The Study of Drinking Water Quality in Jimei District of Xiamen City

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Abstract. With the acceleration of urbanization in China, the demand for water is increasing, and the consequent problem of drinking water safety is attracting more and more attention. This experiment is aim to learn about the water quality in Xiamen, and the water quality of water resources, the waterworks and users were collected and analyzed. The results showed that the water quality of water sources is reach to class II of the national water quality standards. The chromaticity, turbidity, conductivity, residual chlorine and bacterial colony of the water from both the waterworks and users were lower than the national standard. The total number of E. coli, cadmium and lead were not detected in domestic water in Jimei district. Based on the analysis of the water quality from the waterworks and the users, it may deduce that the pipe material in this area met the relevant requirements and did not cause secondary pollution.

1. Introduction

The problem of air pollution in China has been widely concerned in recent years; in fact, the water pollution in China is as serious as air pollution. Although water pollution has been paid more attention to, and has been took measures for decades of years, the situation still not optimistic [1, 2]. Large-scale water pollution seriously affects the water quality of drinking water. As China’s economy takes-off in recent years, the social and economic demand for water quality is constantly increasing, and the goal, scope and requirements of the protection and management of drinking water safety will change [3]. The drinking water safety faces severe challenges. With the acceleration of urban development, the original remote urban water source has been surrounded by urban and rural areas, and the production and living of surrounding residents pose a potential threat to the water quality of water source. In 2016, the water quality of 1,333 drinking water sources has been investigated, of which the water quality of 98 water sources not up to standard, accounting for 7.35%. The water quality of 16 water sources has been exceeding the standards for 12 months of the year. In addition, the water quality of 63 water sources exceeded the water quality standard for 3 months or more of a year [4-6].

In addition, the process of water intake, conveyance and treatment are vulnerable to pollution, lead to the safety of urban water supply cannot be guaranteed. Chen xia et al. investigated the quality of secondary water supply in Jinshan district of Shanghai, and the results showed that the qualified rate of water samples in 31 residential communities was 74.19%, and the qualified rate of 93 water samples was 86% [7]. There are 1,371 secondary water supply units in Xiamen with a qualified rate of 71% [8].
On the other hand, the quality of water supply pipes arose more and more attentions. The nonstandard materials, the aged and rusted galvanized pipes seriously affect the quality of drinking water. According to the investigation, lead release caused by corrosion of water supply pipes is the main source of lead in drinking water, and lead pollution in drinking water accounts for more than 20% of the total amount of lead pollution on human body [9, 10]. In addition, 32.8% of the main pipe in domestic urban water supply network was made of inferior material, which leads to the release of benzene, volatile phenols and radioactive substance in water [11]. Therefore, it is of great significance to carry out investigation and research on water quality for a comprehensive understanding of the drinking water safety and make targeted improvement measures.

This paper investigates the water quality of water sources, waterworks and domestic water in Jimei district of Xiamen city, and analyzes the relationship of water quality between different stages, in order to find out the main factors affecting drinking water quality and provide scientific basis for its treatment.

2. Materials and Methods

2.1 Sampling
The sampling sites including water source, water works and domestic water users. The sampling sites of water sources include Bantou reservoir (a), Shidou reservoir (b) and Tianma reservoir (c). The water works is mainly Jimei water works (d). Users including the Jimei district government (e), Jimei procuratorate (f), Xiamen second hospital (g), Xiamenbei railway station (h), KFC(i), McDonald’s (j), Coffee shop (k), Wanda plaza (l), Xiamen university of technology (XMUT, m), Huqiao university (HQU, n), Jimei university (JMU, o), Duishan community(p), Pingyangli community(q) and Yingcun community (r). The specific sampling sites are shown in Figure 1.

![Sampling sites in Jimei District of Xiamen City](image)

**Figure 1.** Sampling sites in Jimei District of Xiamen City

2.2 Experiment methods
The chromaticity was measured by platinum-cobalt colorimetry (GB/t 11903-1989). The conductivity value and total dissolved solids were measured by conductivity meter. The turbidity of water was determined by spectrophotometry (GB/t13200-1991). Residual chlorine was determined by DPD photometry. The content of heavy metals in drinking water was determined by ICP-MS. The number of coliform bacteria was determined by filtration membrane method.
3. Results and discussion

3.1 Chromaticity and turbidity

The water resources have been well protected in Xiamen, so the water quality of Bantou Reservoir, Shidou Reservoir and Tianma Reservoir meets relative standards. The index of smell and visible particles of the water samples from these reservoirs was good enough.

![Chromaticity graph](image1)

**Figure 2.** The chromaticity of water from different sampling sites in Jimei district of Xiamen City

![Turbidity graph](image2)

**Figure 3.** The turbidity values of water from different sampling sites in Jimei district of Xiamen City

As shown in Figure 2, the chromaticity of water from the water sources was between 12 and 15, which is lower than the national standard limit. After treatment by waterworks, the chromaticity value decreased to 4 to 6, and it was 2 to 7 of the water from all the domestic water samples.

The results of turbidity were shown in Figure 3. The results indicated that the turbidity of the water from the water sources is between 3.42 and 4.63, and the turbidity of all reservoirs greatly exceeds the
national standard limit of 1. The water quality is turbid. After the treatment in water works, the
turbidity was decreased to 0.21 - 0.24, which met the standard of 1. The turbidity value in the user’s
water is between 0.12 and 0.54, and the highest value from the water of Jimei Procuratorate and the
Xiamen Second Hospital. It indicated that there may be pollution in the pipe or water storage
equipment in this area.

3.2 $pH$ and conductivity
As can be seen from the Figure 4, the pH value of the water source is between 5.95 and 7.36, and it’s
lower in Tianma Reservoir. After treatment, the pH is between 6.21 and 6.36. The relatively lower pH
is ascribing to the addition of chloride to disinfect. As can be seen from the figure, the pH value of
water from the users is from 5.54 to 7.65, and it means that the pH value increased after the
transmission. The reason maybe the volatilization of the chloride and the neutralization of water with
other substance exists in the transmission system.

![Figure 4](image)

Figure 4. The pH values of water from different sampling sites in Jimei district of Xiamen City

![Figure 5](image)

Figure 5. The conductivity values of water from different sampling sites in Jimei district of Xiamen City

The conductivity of the water from the reservoir is 206.4-337 us/cm (Figure 5), and the dissolved
solids are between 540-840 mg/L, which all meet the national standards. After treatment, the
conductivity was decreased to 155.3-176 us/cm, and the dissolved solids were between 105-110 mg/L.
The conductivity of the water from the user is between 119-352 us/cm, the dissolved solids between
72-142mg/L, and the conductivity of most areas is higher than the water from the water works. Considering the low pH of the water from the water works, the slightly acidic water leads to the dissolution of substances in the pipe or water storage equipment, which increases the conductivity.

3.3 Free chlorine residual
The value of residual chlorine was demonstrated in Figure 6. No chlorine was detected in water samples of water sources. After treatment in the waterworks, the free chlorine is between 0.92-1.1mg/L, which meets the national standard. The residual chlorine content of residential water is between 0.45 and 1.12mg/L, which is close or lower than the value from the waterworks. It means that chlorine will decreased in the transportation of the pip. Residual chlorine content may be related to the transportation distance of the pipe network and the storage time of water.

![Figure 6](image)

**Figure 6.** The residual chlorine values of water from different sampling sites in Jimei district of Xiamen City

3.4 Cadmium and Lead
Lead was detected in both Bantou Reservoir and Tianma Reservoir with the concentration of 0.0045 to 0.0072mg/L, lower than the national standard of 0.01mg/L. However, it still indicated that the possibility of heavy metal pollution in the reservoir. Due to limited sampling sites, we cannot draw the conclusion that there was heavy metal pollution in these reservoirs. More samples should be collected to investigate the heavy metal pollution in these reservoirs.

After treatment by the waterworks, the cadmium and lead were not found in the water samples of the waterworks and domestic water, indicating that the pipe material in this area met the relevant requirements and did not cause secondary pollution.

3.5 Microorganism
The total number of bacterial colonies from reservoir water samples was between 329-372 cfu/mL, among which the number of escherichia coli groups was between 70-110 cfu/mL. The bacterial colonies and escherichia coli were not detected after treatment. However, bacterial colonies were detected in the water samples of Jimei procuratorate, the Xiamen second hospital and Jimei university with the concentration of 2, 6 and 3 cfu/mL, respectively, and no e. coli group was detected. Generally speaking, water quality is relatively good and has little impact on residents’ health.
In general, the drinking water quality in Jimei district of Xiamen better than that of past few year. The water quality of Xiamen from 2007 to 2010 was investigated by Huang et al., the results indicated that The contamination of microorganisms was serious in non-centralized water supplies and untreated source water with a disqualified rate of 56. 77% and 44. 44%, respectively, and the content of residual chlorine is another big problem [8]. The domestic water quality in Zhangzhou from 2007 to 2012 was investigated, and it showed that the residual chlorine and total plate count are the most serious factors that affect the water quality. The qualification rate is only 28.1% for the residual chlorine and 60.5% for total plate count [12].

4. Conclusion
In general, the water sources in Xiamen are well protected, and the water quality meets the standards. Advanced technologies were applied in the waterworks, and it can provide high quality water. Although there are some differences in water quality among different users, all the indicators basically meet the national water quality standards. It shows that water treatment technology, pipe network, storage technology and materials meet the requirements. In the future, the detection of trace pollutants such as antibiotics should be carried out to comprehensively evaluate water quality.

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