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Research Article

Analysis of the effect of tofu industrial waste on dug well water quality

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ABSTRACT

The industrial tofu factory located in Lautingara Kelurahan Kalabahi Tengah, where the remaining liquid waste is channeled directly into the reservoir without prior treatment, can affect water quality in the dug wells. The purpose of this study was to determine the quality and feasibility of dug well water as drinking water-based on parameters of pH, BOD, COD, nitrite, and nitrate of dug well water, which is suspected to be contaminated by the presence of tofu waste. The results showed that the pH value and nitrite value (NO_2^-) of the three dug well water samples in Lautingara met the drinking water quality standards, while the BOD, COD, and nitrate (NO_3^-) values in the three dug well water samples in Lautingara did not meet the values quality standards and not suitable for drinking water.

1. INTRODUCTION

Water is the main requirement for the survival of organisms and determinants of the continuity of life. Besides being consumed, water is also used in various life activities such as cooking, bathing, washing, irrigation in the agricultural industry and fisheries. Water is composed of two atoms, namely hydrogen and oxygen, and can form itself in nature in the form of two diatomic molecules, H_2 and O_2, through covalent bonds to write the formation reaction: $2\ H_2 + O_2 \rightarrow 2\ H_2O$. The proviso for clean water is tasteless, colorless, and odorless (Botahala, 2019; Karbeka, Botahala & Duka, 2020).

The health impacts of water pollution generally consist of two, namely directly, in this case, contaminated water is drunk directly and indirectly, namely consuming materials accumulated by pollutants from the water (Botahala, Zakir, Patarru & Yasser, 2018). Water pollution is the incidence or entry of other substances into the water, resulting in a decrease in water quality to a certain level and no longer suitable for its purpose (Manurung, 2009) so that it can seriously interfere with health, for example, cancer, organ damage, nervous system damage, and others (Gunatilake, 2015; Tripathi & Ranjan, 2015; Barakat, 2011). Water pollution has become a common problem faced by humans worldwide (Balaji, Sasikala, & Muthuraman, 2014).

According to Ratnani (2012), food processing industrial waste can cause contamination of a water body. Most of the food industry wastewater components are organic materials such as carbohydrates, proteins and fats, mineral salts, and chemical residues used in processing and cleaning. The resulting waste is disposed of into a reservoir that has been provided continuously without proper treatment. This problem can reduce the quality of

Table 1. Quality standards for drinking water quality (Peraturan Pemerintah No. 82, 2001).

Parameter	Unit	Class			
		I	II	III	IV
BOD	mg/L	2	3	6	12
COD	mg/L	10	25	50	100
Sulfate	mg/L	400	-	-	-
Ferrum	mg/L	0.3	-	-	-
TSS	-	-	500	1500	500-1500
pH	-	6-9	6-9	6-9	5-9

Table 1. Quality atandards for drinking water (Permenkes RI No.32, 2017).

Parameter	Unit	Maximum Value
Nitrate	mg/L	10
Nitrite	mg/L	1
Total pesticides	mg/L	0.1

water from surrounding water sources. Tofu liquid waste will seep through the water bodies and enter the people's dug wells about 7-15 meters deep. Tofu industrial wastewater has a very high content of organic matter, so that if it is not appropriately managed, it can harm the environment (Siswoyo & Hermana, 2017). Dissolved oxygen levels will experience a decrease in water, which is indicated to be contaminated.

Oxygen solubility can be determined by measuring levels of BOD, COD, pH, nitrate, and nitrite (Atima, 2015; Rivai & Syamsinar, 2017). A low pH value will reduce dissolved oxygen in water, causing a foul odor and darkening of the water. Bad odor is caused by nitrogen content, which is high enough to cause the nitrification process. Therefore it is essential to know the nitrate and nitrite content. Quality standards regarding water quality management based on Peraturan Pemerintah No. 82 (2001), with the classification that class I is drinking water; class II water for recreation, animal husbandry; class III water for agriculture, fish farming; class IV water for plants; and by Peraturan Menteri Kesehatan Republik Indonesia No. 32 [Permenkes RI No.32] (2017) (**Table 1 and 2**).

2. MATERIALS AND METHODS

Materials

The materials used in this study were water samples, manganese sulfate ($MnSO_4$), alkaline iodide azide, sodium thiosulfate ($Na_2S_2O_3$), 0.025 N, sodium hydroxide (NaOH), concentrated ammonium chloride (NH_4Cl-EDTA), iodine, dye solution. Sulfanilamide, naphthyl ethylene diamine (NED) dihydrochloride solution, potassium dichromate ($K_2Cr_2O_7$), potassium permanganate ($KMnO_4$), and concentrated sulfuric acid (H_2SO_4). Meanwhile, the equipment used includes mineral bottles measuring 1.5 liters, box (cooler), thermometer, universal pH meter, UV-Vis spectrophotometer, and glassware.

Procedures/Methods

Well water sampling

A sampling of well water is carried out at three well points from the tofu waste storage tank at a distance of 14 meters for wells (1), 17 meters for wells (2), and 47 meters for wells (3). In water sampling, a mineral bottle is used as a sample container. The mineral bottles used are washed with a sample of well water, taken three times. Then the well water sample is put into a mineral water bottle with the required amount. Well water samples are taken from three points, so the volume of well water samples taken from each point must be the same. The water sample has slowly flowed into the bottle until it is full, then the bottle is closed so that no water comes out of the bottle mouth. Examination of rapidly changing characteristics such as pH is carried out directly after well water sampling. Well, water samples are chemically preserved or acidified by adding concentrated oxidizing agents (H_2SO_4). This compound can inhibit biological activity so that it can be used to examine the characteristics that can undergo biological changes, namely COD, BOD, nitrate, and nitrite.

Measurement of the degree of acidity (pH)

At first, 100.0 mL of water was taken and poured into the container, and then the pH was measured using a universal indicator by inserting a universal pH meter into the container containing the dug well water sample for 10 seconds then observing the change in the degree of acidity and recording the results.

Biochemical Oxygen Demand (BOD) analysis

First, put 250.0 mL of water sample into a winkler bottle, incubate at 25 °C for five days, add 0.5 mL $MnSO_4$, and 0.5 mL of alkaline iodide azide, close the bottle, shake until homogeneous. Let stand until it forms a clot (floc) and then adds 1.0 mL of H_2SO_4 and shake until homogeneous (Sasono & Asmara, 2013).

Chemical Oxygen Demand (COD) analysis

At first, 20.0 mL of water was taken, added to the digestion solution, then closed reflux for two hours at 150 °C. Measured absorption at λ = 600 nm or λ = 420 nm (Badan Standardisasi Nasional [BSN], 2009; Sasono & Asmara, 2013).

Nitrate (NO_3^-) analysis

At first, the pH of the water is adjusted between 7-9 by adding NaOH. As much as 25.0 mL, the water sample is put into a volumetric flask, 75.0 mL of concentrated NH_4Cl-EDTA solution is added, and then shake. Pass the solution through the reduction column with a flow rate of 7-10 mL/minute, remove the first 25.0 mL of the first reservoir, the next eluent reservoir on the Erlenmeyer, quantitatively enter 50.0 mL of eluate into the erlenmeyer and 2.0 mL of the dye solution, then shake it. Measure the absorption within ten minutes to two hours after adding the dye solution at a wavelength of 540 nm (Emilia, 2019).

Nitrite (NO_2^-) analysis

At first, the water sample's 50 mL pipette is put into a 200 mL beaker, and 1 mL of sulfanilamide solution is added, shaken, and leave for 2 minutes to 8 minutes. Then add 1 mL of naphthyl ethylenediamine dihydrochloride solution, shake it, leave it for 10 minutes and immediately take the absorbance measurement at a wavelength of 543 nm (BSN, 2004; Emilia, 2019).

3. RESULTS AND DISCUSSIONS

Analysis of the degree of acidity (pH)

The measurements of the acidity in well water samples are described as follows: pH 7 for wells (1), pH 8 for wells (2), and pH 8 for wells (3). The resulting data shows that the pH in the well water dug in Lautingara is still within the allowable value according to Permenkes RI No. 32 (2017), namely 6.5-8.5.

BOD and COD analysis

The results of BOD and COD measurements in the three dug wells in Lautingara (**Figure 1**), shows that the high concentration of BOD in well one and well 3 exceeds the quality standard for drinking water class (1). Meanwhile, the three wells' COD concentrations also exceeded the drinking water quality standard class (1). This result is thought to be caused by tofu waste, which is just thrown away without being treated first. The tofu wastewater will be absorbed by the soil and mixed with groundwater, then moves through the soil pores causing widespread groundwater pollution. The amount of oxygen needed by microorganisms to oxidizes organic material in waste in protein, carbohydrate, fat, and oil is challenging to break down by microbiology; so that in the water, there is already a deficit of oxygen, which polluted the well water of the people in Lautingara.

Nitrite (NO_2^-) and nitrate (NO_3^-) analysis

The measurement of the concentration of nitrite parameters at the three well points was 0.01 mg/L.

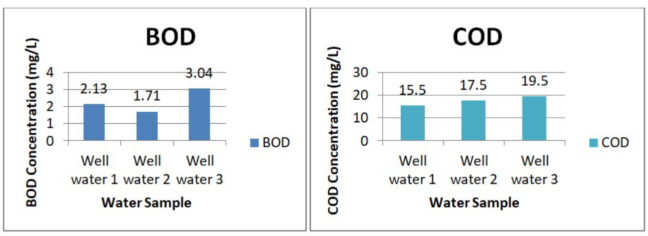

Figure 1. Graph of BOD and COD in dug well water in Lautingara

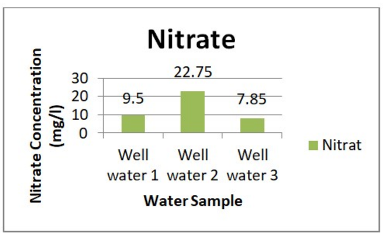

Figure 2. Graph of nitrate in dug well water in Lautingara

However, this result is different from the measurement results of the Nitrate parameter concentration at the three dug well points (**Figure 2**). High concentration of nitrate in well two is thought to be caused by the existence of a latrine between the waste tank and the well water; so that it can seep into the unsaturated soil layer. The wastes flow down to the saturated soil layer and pollute the well water around the waste tub. In the dry season, this water produces an unpleasant odor due to pathogenic bacteria and their metabolic products, so that residents who collect well water at this point use it for bathing and washing only. According to Loganathan, Vigneswaran and Kandasamy (2013), high nitrate concentrations lead to eutrophication of natural water bodies, affecting the aquatic environment and reducing drinking water quality. This problem, in turn, endangers public health, especially the health of babies and livestock.

4. CONCLUSIONS

Based on the results of the study, it can be concluded that the pH and nitrite (NO_2^-) values of the three dug well water samples in Lautingara meet the drinking water quality standards, whereas the BOD, COD, and nitrate (NO_3^-) values in the three dug well water samples in Lautingara do not meet the standards quality and not suitable for drinking water.

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