

# Evaluation of Refillable Drinking Water Quality Based on MPN Coliform and Escherichia coli in Sesetan Village

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## Evaluation of Refillable Drinking Water Quality Based on MPN *Coliform* and *Escherichia coli* in Sesetan Village

### Evaluasi Kualitas Air Minum Isi Ulang Berdasarkan MPN *Coliform* dan *Escherichia coli* di Kelurahan Sesetan

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#### Abstract

**Background:** Refilled drinking water given by depots that currently have a permit for operation can be used to meet the community's drinking water demands. The quality of refilled drinking water, however, has been discovered to be tainted with germs that can cause health problems. **Purpose:** The objective of this study is to assess the quality of replenish drinking water in Sesetan Village using MPN coliform and *Escherichia coli* as indicators. **Method:** A qualitative approach to descriptive observational research. The Ministry of Health standard number 492/Menkes/PER/IV/2010 is used to assess the quality of drinking water. In this investigation, ten samples were used. The sampling took place in the Sesetan Village neighborhood of South Denpasar, Bali. **Result:** MPN Coliform was found in four samples: 96 MPN/100 mL (X<sub>1</sub>), 38 MPN/100 mL (X<sub>7</sub>), 15 MPN/100 mL (X<sub>8</sub>), and 5 MPN/100 mL (X<sub>10</sub>). Meanwhile, all of the samples tested negative for *Escherichia coli*. **Conclusion:** Based on drinking water quality criteria, 4 DAMIU (40%) did not meet quality requirements (Permenkes number 492/Menkes/PER/2010).

**Keywords:** Coliform, *Escherichia coli*, Refill Drinking Water Quality, Sesetan Village.

#### Abstrak

**Latar Belakang:** Pemenuhan kebutuhan air minum di masyarakat dapat memanfaatkan air minum isi ulang yang disediakan oleh depot yang telah memiliki izin untuk penyelenggaraannya. Akan tetapi, kualitas air minum isi ulang masih ditemukan tercemar bakteri yang mampu mengakibatkan gangguan pada kesehatan manusia. **Tujuan:** Mengevaluasi Kualitas Air Minum Isi Ulang Berdasarkan MPN *Coliform* dan *Escherichia coli* di Kelurahan Sesetan. **Metode:** Metode penelitian deskriptif observasional dengan



pendekatan kualitatif. Evaluasi kualitas air<sup>20</sup> minum menggunakan standar Kemenkes nomor 492/Menkes/PER/IV/2010. Terdapat 10 sampel yang digunakan pada penelitian ini. Pengambilan sampel dilakukan di wilayah Kelurahan Sesetan, Denpasar Selatan, Bali. **Hasil:** Hasil penelitian menunjukkan 4 sampel mengandung MPN *Coliform* yakni 96 MPN/100 mL (X<sub>1</sub>), 38 MPN/100 mL (X<sub>7</sub>), 15 MPN/100 mL (X<sub>8</sub>) dan 5 MPN/100 mL (X<sub>10</sub>). Sedangkan seluruh sampel negatif *Escherichia coli*. **Kesimpulan:** 4 DAMIU (40%) tidak memenuhi standar baku berdasarkan persyaratan kualitas air minum (Permenkes nomor 492/Menkes/PER/2010).

**Kata kunci:** Coliform, *Escherichia coli*, Kualitas Air Minum Isi Ulang, Kelurahan Sesetan.

### Introduction

Water is both a life supply and a vital requirement for human survival (Sudaryati and Adnyana, 2018). Water is utilized for a variety of purposes including everyday necessities and household chores. Water ingested should fulfill health requirements to maintain the safety of the entire population, including being pathogen-free, non-toxic, tasteless, odorless, and having a clear color as well as being available at all times (Saimin et al., 2020). However, due to the diversity and complexity of human requirements the demand for water particularly drinking water has increased (Ahmed et al., 2020). However, water availability particularly clean water and water fit for human use continues to be a concern (Amallia et al., 2020). As a result, a portion of the community relies on replenished drinking water to satisfy their daily drinking water needs (Pulungan and Away, 2019).

The conduct of individuals who are still unwilling to safeguard the environment especially water sources is causing a reduction in the amount, location, and volume of pure water (Agista and Purwantisari, 2020) as a result, deliberate measures are required to preserve and increase the amount and volume of water available for mankind's existence by increasing the quality of refilled drinking water. The purification procedure for refillable drinking water is sought to have passed by UV irradiation, ozonation, or a combination of the two techniques (Uddin et al., 2021). Refilled drinking water must pass bacteriological, organoleptic quality, and consumption safety tests before being drunk by the general population (Wen et al., 2020). According to the Minister of Health of the Republic of Indonesia's Decree No. 907 of 2002, bacteriological examinations of bottled drinking water, refill drinking water, and filling stations must be conducted at least once every month and no more than once every three months (Ministry of Health, 2002).

Cleaning, filtration, and replenishing of drinking water fit for use are usually available at refill drinking water depots (Sehol et al., 2020). It is hoped that there would be no pathogen contamination in the three processes and locations, which might have a detrimental influence on the quality of the generated replenishment drinking water. According to Regulation No. 492/Menkes/PER/2010 of the Minister of



<sup>8</sup> Health of the Republic of Indonesia, refilled drinking water must go through several processing steps to ensure that it is free of pathogen contamination, odorless, colorless, and tasteless, and that it does not endanger human health (Chaniggia et al., 2020; Slavik et al., 2020).

Previous study has indicated that many refilled drinking water bottles do not match the ministry of health's quality requirements, which can indicate the emergence of digestive and skin illnesses that are hazardous to the population (Sari et al., 2020). Agustina (2021) Five samples of raw water from Semarang City's Refill Drinking Water Depots were positively contaminated with Coliform bacteria with MPN values, including Candisari District (20/100 ml), Tembalang District (7/100 ml), Ngaliyan District (11/100 ml), West Semarang District (4/100 ml), and Gunung Pati District (4/100 ml), and two samples were not. Furthermore, Amallia et al (2020) discovered that 14 out of 20 <sup>14</sup> samples of replenished drinking water did not satisfy the criteria with the quantity of coliform exceeding the quality level and 5 samples positive for bacteria *Esherichia coli*. This situation demonstrates that the quality of Indonesian refilled drinking water is still poor and unfit for human consumption.

According to observations made in Sesetan Village, South Denpasar District, more than half of the refill drinking water depot owners failed to follow refill drinking water depot (DAMIU) procedures such as changing filters beyond the time limit, not wearing gloves and masks during production, and not conducting regular health checks at the production site. As a result, it's critical to undertake study and assessment in the region on the safety of replenished water. Based on these issues, the objective <sup>4</sup> of this study was to assess the quality of replenish drinking water in Sesetan Village, South Denpasar District, Bali using MPN coliform and *Esherichia coli* criteria.

## Material and method

### *Design of research*

Descriptive observational research design is used to analyze and observe the study sample's procedure and quality by comparing it to standardized parameters (Darwin et al., 2021). The study was carried out by making firsthand observations and or obtaining water samples at the refill drinking water replenishing depot, which were then examined and evaluated in the laboratory.

### *Implementation of research*

Studies conducted during one month (August) 2020. Point sampling locations namely Depot Water Recharge (DAMIU) situated in the Village Sesetan, South Denpasar District, Bali Province. Meanwhile,



the water quality test (sample) was carried out at the Quantum Medical Facilities Public Health Laboratory having its address at Sesetan street number 20, Sesetan Village, South Denpasar District, Bali Province.

#### ***Determination of population and sample***

Determination of the sample in this study using purposive sampling (Darwin et al., 2021) which took into account the owner of the refill drinking water depot's readiness to undertake an evaluation and test of samples of drinking water generated. The study population consists of 15 refill drinking water depots (DAMIU) scattered throughout the Sesetan village area. Meanwhile, 10 replenish drinking water depots are willing to collect water samples for laboratory testing, which will be referred to as research samples.

#### ***Tools and materials***

Analytical balance, autoclave, measuring cup, incubator, Beacker glass, erlenmayer, test tube, Durham tube, measuring pipette, bull filler, stirring rod, Bunsen lamp, tripod and asbestos gauze, petri disk, Ose, sterile vial were the instruments utilized in this investigation. The following are the materials that were used: refill drinking water samples, Lactose Broth (LB), Brilliant Green Lactose Bile Broth (BGLB), Mac Conkey Agar (MC), Triple Sugar Iron Agar (TSIA), Simon Citrate Agar (SC), Sulfur Indole Motility (SIM), Sugar Media (Glucose, Lactose, Manitolose, Maltose, Sacharosa) and Aquadest.

#### ***Data analysis***

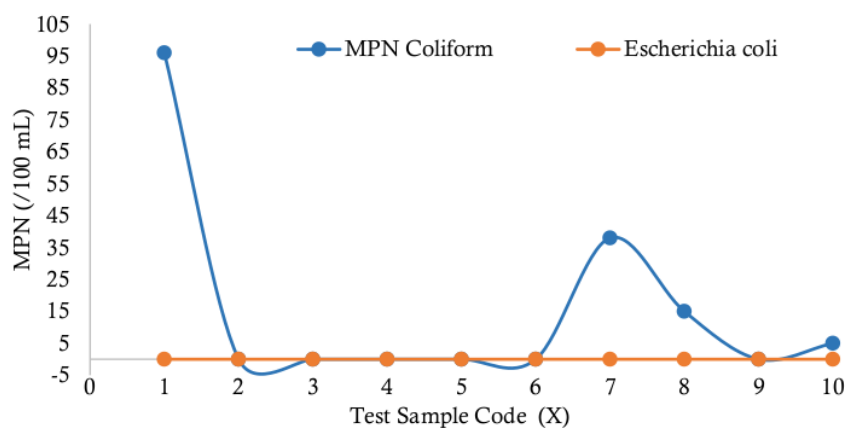
The data was collected in the form of findings from the laboratory's refill drinking water quality test which were then evaluated in a comparative descriptive way using tables and narratives. Most Probable Number (MPN) *Coliform* with MPN/100 mL units and data for *Escherichia coli* in the form of positive (+) and negative (-). Furthermore, the data is compared to the drinking water quality criteria established by the Ministry of Health of the Republic of Indonesia Number 492/MENKES/PER/2010 for Drinking Water Quality Requirements in the Republic of Indonesia.

#### **Result**

Various findings on the Most Probable Number (MPN) *Coliform* and *Escherichia coli* values were obtained based on the results of study linked to the assessment of the quality of refill drinking water at 10 depots in the Sesetan Village area, South Denpasar District, Bali Province, as shown in Figure 1. According to the results of laboratory tests (Figure 1), there are four (40%) refill drinking water depots in Sesetan Village, South Denpasar District, Bali Province that do not meet the standards and exceed the MPN 0/100 mL threshold set by the Minister of Health Regulation No. 492 of 2010 (MPN 0/100 mL). X1 (MPN 96/100 mL), X7 (MPN 38/100 mL), X8 (MPN 15/100 mL), and X10 (MPN 5/100 mL) were the refill water samples



that surpassed the threshold. Meanwhile, no replenished drinking water samples from ten depots contaminated with *Escherichia coli* bacteria were found. As a result, 6 samples passed the established standard standards, allowing operations to be evaluated on a regular basis, and 4 positive samples MPN *Coliform* for review in line with standard requirements (Ministry of Health, 2002; Ministry of Industry and Trade, 2004).



**Figure 1.** MPN test value *Coliform* and *Escherichia coli*.

Field observations revealed that some depots had an unsuitable atmosphere and squandered sanitation. Three of the four *Coliform* containing depots have been identified by researchers as being connected with other activity areas such as booths, sellers of LPG gas, fruit sales, and the presence of pet birds. One of the three depots did not fulfill the physical standards, as seen by the filthy floor, moldy walls, and perforated ceiling, all of which influenced the quality of the drinking water produced. The physical space requirements for the refill drinking water depot must be met during construction. The condition of the floor, the state of the walls, the condition of the ceiling, and the size of the room are all physical criteria. The floors, walls, and roofs of the refill drinking water depot must be constructed of waterproof material, have a level surface, be smooth but not slippery, be dust-resistant and simple to clean, and be kept clean and dust-free at all times. Pollution from the surrounding environment is allowed by depots that do not stand alone and are combined with other sites of activity. The cleanliness of the depot must be maintained at all times to avoid pathogen contamination and a reduction in the quality of the replenish drinking water (Kato et al., 2021; Sehol et al., 2020). Figure 2 depicts depots that are connected with other activities.



**Figure 2.** Depots associated with other activities.

Description: a. Filling operators do not use personal protective equipment; b. Depot with LPG Gas sales; c. Depot with stalls; d. Depot with bird's nest.

### Discussion

Drinking water is a human need as a source of life (Sudaryati and Adnyana, 2018). The community consumes refilled drinking water on a daily basis to satisfy the availability of water consumption. The safety of replenish drinking water is monitored on a regular basis to guarantee that the water generated is of high quality. The microorganisms that cause sickness in humans must be kept out of a refillable drinking water that is appropriate for consumption. Total *coliform* and *E.coli* were the parameters examined. The results of the investigation in Figure 1 show that pathogens were found in refilled drinking water at a depot located in the Ssetan area, South Denpasar sub-district, Bali province.



The high value of the Most Probable Number (MPN) *Coliform* in the four samples tested, namely Samples X1, X7, X8, and X10, is due to the fact that the water used as refill drinking water is sourced from groundwater and or water sources distributed using less hygienic tanks, resulting in contamination during the distribution process. The cleanliness and quality of the water used as the major raw material determine the quality of replenish drinking water (Uddin et al., 2021). The main raw material for refilled drinking water comes at least from water sources that have been guaranteed and tested for quality with the objective of producing drinking water that is suitable for consumption, safe for health, and free of pathogens and other contaminants, and that is checked physically, chemically, and biologically on a regular basis (Winandar et al., 2020). According to research conducted by Najah et al (2020), the quality of replenishment drinking water is determined by the quality of the raw materials utilized.

Furthermore, Puspitasari et al (2020) and Sari et al (2020) discovered a high value of MPN *Coliform* in refill drinking water caused by wastewater from human waste and or household waste (laundry, bathing, washing toilets) seeping into river waters, springs, and raw water in nature, despite the weak filtration system. As a result, polluted water is classified as contaminated water. Drinking water must be free of all kinds of *coliforms* according to Ministry of Health regulations. The higher the degree of contamination with bacteria *coliform*, the greater the danger of the presence of other diseases that reside in human and animal excrement. Hygiene and sanitation that had not been implemented according to recognized requirements contaminated four refill drinking water filling terminals in the Sesetan Village region, South Denpasar District, Bali Province. Hygiene and sanitation are critical for maintaining the health and quality of replenish drinking water production (Evans et al., 2020; Saimin et al., 2020). The presence of *Coliform* bacteria in drinking water suggests that the process and or sanitation are insufficient. Furthermore, cleaning and storing for longer periods of time might degrade the quality and increase the population. *Coliform* bacteria in water (Wen et al., 2020). According to Ministry of Industry and Trade of the Republic of Indonesia decision number 651/MPP/Kep/10/2004, refilled drinking water must meet the technical requirements of drinking water depots, which must be monitored and inspected on a regular basis and at least once every three months for inspection laboratory (Ministry of Industry and Trade, 2004).

The cartridge filters used for the production and filtering of refill drinking water were not replaced regularly and staff and or employees did not know when to replace the cartridge filters, according to the results of observations and interviews with the owner and or staff of the depot located in the Sesetan Village area. As a result, the equipment was dirty and goes beyond the set limitations. The cartridge filter has an influence on the quality of the resultant drinking water, and the extremely short cleaning time of gallons of





water with food detergent (*Food grade*) results in gallons of water that are highly dubious in terms of cleanliness. Gallons are rinsed with clean water heated to 60-85°C to eliminate any leftover detergent then dried and filled with raw water (Agustina, 2021).

Observations at ten depots revealed that the procedure of replenishing water was carried out in multiple phases, including rinsing with water, brushing, rinsing again with water, sterilization, and finally filling with drinking water suitable for public use. Many behaviors and phases were seen that were not in line with the requirements established in the four depots that revealed positive *Coliform*, such as personal hygiene personnel and or depot employees who did not wear personal protective equipment, according to the observations. Furthermore, the majority of staff who meet with potential clients do not wash their hands first. During cleaning, employees who do not use gloves or wash their hands risk spreading germs inside and/or the gallon's tip. Furthermore, the filling operator's expertise is insufficient and the filling location is filthy which has an impact on the quality of the drinking water generated. According to Agustina (2021) and Najah *et al* (2020), the cleanliness of refill drinking water locations the procedure of handling containers and refills and the knowledge of filling operators all have a significant impact on the quality of refilled drinking water at the depot.

The equipment used in the manufacture of replenishment drinking water must fulfill technical criteria and be serviced on a regular basis (Chaniggia *et al.*, 2020; Pulungan and Away, 2019). Furthermore, sterilizing equipment is a determinant of the quality of the drinking water generated. Sterilization equipment that has outlived its usefulness is unable to remove germs from drinking water, resulting in water contamination with bacteria *Coliform*. Agustina (2021) explains that there are several determining factors for drinking refilled drinking water contaminated with *coliforms*, including: (1) The length of time water is stored in reservoirs so that it affects the quality of the raw water sources used; (2) The presence of contamination during entering the water into the transport tank; (3) Shelters are not clean; (4) less than optimal processing; (5) Environmental cleanliness; (6) The presence of contamination from unsterilized gallons.

The findings of ten depots and samples revealed that the bacteria *Escherichia coli* were not present. This means that six out of ten refill drinking water depots are open for business, and the water produced is safe to consume. According to Agista & Purwantisari (2020) research, water that was not contaminated with *Escherichia coli* was indicated by appropriate depot cleanliness, requirements that had been reached, raw water that was safe for consumption, and filling operators' knowledge and conduct. Furthermore, the requirements and procedures for refilling drinking water containers at 10 Refill drinking water depot have gone through several filtering stages, including a pre-filter (sand filter) to remove coarse particles, a carbon



filter to absorb odors, tastes, colors, and organic matter, a Catrige filter to filter out fine particles, and Ultra Violet (UV) filters or ozonation to disinfect drinking water containers (Ahmed et al., 2020). If these processes are not followed and carried out with care, the quality of the replenished drinking water will suffer (Rohmah et al., 2021; Winandar et al., 2020).

### Conclusion

The quality of refill drinking water in Sesetan Village, South Denpasar District, Bali is 40% (4 refill drinking water depot) positive for *Coliform* and does not meet the standards set by the Minister of Health of the Republic of Indonesia's Regulation No. 492/Menkes/PER/ IV/2010 concerning Drinking Water Quality Requirements. All of the depots were found to be free of *Escherichia coli*. It is intended that this study will be utilized as information, reference, and reference material in policymaking on refill drinking water depot providers (DAMIU) in the Sesetan Village region of the South Denpasar District of Bali Province.

### Acknowledgment

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