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Potential hazards from hygiene, sanitation and bacterium of refill drinking water at Barrang Lompo island (water and food safety perspective)

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Abstract. Coliform bacteria are suspected to come from faeces. As a result, their presence in various places ranging from drinking water, foodstuffs or other ingredients to human needs are not expected. This research aimed to describe bacterial contaminations, depot sanitations, equipment sanitations, worker hygiene, raw water quality, and refill drinking water in Barrang Lompo island in 2017. The observational research applied descriptive approach. Water samples collected grab from the drinking water depot taps, then examined using Most Probable Number (MPN) method. The results showed that three of six depots have qualified drinking water quality. Raw water samples from all depots indicated that none were eligible. The samples examined contained gram-negative bacteria. The types of bacteria that grew on the sample were *Klebsiella pneumoniae* and *Pseudomonas aerogenosa*. In the environmental sanitation depots and worker hygiene, there was no one eligible. Sanitary appliances were all eligible and there were depots that used reserve osmosis methods and used combination methods between reserve osmosis and ultraviolet light. It was concluded that almost all samples of drinking water were contaminated by bacteria. Owners and depot workers were advised to improve and implement better hygiene and sanitation.

1. Introduction

According to Global Water Supply and Sanitation Assessment 2000 Report claimed by WHO/UNICEF around 1.1 billion world populations still found difficulties to access clean water and almost 2.5 billion inhabitants has no accessed to proper sanitation [1]. In addition, about 10 thousands dwellers that lived in developing countries were dead every day because of the diseases caused by unavailability of clean water and low quality of environmental sanitation. In spite of having means to access clean water easier, most of the inhabitants in developing countries prefer to use water without any process first [2].

More than 100 million Indonesia's citizens lack the access to clean water and at 150 million water sources contaminated by pollutants [3]. One of the Indonesia's government strategies to fulfill water needs was through a policy to create local water company or Perusahaan Daerah Air Minum (PDAM) that engaged in distribution and water supply facilities for general public. Current drinking water standard refers to the Regulation of Health Minister No. 492 of 2010.

Clean water supply for drinking water should comply the existing regulation. Drinking water was categorized safety for societies just if it met the physical, microbiological, chemical, and radioactive parameter. For microbiological parameter, it included bacterial *Coliform* and *Escherichia coli*. The higher contamination of *Coliform* bacteria, the higher attendance risk of other pathogens, such as



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bacteria, virus, and parasite [4]. One example of the pathogens was *Escherichia coli* which caused symptoms of diarrhea, fever, abdominal cramps, and vomiting [5]. *Escherichia coli* was usually made as indicator of contamination of human feces and it also showed the appearance of other potential pathogens in drinking water [6].

Diarrhea was in the second position that led to the mortality of children under five years old in the world. In Indonesia, diarrhea was the main cause of death in the children under five years. Riskesdas reports showed that diarrhea was behind the 31% mortality of children in age from a month to a year, and 25% mortality in children from one to four years old [7]. Based on the data on Barrang Lompo Primary Healthcare in Singkarang Sub-district in Makassar City (2015) diarrheal diseases was one of the notable public health problems and was classified on ten major diseases in this primary health care scope. The number of people with diarrhea in 2013, 2014, and 2015 was 192, 187, and 199 inhabitants, consecutively [8]. Till this time, the needs for clean water and drinking water for the residents of Barrang Lompo was fulfilled through dug well, boreholes, and clean water supply business [9].

Drinking water was the main source consumption for the family as well, such refill water. Residents could feel economic benefits for this water, especially in lower middle class families. However, not all depot gave guarantee to consumer towards the good quality of product that they produce. According to research in risk analysis in drinking water in Semarang (2015) there was a risk of bacterial contamination in clean water sources and water treatment process, and even the high risk bacterial contamination was found in processed water [10]. Another research found that there was connection between existence of *Escherichia coli* in drinking water and diarrheal for consumers in refill drinking water in Ciputat Timur [11] and that about 55.6% samples of refill drinking water in Padang did not meet the specified requirements the regulation of Health Minister [12]. A research result also concluded that there was a significant correlation between hygiene sanitation and microbiological quality of drinking water refills [13].

The number of refill drinking water depots in Barrang Lompo Island in 2016 was six depots which used source of raw water from boreholes that most likely made *Coliform* bacteria easy to contaminate. Oppositely, it was different from raw water in refill drinking water in Makassar that used raw water from PDAM. Many numbers of DAMIU scattered in Barrang Lompo Islands were not guarantee the quality of drinking water in this region since the management and filling of the depots could not always been supervised. As a consequence, lots of public health issues could be emerged distinctively.

2. Materials and Methods

This research used observational method with descriptive approaches. This research conducted in refill drinking water depots in Sangkarang Sub-district in Barrang Lompo Island in Makassar City and also in Microbiology Laboratory in Medical Faculty in Hasanuddin University. This research held from 20 February 2017 to 6 March 2017. Population in this study was all refill drinking water depots in Sangkarang Sub-district in Barrang Lompo Island in Makassar City and the sample was six depots of refill drinking water in Sangkarang Sub-district in Barrang Lompo Island in Makassar City. In six depots, AMIU was taken and 150 ml raw water per sample, with total 12 samples. Type of sampling was non probability sampling which sampling techniques that do not provide the same opportunity for each member of the selected population to be sampled because of the relatively small population.

3. Results

The number of *Coliform* bacteria, total colony, types of the bacteria that was found in raw water and refill drinking water in DAMIU in Barrang Lompo Island shown in the table 1. Table 1 illustrates that there were three depots which did not meet the requirements both in raw water and refill drinking water and there were three depots that did not fulfill the criteria of raw water, yet they still met the qualifications for refill drinking water. Depot that has the highest MPN was AB D3 at 460 and the lowest one were AMD3 at 28, respectively. Also, table 1 shows that there was no one *Escherichia Coli* that found in both raw water and refill drinking water, yet there were found two types of bacteria called *Klebsiella pneumonia* dan *Pseudomonas aerogenosa*.

Table 1. *Coliform* bacteria contaminations in refill drinking water and raw water in dam in Sangkarang sub-district in Barrang Lompo island in Makassar City 2017.

No.	Sample code	MPN/100ml Index	Total Colony	Culture and Bacterial Identification
1	AB D1	4	12	<i>Pseudomonas aerogenosa</i>
2	AM D1	0	0	uncultured and unidentified
3	AB D2	15	52	<i>Klebsiella pneumonia</i>
4	AM D2	0	0	uncultured and unidentified
5	AB D3	460	88	<i>Pseudomonas aerogenosa</i>
6	AM D3	28	80	<i>Pseudomonas aerogenosa</i>
7	AB D4	93	130	<i>Klebsiella pneumonia</i>
8	AM D4	4	6	<i>Klebsiella pneumonia</i>
9	AB D5	8	59	<i>Klebsiella pneumonia</i>
10	AM D5	7	32	<i>Klebsiella pneumonia</i>
11	AB D6	4	15	<i>Klebsiella pneumonia</i>
12	AM D6	0	0	uncultured and unidentified

Observational result for environmental sanitation, sanitary equipments, and workers hygiene in DAMIU that existed in Sangkarang in Barrang Lompo Island showed on the in table 2. Table 2 illustrates that in environmental sanitation aspect, there were two depots which met the standard and others still did not meet the defined criteria according to regulation of the Indonesia's Minister of Industry and Trade No. 651/MPP/Kep/10/2004. Based on building aspects of the six drinking water depots, none of them fulfilled 100% criteria according to regulation of the Indonesia's Minister of Industry and Trade No. 651/MPP/Kep/10/2004. Moreover, sanitary equipments in the six drinking water depots in Barrang Limpo Island has qualified with the requirements according to regulation of the Indonesia's Minister of Industry and Trade No. 651/MPP/Kep/10/2004. Furthermore, no one drinking water depots qualified the defined standard according to regulation of the Indonesia's Minister of Industry and Trade No. 651/MPP/Kep/10/2004. Unfulfilled criteria was in using medical mask which showed that 100% workers did not use this mask in workhours.

4. Discussion

The laboratory results on raw water and refill drinking water depots in Sangkarang Sub-district in Barrang Lompo island showed that raw water in all depots have no qualified to standard, however, there were three depots that could meet the standard on drinking water according to Indonesia's Health Ministry regulation No. 492 year 2010.

All raw water samples were stated positive contained *Escherichia coli* with MPN/100 ml water, in which the largest one found in D3 samples at 460 MPN/100 ml water, while the smallest one found in D1 and D6 samples. The presence of Coliform bacteria in drinking water refills indicated the possibility of contamination and the existence of enteropathogenic microbes that can interfere with health. The possible factors that could cause positive results and presumptive MPN test was the contamination of drinking water refills on processing method, specifically on raw water reservoir, disinfection, and filtration. Other factor that influenced water quality of production was raw water, the type of equipment used, the maintenance of equipments and handling of water treatment and distribution [14].

Based on the following research, not one of *Coliform* bacteria was found on samples, yet *Klebsiella pneumonia* and *Pseudomonas aerogenosa* were discovered. The results of bacterial examination samples that grew much in samples was *Klebsiella pneumonia* bacteria. This bacteria could be easily found on skin, throat, digestive tract, and even in sterile wounds which also led to pneumonia and bronchitis [15, 16].

Table2. Environmental Sanitation, Sanitary Equipments, and Workers Hygiene in DAMIU in Sangkarang Sub-district in Barrang Lompo Island in Makassar City 2017

Environmental Sanitation	N	%
Site		
a. Qualified	2	33
b. Unqualified	4	67
Building		
a. Qualified	0	0
b. Unqualified	6	100
Total	6	100
Sanitary Equipments	N	%
Made of food tare, corrosion-resistant, do not react with chemicals	6	100
a. Qualified	0	0
b. Unqualified		
The tool used is still in its lifetime		
a. Qualified	6	100
b. Unqualified	0	0
Materials not made of heavy metals that are soluble in water		
a. Qualified	6	100
b. Unqualified	0	0
Total	6	100
Workers Hygiene	n	%
Must be free from infectious diseases		
a. Qualified	6	100
b. Unqualified	0	0
Free from wounds, boils, and other injuries		
a. Qualified	6	100
b. Unqualified	0	0
Wash hands before and after serving the consumers		
a. Qualified	5	83
b. Unqualified	1	17
While serving the consumers, not eating, not having long nails, not scratching, and not prying ear/nose/teeth	6	100
a. Qualified	0	0
b. Unqualified		
Use medical mask		
a. Qualified	0	0
b. Unqualified	6	100
Must be free from infectious diseases		
c. Qualified	6	100
d. Unqualified	0	0
Total	6	100

Furthermore, sanitation and hygiene of DAMIU itself could affect MPN results. Poor sanitation and low hygiene induce contamination. Based on observational research in, there were some depots that have poor sanitation and low hygiene and disinfection process of less qualified containers. Contamination was not only caused by the high contain of microbial pollution from raw water

used but also inadequate filtration process, sterilization used ultra violet or ozonization that were usually done in drinking water refill depots, and sanitation along with the process of filling the water to gallons of drinking water [17]. Based on location criteria that involves free from pollutants, such dust, garbage dump, breeding place of insects, poor sewer system, the results showed that just two depots that were eligible to the drinking water requirements. The observational output for building criteria such as cleanliness of the floor, wall, ceiling, door, lighting, and ventilation pointed that there was no one depot to fulfill 100% standard issued. If properly observed that it could contaminate processed water.

Observation on adequate lighting on production signified that all depots have utilized adequate lighting on production area, washing place, rinsing, sterilization, filling gallons. These places should be bright enough to find out physical contamination, thus workers has a sight to contamination products [18]. Results of research conducted on drinking water depots in Sangkarang Sub-district in Barrang Lompo in Makassar City showed that every depot has met the criteria needed. Observational results on sanitation equipments with tools and fittings criteria should be made by food tare, not corrosive, not react to with chemical material, tools still in a lifetime, and not made from heavy metal that is soluble in the water. This represented that depot owners has understood sanitation equipments of qualified drinking water depots.

Equipment was highly important to turn raw water become drinking water. The great condition and qualified criteria on equipment condition on drinking water treatment would produce high quality of drinking water as well. A significant correlation was found between condition of drinking water refills processing and its bacteriological quality [19] but on the contrary, in other study no correlation between drinking water treatment and biological quality of refill drinking water was found [20]. Observational results and direct interview with workers in six drinking water depots in Sangkarang Sub-district in Barrang Lompo in Makassar City showed that the use of masks was still not eligible, in which no one workers used it in their working hours. This happened because most of them consider consumers would feel offended when seeing workers used masks. Moreover, criteria of workers hygiene that was not fulfilled in one depot was wash hands before and after serving consumers. This would lead to drinking water contamination by bacteria on hands with the result that could generate the certain diseases for those who consume the water later. Workers who did not behave cleanly and healthily as if not wash their hands or smoking when serving the consumers undeniably would affect drinking water.

Observational results for healthiness of workers such as not having infectious diseases, skin diseases, ulcers, and other diseases showed that all workers were in good health. In terms of use of clean clothes, all laborers used net clothes when in workhours or when doing production process of refill drinking water [21]. Good habits were found in all laborers in drinking water depots in Sangkarang Sub-district Barrang Lompo island in Makassar City such as do not eating, not having long nails, no scratching, and scraping ears/nose/teeth when they were in production process.

5. Conclusion

The bacteriological quality of raw water and refill drinking water in six depots showed that none raw water in depots that fulfilled the proper standard, while in refill drinking water, three depots has been eligible to reach the certain parameter of drinking water refills. *Klebsiella pneumoniae* dan *Pseudomonas aerogenosa* was found on refill drinking water depots. Environmental sanitation for drinking water depots based on location has qualified criteria set by Ministry of Home Affairs. Yet, in building aspect, all depots did not meet the defined criteria. On the contrary, equipment sanitation of drinking water depots represent that all depots have fulfilled criteria issued by Ministry of Home Affairs.

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