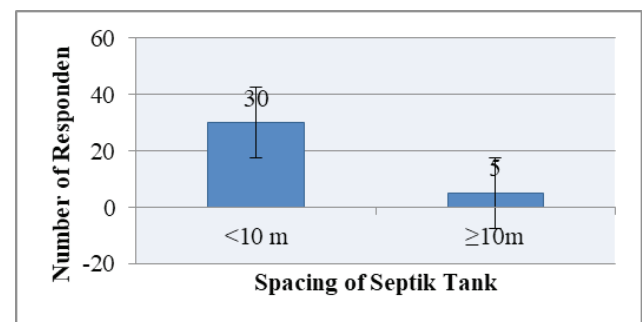
a. Well depth

The depth of the well will affect the spread of bacteria vertically. At a depth of 3 meters is estimated to contain bacteria. Therefore, the inner wall lining the water source should be waterproof up to 3 meters^{18,19}. Based on observations made on Bonetambung Island most of the wells have shallow depths. This is a factor that influences the high concentration of Coliform bacteria in the well water

This research is in line with that done by Natsir, that Total Coliform bacteria concentrations on dug wells are higher than wells, this is because the depth of the wells is shallower than that of the well so it is easily penetrated by Coliform bacteria contamination from septic tanks or in river water seeping through the soil pores²⁰.

b. Spacing of Wells with Pollution Source

Spacing of wells with septic tanks is one of the causes of pollution of water sources used for various needs of cleaners and drinking water. According to Susilawaty, the existence of septic tanks on the island is not safe because the distance is too close to the well digging residents. Based on research conducted there are 30 respondents who have septic tank spacing <10 m (**Graph 2**). This is supported by research conducted by Tendean, there is a meaningful relationship between the distance of wells with pollutant source to the number of Coliform bacteria in Kapitu Village, Amurang Barat District, South Minahasa regency.



Graphic 2. Spacing of Wells with Pollution Source

The distance of pollution of the ground by the bacteria horizontally is 11 meters, and vertical is

2 meters. It is important to know to prevent water spills by sewerage or feces. Based on this, it is clear that the closer the septic tank with wells dug, the greater the content of bacteria contained therein^{21,22}.

Assessment of Physical Condition of Dug Well Water

The normal temperature of water in nature (tropical) is about 20°C to 30°C. In addition, the temperature of a body of water is affected by the seasons, latitude (latitude), the height of the sea surface (altitude), time, air circulation, cloud cover, flow, and depth. Temperature changes affect the physical, chemical, and biological processes of water bodies. Island tofografi conditions affect the well water temperature in the island. As according to Tarigan and Edward in Galus (2014), factors that influence the high temperature of water such as altitude factors, the lower the potential where the rainfall potential will receive more, because in general the lower the temperature of a region will be higher²³. That is, the more pH or BOD rises, the pH or BOD of the well water will increase²⁴.

In the research, it was found that the average temperature of dug well water in Bonetambung Island was 31.46°C and the average pH was 8,24. In addition, if the bacteria are on the surface of water, then one of the factors that affect the survival of bacteria is salinity. Salinity provides influence on the magnitude of Coliform bacteria concentration in water. The higher the salinity of water the less Coliform bacteria in the water. On Bonetambung Island Makassar City obtained the result that from 10 points of water sampling dug well, only 1 point that meet the limits of coliform bacteria contamination, which is 4 MPN. That means, there are 4 coliform bacterial colonies in every 100 ml of well water. While 9 sampling points are not eligible Bonetambung Island, water salinity is at the value of 0.046.

The development of settlements with all the facilities resulted in the increasing demand for ground water. If that happens, it can cause a decrease in the groundwater surface which leads to salt water into the aquifer in the mainland, so the water wells residents feel brackish or salty²⁵. Several studies have shown that temperature, pH, and salinity have a correlation with the proliferation of Colifom bacteria in waters or sources of clean wa/ter.

Although there are other environmental factors that also give effect.

Quantitative Microbial Risk Assessment (QMRA)

The spread of disease in the era of globalization takes place so quickly that a risk assessment method is needed to overcome the current and future risk of disease. Therefore, a microbial risk assessment (QMRA) is needed as a method to determine the risk of microorganisms.

Based on the result of calculation using QMRA got final result that 3 point of sample of water taker indicated low risk, and 7 of them high risk (**Table 1**). In categorizing risks, WHO (2008) establishes a risk reference level standard for knowing the danger of pathogenic pollution in water. The risk-level reference level is 10^{-6} disability-adjusted life-years (DALY) per person per year, which is equivalent to a cancer lifetime risk of 10^{-5} (ie, 1 cancer case per 100 000 water consumers who have ingesting substances over the life span).

Table 1. Qualitative Microbial Risk Assessment of Well Water Dig Bone Tambung Island

NO	Sample Code	CR	CD	E	$P_{inf.d}$	$P_{inf.y}$	P_{iil}	Category
1	A1	2400	24	24	2.39728E-06	0.000875009	1.69516E-05	High Risk
2	A2	2400	24	24	2.39728E-06	0.000875009	1.69516E-05	High Risk
3	A3	120	1.2	1.2	1.19865E-07	4.37508E-05	6.71348E-06	Low Risk
4	A4	2400	24	24	2.39728E-06	0.000875009	0.000134269	High Risk
5	A5	2400	24	24	2.39728E-06	0.000875009	0.000134269	High Risk
6	A6	4	0.04	0.04	3.99551E-09	1.45836E-06	2.23783E-07	Low Risk
7	A7	2400	24	24	2.39728E-06	0.000875009	0.000134269	High Risk
8	A8	120	1.2	1.2	1.19865E-07	4.37508E-05	6.71348E-06	Low Risk
9	A9	2400	24	24	2.39728E-06	0.000875009	0.000134269	High Risk
10	A10	2400	24	24	2.39728E-06	0.000875009	0.000134269	High Risk

Based on the Drinking Water Guideline WHO (2008), the risk reference level standard is 10^{-6} . Thus, if the value of P_{iil} or $P_{inf.d}$ is greater than 10^{-6} (eg 10^{-5}) then the risk is high whereas if the value of P_{iil} or $P_{inf.d}$ is smaller than 10^{-6} (eg 10^{-7}) then

the risk is low. As for if the value of P_{iil} or $P_{inf.d} = 10^{-6}$ then assumed with medium risk.

Dug well water sources that include low risk should still be wary because the level of risk

may rise to medium risk and even become a high risk. Other factors that can increase the risk of gastrointestinal disease, namely there are still island communities who do not cook water wells before drinking.

CONCLUSION

The concentration of Coliform bacteria on the well water source in Bone Tambung Island exceeds the standard of clean water quality standard. Based on the calculation of Quantitative Microbial Risk Assessment (QMRA), Bonetambung Island as a whole has a high risk of coliform bacteria contamination. This makes the island community must remain vigilant against the use of dug wells.

Conflict of Interest: None

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Ethical Clearance: Obtained from University committee

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