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Identification of*total coliforms*and*e. Coli*bacteria contamination in the refill drinking water depot located in Pringsewu sub-district

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ABSTRACT

The demand for high-quality and safe drinking water has led to an increase in the number of refill drinking water depots. While these depots offer a more affordable option, not all of them can guarantee the safety of their products. Coliforms, which are indicative of fecal contamination, can pose a significant health risk to consumers. This research aims to identify the presence of total coliform and E. Coli bacteria in the refill drinking water depots located in Pringsewu sub-district. The study employed an analytical method with an observational approach to analyze the samples collected from the depots. The results revealed that 3 out of 5 depots (60%) tested positive for total coliform bacteria above the standard, and one sample (20%) did not meet sanitation inspection standards.

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1. Introduction

The target for providing drinking water based on the 2020-2024 RPJMN and SDGs 2030 is 100% access to adequate drinking water and 15% access to safe drinking water and by 2030 the target for safe drinking water must be 45%. Fulfillment of unsafe drinking water quality is highly correlated with the high incidence of infectious diseases in particular, including stunting, which in turn has an impact on public health (Widyawati, 2021).

Currently, refillable drinking water is the most widely used source of drinking water in Indonesia. Around 3 out of 10 households in Indonesia (31.1%) use refilled drinking water for drinking purposes. Household users of refillable drinking water in DAMIU increased by 19.6% in the 2008-2020 period (National Water & Sanitation Information Services, nd). In a study conducted in 2020, 7 out of 10 Indonesian households consumed drinking water contaminated with e-coli (Widyawati, 2021).

There are several existing regulations regarding refill drinking water depots, namely regarding drinking water quality requirements which have been regulated regarding mandatory parameter thresholds, for example regarding microbiology such as (E-Coli bacteria), regarding chemistry such as (chemical elements argon, fluorine). , chrome, etc.), and those that are not directly related such as smell, temperature, etc.), as well as additional parameters that are rarely found. The procedures for monitoring the quality of drinking water are regulated by Minister of Health Regulation number 736 of 2010, internally monitoring the quality of drinking water refills is carried out by entrepreneurs. Externally, supervision is carried out by the Health Service, by carrying out laboratory examinations (at Balai POM, BTKL, etc.). This

Minister of Health Regulation regulates sanctions by the Regional Government, in the form of warnings up to prohibiting distribution in the region (Ministry of Health of the Republic of Indonesia, 2013)

The existence of refill drinking water depots continues to increase in line with the dynamics of the community's need for drinking water that is high quality and safe for consumption. Even though it is cheaper, not all refill drinking water depots have products that are guaranteed to be safe (Apriliana et al., 2014). In line with this, the research results show that 42% of the refillable drinking water depots in Bandar Lampung were contaminated with Escherichia coli. 42% of the refillable drinking water depots in Bandar Lampung had an MPN coliform index of >0/100 ml of sample and of the total samples there were 12% contaminated with Escherichia coli. . The results of other research show that almost half, namely 49%, of the total 47 depots examined did not meet cleanliness standards (Ishak Nurlang et al., 2020). In Manado City, drinking water refills from depots were analyzed for bacterial contamination, from nine sub-districts it showed that the nine drinking water samples tested contained microbial contamination ranging from 1.6 x 103 to 2.9 x 104 colonies/mL. All samples contained coliform bacteria which did not meet the requirements according to Minister of Health Regulation no. 492/MENKES/Per/IV/2010 which states 0 APM/100 mL sample (Andrian G. Bambang et al., 2014)

In the Republic of Indonesia Minister of Health Regulation No.492/MENKES/PER/IV/2010 it is stipulated that the maximum level of Escherichia coli and Coliform bacteria is 0/100ml. Coliforms are also known as "Indicator" organisms, water pollution caused by fecal contamination is a serious problem because it has the potential to transmit disease. Testing for coliform bacteria can be an appropriate step to determine whether other pathogenic bacteria are present (Mijin Seo et al., 2019).

The water used by the community for household needs (such as cooking, bathing and drinking) in Pringsewu Regency is managed by PDAM Way Sekampung and tends not to reach all sub-districts in Pringsewu Regency. PDAM Way Sekampung is only able to access two sub-districts, namely Pringsewu District and Gadingrejo District, out of a total of 9 (nine) sub-districts in Pringsewu Regency (Umayasari et al., 2022).

Based on the background description above, it is necessary to carry out research related to checking the quality of refillable drinking water circulating in the community. This research itself is useful in helping the health department monitor the quality of drinking water and managers of refill drinking water depots in making improvements.

2. Method

The type of research used is analytical with an observational approach to observe the presence or absence of total coliform and E.Coli bacteria. The samples in this study were 5 refill drinking water depots in the refill drinking water depot in Pringsewu sub-district. Sample examination was carried out at the Regional Health Laboratory of Lampung Province. Samples were collected in sterile sample bottles. Primary data obtained directly from the testing site includes research results of total Coliform and E. Choli MPN content tests. Data analysis was carried out in an observational manner, displaying data on the number of bacteria from the results of observations made during the examination of total coliform and E.Coli bacteria found in refill drinking water samples and then compared with the standards set by the Republic of Indonesia Minister of Health Regulation Number 2 of 2023.

3. Research results and discussion

3.1 Research result

Univariate analysis was carried out to determine the frequency distribution picture studied, namely bacteriological analysis of total coliforms and E. Coli in refill drinking water at the refill drinking water depot in Pringsewu District as follows:

Table 1.
Frequency Distribution of Raw Water Sources

Raw Water Source	Number (n)	Percentage (%)
Boreholes	5	100%
Mountain Water	0	0
Excavated Wells	0	0
Total	5	100%

From table 1 above, the data shows that all refill drinking water depots examined use drilled wells as a source of raw water, which is then processed into refill drinking water.

Table 2.
Frequency Distribution of Bacteriological Quality of Total Coliforms

Bacteriology Total Confirm	Number (n)	Percentage (%)
Qualify	2	40%
Not eligible	3	60%
Total	5	100%

From table 2. above, it shows that of the total of 5 refill drinking water depots studied, 2 depots fulfilled the requirements for total coliform bacteria content (40%), while 3 depots did not meet the requirements for total coliform bacteria (60%).

Table 3.
Frequency Distribution of E.Coli Bacteriological Quality

E. Coli bacteriology	Number (n)	Percentage (%)
Qualify	5	10%
Not eligible	0	0%
Total	5	100%

From table 3. above, the data shows that of the total of 5 refill drinking water depots studied, all met the requirements for E.Coli content of 5 depots (100%),

Table 4.
Distribution of Sanitation Inspection Frequency

Sanitary Inspection	Number (n)	Percentage (%)
Qualify	4	80%
Not eligible	1	20%
Total	5	100%

From table 4. above, the data shows that a total of 5 drinking water refill depots were studiedThose who met the requirements for sanitation inspection were 4 depots (80%), while those who did not meet the requirements for sanitation inspection were 1 depot (20%).

3.2 Discussion

Analysis of raw water sources

Table 5.
Analysis of Raw Water Sources

Depot	Raw Water Source
Depot A	Boreholes
Depot B	Boreholes
Depot C	Boreholes
Depot D	Boreholes
Depot E	Boreholes

Table 5. Shows that the raw water source processed by the refill drinking water depot comes 100% from its own drilled well. In accordance with the Republic of Indonesia Minister of Industry and Trade

Decree No.651/MPP/kep/10/2004, water sources for refill drinking water depots must carry out laboratory tests in the form of raw water quality testing which must be carried out in a water quality inspection laboratory appointed by the district/city government or accredited. Raw water quality testing is carried out at least once every three months for coliform analysis and twice a year for complete chemical and physical analysis (Minister of Trade of the Republic of Indonesia, 2004).

Unsafe water can cause many illnesses, deaths, and economic failure. Therefore, monitoring water quality is very important. A study conducted on 218 drinking water samples to assess water quality found that the majority of water quality was above standard limits. This indicates that the drinking water source is contaminated (Bedada et al., 2018). Other research results related to bacteriological analysis of total coliforms, turbidity, pH and temperature were measured on water samples originating from taps, open springs, open dug wells and protected springs. Most drinking water sources were found to have total coliform counts above the recommended standard limits, as well as having a high sanitation risk score. There was a statistically significant difference between water sources with TC and TTC ($p < 0.05$) and there was a statistically significant positive correlation between total coliform count and sanitation risk score ($p < 0.01$). Most water sources do not meet the WHO recommended turbidity values (Tsega et al., 2014)

Study of water samples collected from the source, disinfection points, tanks, distribution systems and household taps. All samples were analyzed for bacteriological, chemical and physical quality parameters using standard procedures. The research results showed that all samples were positive for containing*total coliforms*with amounts ranging from 12 to 120 CFU/100 ml, while fecal coliforms were only detected in 37% of tap water samples. (Duressa et al., 2019)

Apart from that, there is a significant relationship between the condition of raw water and the hygiene of officers/employees and microbial contamination of refilled drinking water (Khiki Punawati Kasim et al., 2014). Meanwhile, based on the results of the chi-square test analysis, the relationship between raw water and bacteriological quality was obtained with a value of $p = 0.065 > 0.05$, which shows that there is no significant relationship between raw water and bacteriological quality (Ricky C. Sondakh et al., 2015)

Protection of raw water sources and monitoring are highly recommended (Tsega et al., 2014).A good drainage system, waste disposal system, and good water disinfection using chlorine are very important to provide safe and suitable drinking water for the community (Duressa et al., 2019)

Bacteriological analysis of total coliforms

Table 6.
Bacteriological Analysis of Total Coliforms

Depot	Test result	Quality Standards (Maximum Content)	Conclusion
Depot A	79 CFU/100 ml	0 CFU/100 ml	Not eligible
Depot B	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot C	8 CFU/100 ml	0 CFU/100 ml	Not eligible
Depot D	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot E	5 CFU/100 ml	0 CFU/100 ml	Not eligible

Based on table 6, the results of the total coliform bacteriological examination at the Regional Health Laboratory of Lampung Province, the coliform test results were obtained on refill drinking water samples which were positive for containing 60% total coliform or 3 drinking water samples where the highest total coliform was found in depot A with 79 CFU/100 ml. Drinking water samples were negative for total coliform contamination of 40% or 2 drinking water samples with total coliforms of 0 CFU/100 ml drinking water samples.

The coliform group has been widely used as an indicator of water quality.*Total coliforms*is a group of bacteria that are often found in the environment, for example in soil or plants, as well as the intestines of mammals, including humans. Its presence in water indicates the possibility that the water is contaminated (Pal, 2014). Coliform bacteria serve as the main indicator of water pollution and the potential presence of

dangerous pathogens. Accurate and reliable detection and counting of coliforms in drinking water is essential to monitor water quality and implement appropriate interventions (Tambi et al., 2023)

Many factors influence the presence of total coliform bacteria in refillable drinking water, including the operator/owner's lack of awareness of cleanliness, surrounding environmental conditions, filter cleanliness, and the condition of the drinking water depot building. The research results related to testing for total coliform bacteria from 8 samples examined, 7 of which were contaminated with coliform bacteria. By analyzing the presence and number of coliform bacteria in refilled drinking water, we can find out the factors that influence the presence of coliform bacteria in refilled drinking water (Isnaini Putri & Bambang Priyono, 2022)

Research resultIn another study, 51 drinking water depots were inspected, showing that the drinking water was contaminated with microbes in 26 drinking water depots (51%), 33.33% contaminated with E. coli, and 51% contaminated with total coliforms (Pakpahan et al., 2015). After carrying out complementary tests, from the 16 samples analyzed, 8 samples contained bacteria including Klebsiella sp., Enterobacter, Pseudomonas sp., and Salmonella sp. (Amelia, 2019) . In addition, analysis of 10 samples taken using the total saturated sampling method. Data were analyzed using frequency distribution. The research results showed that positive samples were obtained as many as 6 samples (60%) and exceeded the contamination limit and negative samples were obtained as many as 4 samples (40%) (Askrening & Yunus, 2017)

When coliform bacteria are found, an investigation must be carried out to find out how the contamination got into the water. Collect additional, or "repeat," water samples for testing, and check the entire management system. Taking repeated samples can help determine whether there is a problem in the management system. If any of the repeat samples detect the presence of coliform bacteria, the initial finding is considered confirmed (Washington State Department of Health, nd)

If there is total coliform bacteria (at least 2 samples with coliform bacteria) in drinking water, systemDrinking water management should be checked to find and eliminate possible sources of contamination. Once the source is identified, it can be addressed by repairing the system, flushing it, and adding chlorine. Water testing is an excellent approach to ensure the supply and availability of drinking water that is free from contamination. At the same time, public awareness of sanitation and more hygienic storage conditions for drinking water is needed to avoid the use of contaminated water (Roy et al., 2013).

Bacteriological analysis of E.Coli

Table 7.
Bacteriological Analysis of E.Coli

Depot	Test result	Quality Standards (Maximum Content)	Conclusion
Depot A	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot B	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot C	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot D	0 CFU/100 ml	0 CFU/100 ml	Qualify
Depot E	0 CFU/100 ml	0 CFU/100 ml	Qualify

Based on table 7, the results of E.Coli bacteriological examination at the Lampung Province Regional Health Laboratory, the results of E.Coli bacteria testing on refilled drinking water samples were obtained, all refilled drinking water samples (100%) were negative for E.Coli bacterial contamination.

In 2018, diarrhea in Indonesia was classified as a potential endemic disease, an extraordinary event that is often accompanied by death. Water is a medium for transmitting diarrheal diseases in the community, this transmission can occur because water is contaminated with E.coli bacteria. Because the presence of E. coli shows a relationship between the incidence of diarrhea cases and E. coli bacteria whose distribution pattern is clustered (Munawarah et al., 2022)

*Escherichia coli (E. coli)*is the only member of the total coliform group of bacteria that is only found in the intestines of mammals, including humans. The presence of E. coli in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens, such as bacteria, viruses, and parasites. About 80% of infectious diseases in the world are transmitted through water. According to WHO estimates, around 80% of water pollution in developing countries is caused by

domestic waste. In India, 70% of water is seriously polluted and 75% of diseases and 80% of child deaths are caused by water pollution (Pal, 2014). E. Coli also functions as a main indicator of water pollution and the potential presence of dangerous pathogens (Tambi et al., 2023)

*Total coliforms, fecal coliforms, and E. coli*is an indicator of drinking water quality. The total coliform group is a large collection of different types of bacteria. Fecal coliform is a type of total coliform which is mostly found in feces. E. coli is a subgroup of fecal coliforms. When water samples are sent to the laboratory, they are tested for total coliforms. If total coliforms are present, the sample will also be tested for fecal coliforms or E. coli, depending on the laboratory testing method.(Washington State Department of Health, nd)

Many diseases are associated with poor drinking water quality including diseases caused by diarrheal pathogens, especially in developing countries where access to a consistent water supply is a problem (Odonkor & Mahami, 2020). Waterborne diseases cause high morbidity and mortality rates in developing countries. Diarrhea and typhoid are among the top five diseases that cause a significant public health burden and economic costs. Therefore, monitoring drinking water quality is very important to prevent water-borne diseases. (Keleb et al., 2022)

The following are factors that influence the presence of E. coli, including sanitation, raw water conditions, sampling locations, and employee hygiene. The factors that most influence the presence of E. coli in refillable drinking water are sanitation, there is standing water at the management location, there is no rubbish dump, close to a pile of used goods, close to the company, close to the market, the depot building does not comply with depot standards good ones, have dirty floors, open ceilings, do not have adequate drainage channels... (Imam Hardjono et al., 2019). The results of other research show that 40.7% of site sanitation, 22.2% of equipment sanitation, and 62.2% of the hygiene of drinking water depot handlers are in the poor category. So it was found that 22.2% of the presence of Escherichia coli bacteria in drinking water refills did not meet the requirements. and there is a relationship between the hygiene of drinking water depot handlers and the presence of Escherichia coli bacteria in drinking water refills (Arumsari et al., 2021).

Sanitary inspection analysis

Table 8.
Sanitation Inspection Analysis

Depot	Sanitary Inspection Results	Assessment Standards	Conclusion
Depot A	< 70	> 70	Not eligible
Depot B	> 70	> 70	Qualify
Depot C	> 70	> 70	Qualify
Depot D	> 70	> 70	Qualify
Depot E	> 70	> 70	Qualify

Based on table 8, the results of the sanitation inspection of drinking water depots using standard guidelines from the RI Regulation No. 43 of 2014 concerning sanitation hygiene of drinking water depots, including the objects of assessment are premises, equipment, handlers as well as raw water and drinking water. It was found that depot A did not meet the established assessment standards. If the inspection score reaches 70 or more, it is declared to meet the physical fitness requirements. If the inspection score is below 70, it is stated that it does not meet the physical fitness requirements, and the entrepreneur is asked to immediately repair the problematic object. From the results of inspections of depots that do not meet sanitation standards, these include the location not being in an area free of environmental pollution because it is close to waste disposal sites (trenches) and septic tanks. The building is made of brick/brick that is not plastered. The floor surface is not waterproof, there is a lot of dust, because the floor surface is not smooth.

It is known that sanitation coverage in Indonesia, especially drinking water, does not meet the needs of the population (Badun, 2021). Sanitation hygiene factors that have a significant relationship to coliform bacterial contamination are sanitation facilities and behavior, while drinking water processing facilities,

raw water, and consumer service hygiene are factors that are not significant in determining bacterial contamination (Aeni et al., 2023). There is a significant relationship between sanitation and bacteriological quality. There is a significant relationship between the processing process and depot sanitation hygiene and the bacteriological quality of drinking water (Ricky C. Sondakh et al., 2015). Meanwhile, the results of other research regarding the sanitary conditions of refill drinking water depots and microbial contamination of refill drinking water did not have a significant relationship (Khiki Punawati Kasim et al., 2014)

Research resultothers show that there is a significant relationship between equipment sanitation (p=0.001); and hygiene conditions of handlers (p=0.001) with the presence of coliform bacteria. Meanwhile, in terms of sanitary conditions (p=0.537), there was no significant relationship with the presence of coliform bacteria. (Virdha Amartya et al., 2023).

The determinants of microbial contamination are knowledge (p value = 0.01), operator attitude (p value = 0.05), operator knowledge (p value = 0.026), operator cleanliness (p value = 0.05) and drinking water depot sanitation (p value = 0.044) (Pakpahan et al., 2015). The results of the analysis showed that there was no relationship between sanitation of the premises and the presence of Escherichia coli bacteria (p value = 0.187), there was no relationship between equipment sanitation and the presence of Escherichia coli bacteria (p value = 0.284), and there was a relationship between handler hygiene and the presence of Escherichia coli bacteria (p value = 0.284). p value = 0.016) (Arumsari et al., 2021).

3. Conclusion

There are 3 refill drinking water depots that do not meet the total coliform bacteriological requirements and of these three depots there is 1 depot that does not meet the sanitation inspection requirements. Place sanitation factors have a significant influence on the presence of bacteriological contamination and sanitary inspections. The limitation of this research is that the sample used was only 5 depots. It is recommended that future researchers use larger samples. The contribution of this research is to provide information to depot managers and the Pringsewu district health service about the results of inspections of the quality of refillable drinking water, so that it is hoped that there will be follow-up from the health service and improvements from drinking water depot managers.

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