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Physical, chemical, and biological analysis of drinking water quality in Tulungagung regency East Java

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ABSTRACT

Water is an essential compound to live, all life forms are dependent on it. This study aims to analyze the quality of water in Tulungagung. Identification carried out is a physical test included pH, salinity, color, and temperature. As well as chemical tests, including alkalinity test, CO2 content, Cl, and Water Hardness using the titration method (SNI). Samples were collected from six locations in Tulungagung Regency which are Sendang, Rejotangan, Campurdarat, Keras, Ngunut, and Tanggunggunung. Our finding in this research shows that the sample water qualifies as good water (pH 6.5 to 8.0) and tasteless, albeit contain bacteria. The content of CO2 water samples shows that result with the highest content is 21 ppm and the lowest 18ppm. Whereas the Cl- test obtained the highest 135.3 ppm and the lowest was 52.7 ppm. This analysis data was enriched with hardness test results with the highest hardness 60.9 ppm while the lowest hardness 20.9 ppm. Our conclusion that the water samples in the range of good water quality.

INTRODUCTION

Water is an abiotic natural material that is needed for human, animal and plant life as a medium for transporting food substances, water sustains us as the essence of life, and an overflow of tears accompanies our leaving loved ones behind.[1] Minister of Public Works Regulation Number 14 / PRT / M / 2010 concerning Minimum Service Standards in the Field of Public Works and Spatial Planning states that the need for water is a source of life for humans.[2,3] The level of human life is proportional to the level of water needs, the higher the water level the person's life is also increasing human needs for water. The world population increases every day and vice versa, resulting in the amount of water needed in life.[4] The increasing of the human needed for clean water sources for survival is not necessarily accompanied by the awareness of the importance of clean water, especially people who live in suburban areas (traditional) who do not directly get access to clean water from the government.[2,5] The provision of clean water for meeting household and domestic needs is a business that can directly affect the overall quality of city life.

Communities in urban areas get access to clean water through PDAM (Regional Water Company) which is one of the regional-owned business units, which is engaged in the distribution of clean water to the general public. In contrast to traditional communities that still maintain the culture of consuming water from wells that are processed by cooking it first.[5,6]

Tulungagung Regency is a small regency in East Java Province which tends to be far from the access of clean water, especially in border areas. Most of the people who use well water sources as less hygienic drinking water need to be analyzed for the water quality. The water quality belongs to the level of suitability of water to certain uses in meeting the needs of human life, ranging from water to meet immediate needs such as drinking water, bathing and washing even for irrigation and agricultural water, livestock, fisheries, recreation, and transportation. Water quality includes physical, chemical and biological parameters. [7] Based on the regulation of the Minister of Health of The Republic of Indonesia No 416 / Menkes /Per/IX/1990 regarding of supervision and water quality requirements referred to drinking water is the water that meets health requirements and it can be drunk directly. Somehow water referred to clean water is the water that meets health requirements, which must be cooked first before drinking. Clean water is water that is clear, colorless, fresh, and odorless.[7,8]

The content of chemicals in the water affects the suitability of water use. In general, the chemical characteristics of water include pH, alkalinity, cations, and anions dissolved. The pH scale is logarithmic and inversely indicates the concentration of hydrogen ions in the solution (a lower pH indicates a higher concentration of hydrogen ions. PH plays a role in an important parameter in water quality analysis because it influenced biological and chemical processes in it. Acidic pH increases corrosivity in a metal due to discomfort and can cause some chemicals to become toxic.[6,9] The result of the previous research shows that pH range of drinking water between 6.05-6.81. Albeit, the pH of the wellbore is 6.69-7.13 and the pH standard for clean water is 6.5-9.0 and drinking water is 6.5-8.5.[10] The water quality can be determined from the level of hardness, which shows the amount of mineral content in water. Good water must have low hardness / soft (0-75 ppm),[3] and also have a threshold level of pollution (chemicals) contained in drinking water. Even more complete Permenkes RI RI No.416 / MENKES / PER / IX / 1990 describes water quality from physical, chemical, and biological parameters. Moreover, poor water quality will have an impact on health both directly and indirectly.[3,11]

Based on this background, research on the quality of drinking water consumed by the community in Tulungagung Regency. The purpose of this study was to analyze the drinking water quality in Tulungagung Regency in physical, chemical and biological parameters.

MATERIALS AND METHODS

Materials and Chemicals

This study is a descriptive survey and analysis that illustrates the qualitative and quantitative study with the results of drinking water by by testing physical, chemical and biological parameters. Sampling was carried out by sampling methods from six different Tulungagung regions. The division of regions was carried out by random sampling and purposive sampling in the six regions of Tulungagung, East Java, namely in the Rejotangan sub-district, Ngunut sub-district, Kras sub-district, Campudarat sub-district, Tanggunggunung sub-district, and Sendang sub-district East Java. In these six regions, we did a random sampling that was carried out by collecting samples in one sub-district of each region in Rejotangan District, Ngunut District, Kras District, Campudarat District, Tanggunggunung District, and Sendang District, Sourced from springs and wells research was conducted from September to October 2018. All testing processes and data analysis

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were carried out at the Chemical Laboratory of STIKes Karya Putra Bangsa Tulungagung. The chemical used are $H_2C_20_4$ 0,01 N, NaOH 0.01 N, Indikator PP 1%, AgNO30,0035 N, NaCl 0,0035 N, Indicator K_2CrO_4 5%, Na_2EDTA 0,03 N, $CaCl_2$ 0,03 N, NaOH 3N, Ammonia buffer solution, pH 10 (Sigma-Aldrich).

Figure 1. Collection of sample site locations on geological map.

Physical Parameters

In the measurement of physical parameters, measurements of the degree of acidity (pH), color, temperature, and water salinity.[12] Six water samples were pipetted and then tested using a pH meter, microscope, refractometer, and water thermometer. Measurement and retrieval of data is carried out three times (triple) to avoid data errors and get consistent results.[13]

Chemical parameters

Determination of Alkalinity through carbonates level: 10 ml sample of each sample is added with 3 drops of phenolphthalein indicator and titrate with NaOH until color changes to pink. Determination of free CO_2 levels: was carried out by 10 ml sample of each sample is added with 3 drops of phenolphthalein indicator and titrate with NaOH until color changes to pink. Retrieval of data is carried out three times (triplo) to avoid data errors.[14] We was measured of Cl^- levels by titration using $AgNO_3$ and water hardness, the content of certain minerals in water, generally calcium (Ca) and magnesium (Mg) ions in the form of carbonate salts was analyzed by Ethylenediamine tetraacetic acid (EDTA) as a standard solution for titration.[15]

The Formula:

$$CO_2 \text{ levels} = = \frac{(V1\text{-}V2) \text{ x NaOH x N NaOH x BE } CO_2}{\text{V Sample}} = \cdots \text{ ppm} \qquad (1)$$

$$\text{Cl levels} = \frac{(\text{ml x N}) \text{ x } Na_2S_2O_3 \text{ x BE } Cl_2}{\text{V Sample}} = \cdots \text{ ppm} \quad (2)$$

$$CaCO_3 \text{ (Alkalinity)} = \frac{(\text{ml x N}) \text{ EDTA x BM } CaCO_3 \text{ x } 1000}{\text{V sample}} = \cdots \text{ ppm} \quad (3)$$

Measurement of Biological parameters

Bacteriological examination was carried out to obtain the total bacteria coliform value of drinking water following previous studies.[2] Six tubes containing LB media were prepared and 2 microliter water samples were added into each tube. Then look at the turbidity and observe the presence of gas in each tube Durham. Then a confirmed test was carried out, carried out by preparing 7 tubes containing 10 mL of BGLB media, then from each positive tube on the LB media, 1-2 oses were taken from each tube and inoculated on LB medium agar, incubated for 24 hours and seen. the number of bacteria on the agar plate.[16]

RESULTS AND DISCUSSION

Physical Parameters

From the results of physical parameter analysis of six water samples, including analysis of temperature, pH, salinity, and color, we found that all of the water samples meet/are at a safe level to use as drinking water. The data of the measurement are presented in Table 1.

Table 1. Physical parameters of Water Samples in Tulungagung Regency

No	Parameter	Measurement results*						Criteria
		A	B	C	D	E	F	
1.	Temperature (^{0}C)	28	28	28	28	28	28	25 -30
2.	pH	7,0	7,0	7,0	7,0	7,0	7,0	6-9
3	Salinity	1	1	1	1	1	1	0
4.	Colours	Clear	Clear	Clear	Clear	Clear	Clear	Clear

*A = Tanggunggunung ; B = Rejotangan; C = Campurdarat ; D = Sendang ; E = Ngunut; F = Kras

Chemical and Biological Parameters

To support the data in this study, we carried out chemical and biological parameter tests of drinking water for six water samples from several Tulungagung region. The six samples are then tested for their alkalinity, CO_2 level, Cl level, and total hardness.[14] The results of testing the chemical parameters of drinking water are presented in Table 2.

Table 2. The Result of Chemical and Biological parameters of six samples.

No	Parameters	Measurement results						Criteria
		A	B	C	D	E	F	
1.	**Biological Parameters**							
	1. Bacterial	+	+	+	+	+	+	0
	2. Microorganism	-	-	-	-	-	-	0
	3. Taste	-	-	-	-	-	-	-
2.	**Chemical Parameters**							
	1. Alkalinity	35,2	35,2	17,9	30,8	26,8	35,4	50-500 (ppm)
	2. CO_2 Levels	4,9	1,3	1,4	1,4	2,1	2,1	<6 (ppm)

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3. Cl^- Levels	52,7	52,7	135,5	56,6	56,6	53,3	250 mg/L
4. Hardness	32,5	23,8	60,9	27,9	20,9	23,9	<500 mg/l

Note : A= Tanggunggunung ; B= Rejotangan; C= Campurdarat; D= Sendang ; E= Ngunut; F= Kras

Water plays a role vital function in a very close relationship with human life because it is a natural resource that is needed for the livelihoods of many people as well as other living creatures. Water is of major importance to all living things; in some organisms, up to 90% of their body weight comes from water.[17] However, it can also be a substance that carries diseases due to water that can contain pathogenic microorganisms and chemicals that are toxic and damage the body/organism. So that it requires the development of understanding and attention in using it.[18]

In the middle to the lower class of residential areas mostly provide drinking water using conventional methods by the cooking process. The material of drinking water used comes from pure springs, even well water. It seems less hygiene and does not follow drinking water treatment standards and it may have an impact on human health. In identifying water quality in Tulungagung Regency we were used physical and chemical parameters.

Physics Parameters

Based on the research results of drinking water material from six regions of Tulungagung, it was found that 6 samples met the physical requirements, pH and color temperature. The temperature of the six samples is still within the limits of drinking water in general, besides that the pH and color meet national standards (Table 1). Not with the case of water salinity, which is one of the parameters for determining water quality. Salinity is related to the level of salinity or the level of dissolved salts contained in water in grams per liter of seawater. Test results on samples A, B, C, D, E, and F have a salinity of 1 ‰. The classification of water salinity level is divided into freshwater with salinity <0.5 ‰, brackish water 0.5-3.0 ‰, saltwater 30-50 ‰, and very salty water or seawater has salinity> 40 ‰. Based on the classification, the six sample water used is categorized as brackish water. This is because some Tulungagung areas are close to the sea and the marble industry which has a high level of salt.[5,18,19]

Chemical Parameters

To enrich the results of water quality identification in Tulungagung Regency, chemical parameters were tested. Tests include CO_2, Cl^-, Alkalinity, Acidity, and total hardness levels (Table 2).

Qualitative Bacteria

Biologically water quality can be determined from the presence of bacteria that are in water. From the qualitative testing of bacteria produced that all six water samples contain bacteria. This result is an indication that the drinking water used by some Tulungagung people has bacteria, so it needs treatment to eliminate bacteria optimally. Bacterial removal can be done by filtering technology or by the addition of bacterial-killing chemicals.[17] Traditionally people use heating / boiling water at high temperatures (100^0C) to kill/ inactivate bacteria. In other words, the heating process (traditionally) will be able to cleanse drinking water from organisms (bacteria, parasites) to the fulles. From the test of our results show that all of water samples used contain bacteria.

Alkalinity of Water

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Alkalinity is closely related to the pH value of water, if the alkalinity value is high then the pH value will be higher. [18,19] The alkalinity value which is not much different shows that the distribution of drinking water material used in Tulungagung Regency tends to be stable with alkaline nature. The highest alkalinity of drinking water was found in sample A (Tanggunggunung) and sample F (Kras), while the lowest alkalinity was found in sample C (Campurdarat). Tanggunggunung and Kras are desert areas in the rock industry. Based on the water standard, the alkalinity value of six samples of drinking water is within safe limits and good enough to be used as drinking water.

CO_2 Levels

Measurement of CO_2 water content of the sample is carried out by the titration method with repetition three times, the results of the titration are converted using the formulation to get the value of the content (table 2). Sample A (4.9 ppm), sample B (1.3 ppm), sample C (1.4 ppm), sample D (1.4 ppm), sample E (2.1 ppm) and sample F (2, 1 ppm). From the results of the experiment found the highest CO_2 levels in sample A and the lowest in sample B. Free carbon dioxide is released and reacts with water to form carbonic acid which is then reduced to bicarbonate and carbonate makes the pH lower. Albeit the pH value between the samples is relatively the same, this seems due to the difference in CO_2 levels is relatively small in units of ppm, so it is not so significant that it can be detected.[20]

Chloride Levels

Chloride content in samples is one of the requirements for chemical drinking water quality measurements. This was stipulated by the Republic of Indonesia Minister of Health's Regulation Number: 492 / Menkes / Per / IV / 2010 with a maximum chloride content limit of 250 mg / L. Six water samples of drinking material used have chloride levels that are still very far below the PerMenKes maxumum limit, because the nature of chlorides in water has little solubility and can only be completely dissolved in nonpolar solvents. In addition, the sampling well has a great distance from the drainage channel, as well as other pollution. This can prevent direct waste pollution which can form chloride compounds.[2,3,21]

Water hardness

According to the Regulation of the Minister of Health of the Republic of Indonesia Number 492 / MENKES / PER / IV / 2010,[21] the maximum limit of total hardness in drinking water maximum 500 mg/l. Based on the results (table 2) shows that the smallest water hardness is 20.9 from the Ngunut area water sample while the highest is 60.9 in the Campurdarat area water sample. Based on the classification of water hardness, water samples A, B, D, E, F are classified as soft water with hardness values <50 mg /, while the water sample C is classified as water rather hard. According to WHO, hard water will have an impact, on health can cause cardiovascular (heart blood clogging) and urolithiasis (kidney stones), cause scaling on metal equipment for cooking so that energy use becomes wasteful, blockages in metal pipes due to $CaCO_3$ deposits, and the use of soap becomes more wasteful because of the little froth produced.[3,20]

CONCLUSIONS

Physical, Biological, and chemical parameters of drinking water samples from six regions of the Tulungagung Regency, it was found that all samples were in good and safe level to be processed and used as drinking water. Maximum CO_2 content is a sample from

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4.9 ppm Tanggunggunung, maximum Cl-maximum content is a sample from 56.5ppm Sendang. Our finding,the highest level of hardness is water from 60.9 ppm Campurdarat.

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