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Water Quality Assessment at Liubena Spring, Fatunisuan Village Based on Physical, Chemical and Biological Parameters

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Abstract

Background: *The water from the Liubena spring has been used by the community as drinking water, but its quality has never been tested. Water quality can affect health and the economy.* **Methodology:** *This research is quantitative. Water sampling was conducted in the morning at a single sampling point. Water samples for laboratory testing were collected, stored in PP bottles and dark glass bottle, and then placed in a cool box. The parameters measured in the field were pH, temperature, and DO. pH and temperature were measured according to the Standar Nasional Indonesia (SNI) method, while DO was measured according to the instrument's instructions. Other parameters are measured using methods used in testing laboratories. The test results were analyzed descriptively, namely, by comparing them with the water quality standards for Hygiene and Sanitation purposes, as set out in the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017.* **Findings:** *The parameter values for TDS, water temperature, hardness ($CaCO_3$), and pH are, respectively, 315 mg/L, 19°C, 334 mg/L, and 7, all of which still meet the quality standards. The parameter values of DO, BOD, COD, TSS, and Iron (Dissolved Metal) are respectively 3 mg/L, 2,90 mg/, 3,51 mg/L, 1,5 mg/L, and 0,271 mg/L, which cannot be compared with quality standards because no values are available. The total coliform value (20 quantity/100 mL) cannot be compared with the quality standard because the units differ. E. coli and fecal coliform testing are necessary to determine whether the water is contaminated and and to trace the contamination source. TDS, temperature, hardness, and pH parameters still meet quality standards; meanwhile, DO, BOD, COD, TSS, Iron (Dissolved Metal), and total coliform parameters cannot be compared with quality standards.* **Contribution:** *This research data can serve as baseline data for developing sustainable water management strategies.*

Keywords: *Hardness; Liubena; pH; Temperature; TDS*

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INTRODUCTION

Water is a primary resource, where access to safe and affordable drinking water is a human right (Fida et al., 2022). However, the right to access safe drinking water is still not fulfilled for everyone. In 2020, it was reported that two billion people lack access to safely managed drinking water services (UN-Water, 2021). In Indonesia, access to safe drinking water is determined by three factors, one of which is water quality. Nationally, only 11.9% of households have access to safe drinking water based on the parameters of TDS, *E. Coli*, pH, nitrate and nitrite. Meanwhile, in East Nusa Tenggara Province, only 5.72% of households have access to safe drinking water based on the same parameters (Irianto et al., 2020).

The source of drinking water for households in East Nusa Tenggara Province utilizes several sources, one of which is springs (BPS Nusa Tenggara Timur, 2022). A spring is a source of groundwater that flows and emerges from an aquifer or rock crack towards the surface of the ground, becoming a source of clean water that is used for the needs of living things (Nurdin et al., 2022). Water from the spring is sometimes available even during prolonged dry seasons, when other sources in many areas have dried up (Sudarmadji et al., 2016). Its year-round availability makes the springs a source of drinking water for the community.

Research examining the quality of spring water in Nusa Tenggara Province have been carried out, focusing on the Lahurus spring in Lahurus village. The findings indicate that the TSS, BOD, COD, and fecal coliform levels comply with the Class I quality standards set by Government Regulation Number 22 of 2021, although the pH level does not fall within the acceptable range (Blegur et al., 2022). Additionally, investigations at the Nifuesu spring in North Baumata Village revealed that the COD and total coliform parameters adhere to the Class II quality standards of PP No. 82 of 2001 (Bulu et al., 2022). The research conducted in Baumata Village employed the storet method to assess the spring water's quality status, which was determined to be lightly polluted (Kadang et al., 2022). Evaluating the pH parameter of the Lahurus spring and the water quality status in Baumata Village indicates that the water condition is poor, despite the spring being a drinking water source in East Nusa Tenggara Province.

Poor water quality can impact health and the economy. Hardness in drinking water requires expensive treatment, which can impact rural and low-income communities (Sudia et al., 2021). The presence of *E.Coli* and total coliform in spring water in Pamboboran Village, West Galung, and Lemba Lembang can cause diarrhea (Nurdin et al., 2022). The use of water for various purposes must pay attention to water quality parameters in accordance with predetermined quality standards (Sulistyorini et al., 2017).

The Liubena spring in Fatunisuan Village is one of source of drinking water for residents. This spring has been a primary source of local water for many years, demonstrating good availability and sustainability. However, the use of the spring has not been supported by scientific studies on its water quality. Based on a literature search, no studies have been conducted to address the quality of Liubena spring's water. Therefore, this study aims to assess the water quality of the Liubena spring. This water quality data serves as the basis for sustainable spring management policies in

semi-arid area and provides assurance to communities about the safety of the spring water they use.

METHOD

This research is a quantitative descriptive study to assess the water quality of Liubena spring. It was conducted from June to September 2023, with sample collection taking place in August 2023.

Sample or Participant

Water sample was collected at a single point in the Liubena spring in the morning. Sampling was only done once due to cost considerations, and this study is a preliminary study to determine water quality at the Liubena spring. The type of sample used in this study was grab sample taken directly from the water source at a specific time. The coordinates of the sampling point are S 09^0 34,329' E 124^0 21,061'. The location of the spring is shown in Figure 1.

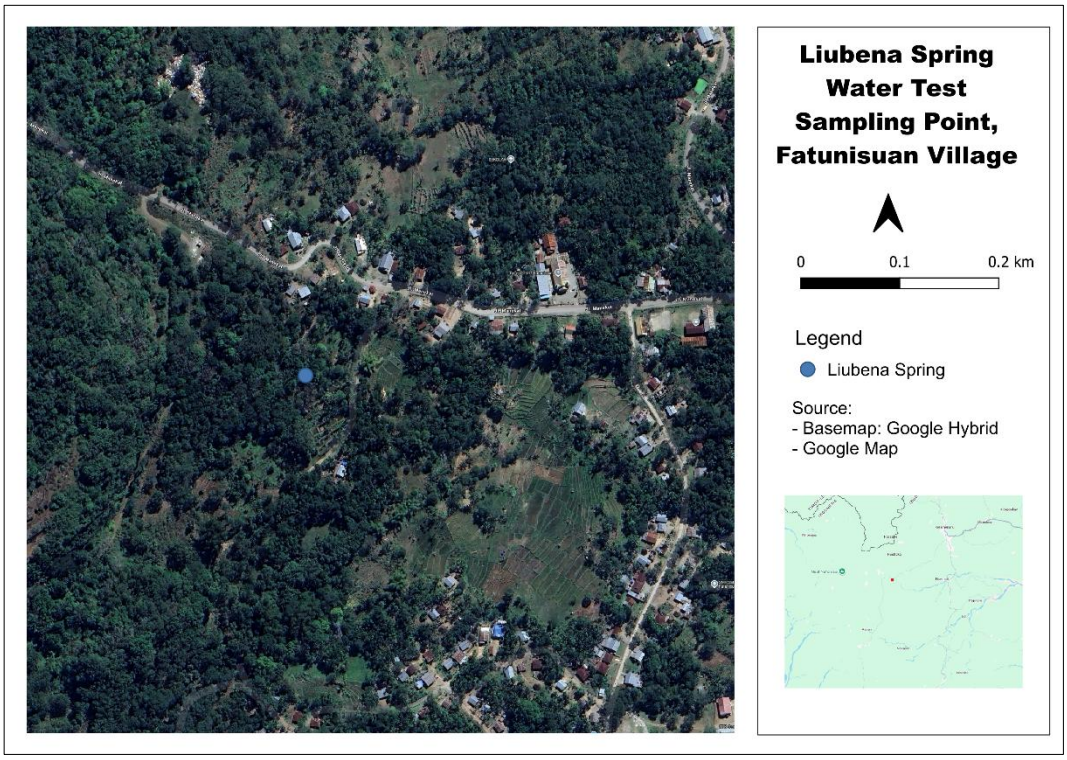

Figure 1. Liubena Spring Location

Figure 2. Condition of The Reservoir at Liubena Spring
(Source: Researcher Documentation, 2023)

Instrument

The tools used in this study were PP bottles, dark glass bottle, thermometer, pH Meter Digital Hanna HI 98107, DO Tester Water Quality Meter DO9100, cool box, stationery, and various laboratory testing equipment. The materials used in this study included water samples, distilled water, tissue, ice cubes, and various materials used to test parameters in the laboratory.

Data collection and Procedure

This research was conducted in several stages: a site survey to identify the location of the spring and surrounding activities, preparation of equipment and materials needed for sampling, calibration of field parameter equipment, sampling, field testing, laboratory testing, and data analysis. Samples were taken from the spring using surface water sampling techniques based on SNI 6989.57-2008. Parameters directly measured in the field (in situ) were pH, temperature, and DO. Parameters analyzed in the laboratory (ex situ) were TDS, TSS, COD, BOD, iron (dissolved metal), and hardness, and biological parameter, namely, total coliform. Water samples sent to the laboratory were placed in PP bottles and dark glass bottle, placed in a cooler with temperatur $\pm 4\ ^0$C, and then transported to the laboratory. Testing methods for each parameter are presented in Table 1 and air temperature measured by a mercury thermometer.

Table 1. Water Quality Parameter Testing Methods

No	Parameter	Methods
1	pH	SNI 06-6989.11-2019
2	Water Temperature	SNI 06-6989.23-2005
3	Dissolved Oxygen (DO)	According to the DO meter instructions
4	Total Dissolved Solids (TDS)	method IK.7.2.2.3 (Multiparameter Analyser) (This method originates from the laboratory)
5	Total Suspended Solids (TSS)	SNI 6989.3-2019

6	Biological Oxygen Demand (BOD)	SNI 6989.72-2009
7	Chemical Oxygen Demand (COD)	SNI 6989.2-2019
8	Hardness ($CaCO_3$)	SNI 06-6989.12:2004
9	Iron (Dissolved Metal)	SNI 6989.84:2019
10	Total Coliform	Standards Method 22nd Ed. Method 9221 D, Pg 9-73 Year 2012

Data analysis

The results of water quality parameter measurements were analyzed descriptively by comparing each water parameter value with the water quality standards for hygiene sanitation in the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning the Standard of Environmental Health Quality and Water Health Requirements for Hygiene Sanitation Purposes, Swimming Pool, Solus Per Aqua, and Public Bath. Water for hygiene sanitation purposes, based on the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, is water used to maintain personal hygiene, such as bathing and brushing teeth, as well as for washing food ingredients, eating utensils, and clothes. Moreover, the same water utilized for sanitation and hygiene can serve as raw water for drinking water.

RESULT AND DISCUSSION

Fatunisuan Village has several springs utilized by the local community for various daily water needs. The spring used in this study was limited to Liubena Spring, which is distributed through pipes, allowing residents to collect water from reservoirs provided in several homes for drinking water.

Physical Parameters

The physical parameters tested in this study were temperature, TDS and TSS, where the test results are presented in Table 2. Temperature does not have a direct impact on health, but it does affect the activity of microorganisms, chemical balance and increases the solubility of various chemicals in drinking water (Harimu et al., 2019). During the sampling process at Liubena Spring, temperature parameter were measured using a mercury thermometer. The water temperature measurements were within ± 3 °C of the air temperature, with a water temperature of 19 °C and an air temperature of 18.5 °C. Therefore, the standard temperature range is between 15.5 °C and 21.5 °C, which still meets drinking water quality standard.

Field conditions, the time of sampling, and climatic conditions are some of the factors that cause water temperatures to vary (Sukristiyono et al., 2021). The lowest average water temperature of the three springs studied in Gianyar Regency was at the Beji Dalem spring at 29.3 ^{0}C, which was caused by the large amount of vegetation that prevented sunlight from entering the water body (Yuliari et al., 2021). The water temperature in the Liubena spring is lower than in Gianyar Regency, presumably due to vegetation factors, where the large amount of vegetation around the spring blocks access to sunlight.

The total dissolved solids (TDS) indicate the overall concentration of substances dissolved in water, encompassing both organic and inorganic materials (Handoco, 2021; Pandiangan et al., 2023). The TDS levels in water are significantly affected by factors such as soil runoff, rock weathering, and human activities, including domestic and industrial waste (Effendi, 2003). According to the Minister of Health Regulation No. 32 of 2017, which sets the TDS quality standard at 1000 mg/L, the spring water at the study site remains appropriate for use as raw water for drinking water. The USGS classification of water based on dissolved solids values according to Todd & Mays (2005) is divided into five category: fresh (<1000 mg/L), slightly saline (1000-3000 mg/L), moderately saline (3000-10,000 mg/L), very saline (10,000-35,000 mg/L), and briny (>35,000 mg/L). The water in the Liubena spring is considered fresh water because the TDS value is 315 mg/L.

The total suspended solids (TSS) are suspended materials (diameter >1µm) that are blocked by a millipore filter with a pore diameter of 0.45 µm (Effendi, 2003). TSS consists of mud and fine sand as well as microorganisms, which are mainly caused by soil erosion, or soil erosion carried by water bodies (Walukow & Surakarta, 2021). The TSS parameter value cannot be compared because it is not listed in the quality standards. Water with a TSS value of less than 20 mg/L is considered clear by most people (Anyanwu & Ihediwah, 2015). Referring to these values, the water in the Liubena spring can be said to be clear water.

Table 2. Results of Physical Parameters Testing of Liubena Spring Water

No	Physical Parameter	Unit	Quality Standards*	Results
1	Water Temperature	^{0}C	± 3	19
2	Air Temperature	^{0}C	-	18.5
3	TDS	mg/L	1000	315
4	TSS	mg/L	-	1.5

Description: **Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning the Standard of Environmental Health Quality and Water Health Requirements for Hygiene Sanitation Purposes, Swimming Pool, Solus Per Aqua, and Public Bath*

Chemical Parameters

The chemical parameters tested were pH, DO, BOD, COD, iron (dissolved metal) and hardness ($CaCO_3$), where the test results are presented in Table 3. pH is a term used to express the intensity of the acidic or basic state of a solution (Yuliana et al., 2023). The pH measurement in this study was conducted directly during sampling using a pH meter and the result was still within the quality standard range in the Minister of Health Regulation Number 32 of 2017. A pH value of 7 is considered neutral. Neutral water pH indicates that the levels of ions contained in the water have almost the same/balanced values (Aurilia et al., 2021). Biological activity (photosynthesis and respiration of organisms), temperature and the presence of ions in water are factors that influence the pH value (Hasanah & Said, 2020).

Table 3. Results of Chemical Parameters Testing of Liubena Spring Water

No	Chemical Parameter	Unit	Quality Standards*	Results
1	pH	-	6,5-8,5	7
2	DO	mg/L	-	3
3	BOD	mg/L	-	2,90
4	COD	mg/L	-	3,51
5	Hardness ($CaCO_3$)	mg/L	500	334
6	Iron (Dissolved Metal)	mg/L	-	0,271

Description: **Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning the Standard of Environmental Health Quality and Water Health Requirements for Hygiene Sanitation Purposes, Swimming Pool, Solus Per Aqua, and Public Bath*

Hardness is the content of certain salts, especially carbonate salts from Ca^{2+} and Mg^{2+} ions, although the actual hardness can also be from salts other than these two ions (for example, sulfate and bicarbonate salts) (Sudia et al., 2021). Based on the Minister of Health Regulation No. 32 of 2017, the maximum permissible concentration of hardness in water is 500 mg/L. Compared to the measurement result, the water quality of Liubena Spring is below the permissible standard threshold. According to Todd & Mays (2005) the USGS classification for water hardness measured in mg/L $CaCO_3$ is categorized as follows: soft (0-60), moderately hard (61-120), hard (121-180), and very hard (over 180). The hardness of Liubena spring water is classified as very hard when classified based on USGS standards. Waters with high hardness values are generally waters located in areas that have thick layers of topsoil and limestone (Effendi, 2003). The higher the hardness value, the cloudy white color of the water will be (Maharani et al., 2022). Based on observation, the color of the water at the research location is clear, so it is suspected that the hardness value is not too high.

Dissolved oxygen (DO) is a parameter that indicates the amount of oxygen dissolved in water (Asrori, 2021). There is no standard recommendation for DO value for health purposes (WHO, 2022), and there is no standard value in the Minister of Health Regulation No. 32 of 2017, so the DO value from research result cannot be compared. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) serve as indicators of organic matter in water (Effendi, 2003). BOD measures the amount of dissolved oxygen that microorganisms need in an aerobic setting to decompose organic substances (Triwulandari & Cahyonugroho, 2023).

Unlike BOD, COD reflects the total organic content, whether easily or not easily decomposable (Djoharam et al., 2018). COD represents the oxygen needed for the chemical breakdown of organic materials (Piranti et al., 2018). Typically, COD values exceed those of BOD (Christiana et al., 2020). In Liubena spring water, BOD and COD concentrations were found to be 2.90 mg/L and 3.51 mg/L, respectively, these values cannot be compared because BOD and COD parameters are not listed in the referenced regulation. The BOD and COD parameters were assessed to identify organic matter in the water, as the sampling point was a container covered with wood, where it was suspected that organic matter, such as leaf litter, might have entered.

Iron in water is in the form of divalent ions (Fe^{2+}) and trivalent ions (Fe^{3+}) (Sumakul et al., 2020). Water smells, corrodes and tastes slightly sour if there is iron in it, where the iron comes from the dissolution of iron mineral content in rocks (Aurilia et al., 2021). Water that smells like rotten eggs will occur if the solubility of iron in water exceeds 10 mg/L (Sumakul et al., 2020). Fe (dissolved metal) testing in Liubena spring water yielded a value of 0.271 mg/L, but this value cannot be compared because the Fe (dissolved metal) parameter is not listed in the referenced regulation. No rotten egg odor was detected during the water sampling, supporting the test result that the Fe (dissolved metal) level did not exceed 10 mg/L.

Biological Parameter

Total coliform bacteria are a type of microorganism that can be found in aquatic environments, soil and plants (Gebrewahd et al., 2020), and generally harmless (Bratovcic & Petrinic, 2020). Total coliform parameter was tested on Liubena spring water where the test result is presented in Table 4 , but it could not be compared to quality standard due to different units. Considering that total coliform bacteria have been detected in spring water, it is necessary to identify the source of contamination (Aram et al., 2021). One approach is to conduct tests for fecal coliform and *E. coli*. Fecal coliform bacteria are a subgroup of total coliform bacteria typically found in the intestines and feces of both humans and animals (Bratovcic & Petrinic, 2020). *E. coli* is a subgroup of the fecal coliform group, mostly harmless and residing in the intestines of humans and warm-blooded animals, although some types can cause disease (Fernández-Ortega et al., 2023).

Table 4. Results of Biological Parameter Testing of Liubena Spring Water

No	Parameter	Unit	Quality Standards	Results
1	Total Coliform	Quantity/100 mL	-	20

Description: **Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning the Standard of Environmental Health Quality and Water Health Requirements for Hygiene Sanitation Purposes, Swimming Pool, Solus Per Aqua, and Public Bath*

CONCLUSION

The Liubena spring's water quality has been evaluated, revealing that the TDS, temperature, hardness ($CaCO_3$), and pH levels continue to align with quality standards. However, the parameters for DO, BOD, COD, TSS, and iron (dissolved metal) cannot be assessed against these standards due to these parameters are not listed in the referenced regulation. Additionally, the total coliform measurement cannot be compared to the standard because of differing units. It is crucial to conduct tests for *E. coli* and fecal coliform to ascertain if the water is contaminated and to trace the contamination source. Testing for *E. coli* should be prioritized, as its presence can lead to diarrhea.

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