Analysis of mineral content in Hotspring Water samples in Tubbe and Aramaba Village, Pantar Tengah District, Alor-NTT

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Abstract. Clean water standards are tasteless, colorless and odorless. Hot spring water in Tubbe and Aramaba villages is used by the community for drinking, cooking, washing, bathing and other needs. However, the physical parameters of the water has no longer met the standard because it is slightly colored and has distinctive odor of sulfur. Low quality of water affects the health of people who consume the water. The main problem is clearly seen from the yellow teeth of the people in Tubbe and Aramaba villages. Therefore, it is important to analyzed water quality to determine the levels of iron (Fe), phosphate (PO$_4^{3-}$) and sulfate (SO$_4^{2-}$) in hot spring water in Tubbe Village and Aramaba Village, Pantar Tengah District. Iron content testing has been carried out using an atomic absorption spectrophotometer. UV-Vis spectrophotometer has been used to test the concentration of phosphate and sulfate. The measurement results show that the hot spring water samples in Tubbe Village contain 0.04mg / L iron (Fe), 0.09 mg/L phosphate (PO$_4^{3-}$) and 11.31mg/L sulfate (SO$_4^{2-}$). This value is below the maximum threshold, according to Minister of Health Regulation No. 149 of 2010. The results of the Aramaba Village are 0.04 mg/L; 0.09 mg/L and 11.31 mg/L for iron (Fe), phosphate (PO$_4^{3-}$) and sulfate (SO$_4^{2-}$). This value is above the threshold of calcium content according to Minister of Health Regulation No. 149 of 2010.

1. Introduction

Water plays a very important role in our life, especially for drinking, cooking and other needs. The quality of drinking water have to fulfill three requirements according to the regulation of the Ministry of Health Republic of Indonesia No. 492/MENKES/PER/IV/2010 [1,2]. Physical requirements, consumable water has to be clear having normal temperature equals to the ambient temperature (20–26 °C). Drinking water does not give flavor, color and smell. Chemical requirements, water acidity (pH) has to be neutral (i.e., pH = 7). Drinking water does not contain toxic chemicals, salt or metal ions. Microbiological requirements, water does not contain pathogenic bacteria such as Coli-type, Salmonella-type, Vibrio-cholera; it also does not contain nonpathogenic bacteria such as Actinomycetes, Phytoplanktoncoliform and Dadocera.

Local people in Tubbe and Aramaba villages in Alor regency have long used hot spring water for their daily consumption due to the lack of clean water. Based on the physical appearance, the hot spring water is not clear and produces a distinctive odor of sulfur that might be originated from Mount Sirung.
an active volcano. The same condition of high sulfur content is also found in hot springs at the area of Samboja, Kutai Kartanegara district because it is near the volcano area [3].

Water with high-temperature can dissolve mineral ions contained in the rocks, such as iron (Fe$^{3+}$), phosphate (PO$_4^{3-}$), and Sulfate (SO$_4^{2-}$) and Sulfate (SO$_4^{2-}$). According to regulation of the Minister of Health of Republic of Indonesia No. 492/MENKES/PER/IV/2010, the maximum limit of water content containing mineral iron (Fe$^{3+}$) of < 0.3 mg/L, mineral phosphate (PO$_4^{3-}$) of 0.2 mg/L, and mineral sulfate (SO$_4^{2-}$) amounting to 250 mg/L [2]. The hot spring water consumed is slightly yellowish in colour indicating that it contains high concentration of sulfur. The use of sulfur contended hot spring water in a long period by the local people caused tooth decay (yellowish tooth) [9]. One of the potential development of hot spring water is to be used a hot spring for health therapy. Hot springs is a very important aspect to relate their balneotherapeutic property and enhance the Medical Tourism of the state. Besides sulfur and sulfate, other nutrients and minerals in hot springs water are also important for therapeutic properties [7,8]. Therefore, in this study focused on the iron (Fe$^{3+}$), phosphate (PO$_4^{3-}$) and Sulfate (SO$_4^{2-}$) contained in Tubbe and Aramaba hot spring water.

2. Materials and Methods

2.1 Sampling

Samples of hot springs water were collected according to its purpose. Station I, water samples were taken from drinking and cooking water in Tubbe village (± 12 Km from Mount Sirung). Station II, water samples were taken from bathing and washing water in Tubbe village. Station III, water samples were taken in Aramaba village, located on the roadside of the main road (there is a reservoir) which is ± 4 Km from Mount Sirung. The hot spring water from Station III is not used for daily consumption by the community. Hot spring water samples were are collected in polyethylene containers and brought to the laboratory for analyses. Samples of hot springs water were chemically preserved by adding oxidizing agents (HNO$_3$, 6 M) to inhibit biological activity and any loss of ions fractions by adsorptions onto the wall of containers. The parameters of hot spring water quality were analyzed using standard methods according to the Indonesian National Standard (SNI).

2.2 Measurement of iron (Fe), (SNI 6989.4:2009)

A total of 50 mL hot spring water sample was inserted into the Erlenmeyer 100 mL and then added 5 mL of HNO$_3$ concentrated and then closed and homogenized. Then heated the sample water slowly until the remaining volume of 15-20 mL. This process is done repeatedly until all the dissolved metals. This is evident from the color of the deposits in the hot spring water samples that will turn clear. Enter the hot spring water sample into the cup cups and then the hot spring water samples are moved into the 50 mL measuring flask and added mineral-free water to the precise marking of the impressions and homogenized then measured by the atomic absorption spectrophotometer. Calculated iron levels with the following formula: Iron content (Fe) (mg/L) = C x F$_F$, C is concentration Fe of the measuring result (mg/L), F$_F$ is the dilution factor.

2.3 Measurement of phosphate (PO$_4^{3-}$), (SNI 06-6989.31-2005)

A total of 50 mL sample solution was inserted into the Erlenmeyer and then 1 drop of phenolphthalein indicator was added to the Erlenmeyer. If the color changes to pink, sulphuric acid solution was added drops by drop until the color disappears and then added 8 mL of a mixed solution consisting of potassium antimonyl tartrate solution, ammonium of molybdate solution and ascorbic acid solution was then homogenized. Furthermore, the sample solution and blanko solution were analyzed using UV-Vis at 880 nm wavelength. Calculated phosphate levels with the following formula: Phosphate (PO$_4^{3-}$) (mg/L) = C x F$_F$, C is concentration (PO$_4^{3-}$) of the measuring result (mg/L), F$_F$ is the dilution factor.

2.4 Measurement of sulfate (SO$_4^{2-}$), (SNI 06-6989.20-2004)

A total of 100 mL water samples was inserted into the Erlenmeyer 250 mL; then 20 mL buffer solution
was added to the Erlenmeyer and homogenized by stirring using a magnetic stirrer at a fixed speed for 60 sec. While stirring, 0.3 g barium chloride (BaCl₂) was added. Measurements were performed with UV-Vis spectrophotometers and are calculated sulfate levels (SO₄²⁻) with the following formula:

\[
\text{Sulfate (SO₄²⁻)} \text{ (mg/L)} = C \times F_P
\]

where \(C\) is concentration (SO₄²⁻) of the measuring result (mg/L) and \(F_P\) is the dilution factor.

### 3. Results and Discussion

#### 3.1 Analysis of hot spring water at station I

Hot spring water at station I is used by the local community for drinking and cooking consumption. Based on the results of the analysis, iron (Fe), phosphate (PO₄³⁻) and sulfate (SO₄²⁻) can be seen in Figure 1.

*Figure 1. Hot spring water test results at station I Tubbe Village*

Referring to the regulation of the Minister of Health Republic of Indonesia No. 149/MENKES/PER/JV/2010 then the hot spring water can be consumed but the conversion for a long time period can cause side effects. The use of hot spring water for a long time period can cause mineral accumulations in the body which is evident in the dental corrosion experienced by both children and adults. Phosphorus is the second largest mineral stored in the body as a calcium phosphate salt, which is part of the hydroxyapatite crystal \(\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2\), in the bones and teeth [9]. Dental corrosion (indicated by yellowish tooth) experienced by the local community can be caused by the high content of sulfate in hot spring water. Sulfate (SO₄²⁻) is replacing (PO₄³⁻) the hydroxyapatite crystal \(\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2\), causing white teeth turn yellow, which is a typical sulfur/sulfur color. Compared to the villagers in Tubbe and Aramaba, the surrounding communities, who utilize well water to meet their daily needs, experience less cases of tooth decay.

#### 3.2 Analysis of hot spring water at station II

Hot spring water at station II is used by the community for bathing and washing. Iron (Fe), and phosphate (PO₄³⁻) levels are very small, while the sulfate (SO₄²⁻) is 11.98 mg/L.
Table 1. Hot spring water testing result at a point II of Tubbe village.

| Parameter | Result (mg/L) | Minister of health 149/2010 |
|-----------|--------------|----------------------------|
| Iron      | <MDL         | 0.3                        |
| Phosphate | <MDL         | 0.2                        |
| Sulfate   | 11.98        | 250                        |

The hot spring of Tubbe village at station II is a pond located on the shore and there is a water channel to the sea. If there is a tide, water will cover the surface of hot springs and there is a mixing dilution between seawater and hot spring water. There is a process of dilution by seawater due to the tidal process that allows the mineral levels of phosphate and iron is very small. Because the two types of water had mixed up. Sulfate level \((\text{SO}_4^{2-})\) is possible high enough so that with the presence of dilution by seawater does not lower the sulfate rate significantly. When compared to sulfate at station I, there is no significant difference in station II and station III; therefore, it can be concluded that the dilution factor by seawater at station II does not give a meaningful influence. Based on its chemical composition, the hot spring water in Tubbe and Aramaba village has the potential to be used as a bath for health therapy purposes [7,8].

3.3 Analysis of hot spring water Mineral levels III
Hot spring water at point III located in Aramaba Village is not used by the community to fulfill daily needs. Based on the results of measuring iron \((\text{Fe})\), phosphate \((\text{PO}_4^{3+})\) and sulfate \((\text{SO}_4^{2-})\) in hot spring water at station III are above the threshold that has been determined by regulation of the Minister of Health 149/2010, about the limit of drinking water content that is worth consuming.

![Hot spring water Station III](image)

This high level of the dissolved mineral is possible because hot spring water at station III is near Mount Sirung with a distance of ± 4 Km. High rates are possible due to the flow of suspension from ash, stone, pebble, and sand in a mass of hot volcanic gas that comes out of Mount Sirung and flows through its slope into hot spring water at station III in Aramaba village.

4. Conclusion
Hot spring water used for daily consumption does not meet the physical requirements of drinking water.
According to the regulation of the Ministry of Health, Republic of Indonesia, the dissolved mineral contents in hot spring water at the station I and II is below the threshold, while at station III is above the threshold. Although the mineral level is below the threshold, hot spring water at the station I is not worth consuming.

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