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Relationship between Turbidity and Microbial Load of Water in Salman Farsi Dam Reservoir

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Abstract

Turbidity can provide nutrients for microbial population growth and reduce chlorination efficiency in downstream treatment plants. These particles, by providing a protective coating, prevent the access and contact of disinfectants with microbes. In this study, to find the relationship between turbidity and microbial characteristics of water in a dam reservoir, 32 water samples were collected weekly in a three-month interval to analyze turbidity, heterotrophic bacteria, and Total Coliforms (TC). The average water turbidity of this dam was 5.92. The results of statistical analysis showed that there was no significant relationship between Coliform and turbidity ($p = 0.116$). But there was a significant relationship between the number of heterotrophic bacteria and turbidity ($P=0.03$) and between the coliform and heterotrophic bacteria ($p =0.008$).

Keywords: Salman Farsi Dam; Turbidity; Total Coliform; Heterotrophic count

Introduction

Dams are one of the most important sources of drinking and freshwater supply. Turbidity in water is caused by the presence of suspended particles such as clay, silt, minerals and non-minerals, plankton and other microscopic microorganisms, and is a measure of the amount of light absorbed or the scattering of light by suspended matter. Turbidity is important in three aspects: aesthetics filter blockage, and disinfection. Because of the association between turbidity and some microbial characteristics, including Giardia cysts, turbidity can be considered as an indirect indicator of the removal efficiency or presence of these agents [1]. Turbidity can provide nutrients for microbial population growth and reduce chlorination efficiency in downstream treatment plants [2]. In fact, organic and inorganic particles provide good bedding for germs by providing food. By providing a protective coating, these particles prevent the access and contact of disinfectants with microbes, thereby greatly reducing the efficiency of disinfectants, resulting in increased disinfectant consumption. UV disinfection also has low efficiency in waters with high turbidity. Colloidal particles provide surfaces for the absorption of biological microorganisms or harmful chemicals or an undesirable odor [3]. Ferguson CM, *et al.* who investigated the relationship between pathogens and river water quality indices reported that following increasing turbidity, water coliform is increased, as well [4]. The World Health Organization (WHO) in 2006 set the microbial health requirement in water based on turbidity, for example, if the average turbidity of the samples is less than 1 Nephelometric Turbidity Units (NTU) or the turbidity of a single sample is less than 5 NTU, most likely as much as 4 logs, water are free of bacteria and viruses [5]. Plate count of heterotrophic bacteria is a method to estimate the number of living water bacteria. This experiment gives us very useful information about water quality and Coliforms as well as the impact of different water processes [6]. Coliforms and Escherichia coli are known as microbial markers of water [7]. Microbial heterotrophic analysis of the Arak drinking water network and its relation to turbidity was performed by Fathi, *et al.* [8]. But so far few studies have been conducted to investigate the relationship between turbidity and the number of bacteria in water dams. Salman Farsi Dam is one of the sources of water supply in the south of Fars province, which is built on the *Qareh Aghaj* river. Therefore, this study aimed to investigate the relationship between water turbidity of this dam and its microbial properties.

Methods

Measuring indicator bacteria are one of the important ways to evaluate the microbial quality of a water source. The most important of these bacteria in importance are Escherichia coli, thermo tolerant Coliforms and Total Coliforms (TC). The presence of these bacteria indicates intermittent and recent contamination of water with human or animal feces. A total of 32 water samples were collected from Salman Farsi dam in Jahrom County in a three-month period. Samples were supported randomly and in accordance with standard conditions in order to perform Most Probable Number (*MPN*) and Heterotrophic Plate Count (HPC) test. The lactose broth medium was used for multi-tube fermentation experiments. Each ternary series of tubes (9 tubes in total) was inoculated with 10, 1, 0.1 mm of the water sample, respectively. After 24 h incubation at 35 °C, the tubes were examined for microbial growth and gas production. Gas production was considered a positive probable test [8]. HPC test was performed to evaluate the growth of heterotrophic bacteria by plate counting method. The nutrient agar culture medium was used for the culture of these bacteria. The incubation temperature of the culture media was adjusted for 48 hours at 30 °C. After this time, the number of colonies per plate was counted and reported as Colony-Forming Unit *(CFU)/mL* [8]. Turbidity determines the amount of water transparency and is used as a non-microbial parameter. A Hach portable turbid meter was used to measure turbidity and the results were reported as NTU. The data were sorted in Excel software and analyzed to determine the relationship between turbidity and heterotrophic bacteria using SPSS version 19. Spearman test was used for statistical analysis because the data were not normal. Significance level (p-value =0.05) was considered.

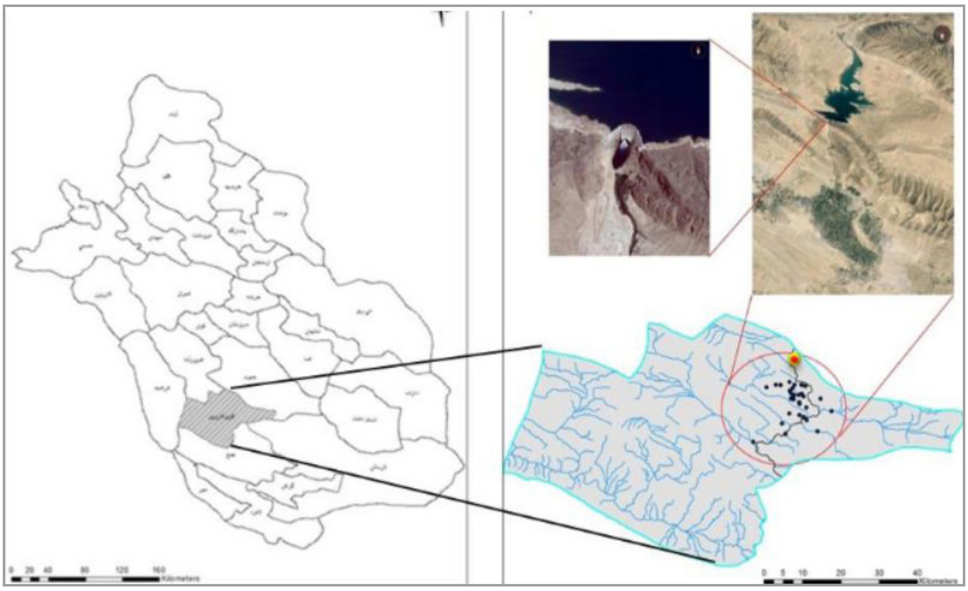

Figure 1: Map of the study area

Results and Discussion

Table 1 shows the results of the turbidity relationship with MPN and HPC. Spearman correlation analysis revealed that turbidity had no significant relationship with coliform (r = 0.283; p = 0.116). Contrary to the results of the present study, the results of the Ferguson CM study indicated a significant relationship between turbidity and coliform in river water [4].

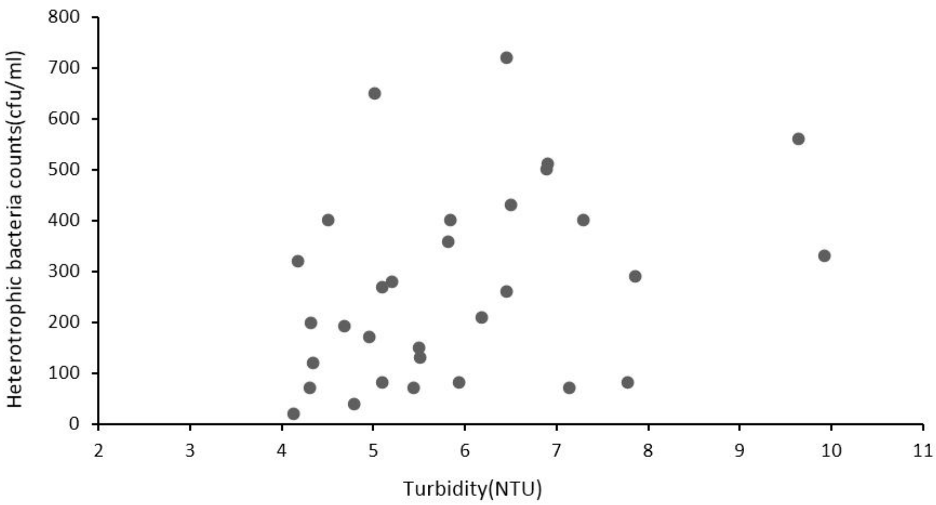

Figure 2: Relationship between turbidity and number of heterotrophic bacteria (p = 0.03)

The high turbidity of the water, which causes the protest of consumers, causes the growth of pathogens, and therefore, it reduces disinfection efficiency. The mean water turbidity in the samples was 5.91. According to the results of heterotrophic bacterial counts and turbidity measurements shown in Figure 2, Spearman correlation analysis revealed that there was a significant relationship between the number of heterotrophic bacteria and turbidity ($r = 0.38$; $p=0.03$) so that the number of heterotrophic bacteria increased significantly with increasing turbidity during the study. Hass et al. also reported that the microbial parameters of the distribution network system have a significant relationship with its physical characteristics [9]. However, the results of the Miranzadeh MB study did not show a significant relationship between HPC and turbidity [10]. Khodadadi, *et al.* performed bacteriological modeling in Semnan water network and reported a significant relationship between HPC and turbidity [11].

Figure 3 shows the relationship between the number of heterotrophic bacteria and Coliforms. Although heterotrophic bacteria were not considered as an indicator of microbial health, as Spearman correlation analysis showed, MPN was significantly correlated with the number of heterotrophic bacteria ($r = 0.460$; $p = 0.008$). The results of the study by Fathi, *et al.* also showed that there was a direct and significant relationship between the number of heterotrophic bacteria and MPN [8]. Today, heterotrophic bacteria are considered as a HPC index and as a complement to the coliform form in water quality control. The US Environmental Protection Agency (USEPA) has set the maximum permissible number of heterotrophic bacteria in the 500 *CFU/mL* distribution networks, which was higher than some of the samples in this study [12].

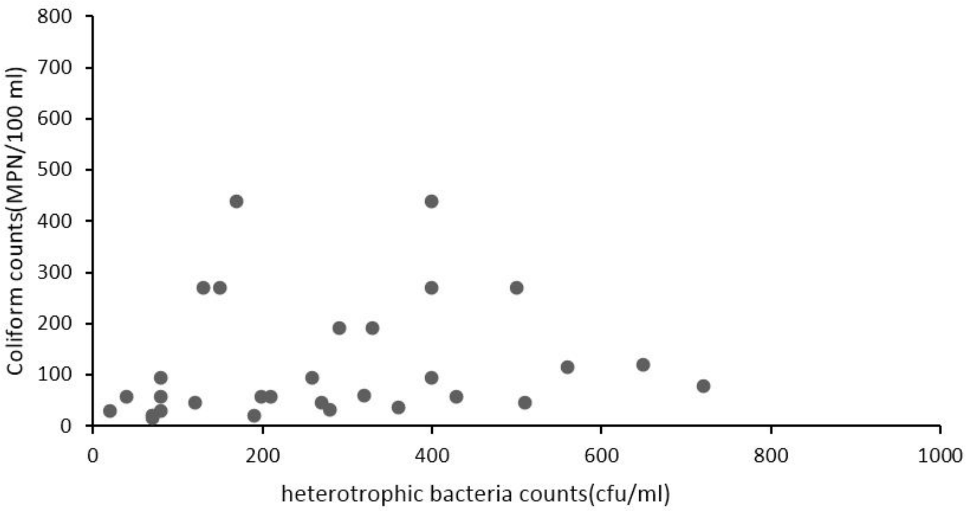

Figure 3: Relationship between heterotrophic bacteria and Total Coliforms ($p = 0.008$)

	Mean	Standard deviation	Maximum	Minimum	r	p-value
MPN	119.21	116.96	439.56	14.82	0.28	0.116
HPC	347.5	477.41	720	20	0.38	0.03
Turbidity	5.91	1.46	9.93	4.12		

Table 1: Relationship between turbidity with MPN and HPC

Conclusion

The aim of this study was to investigate the relationship between turbidity and the number of heterotrophic and coliform bacteria in Salman Farsi dam water. The results of Pearson correlation analysis showed that there was a direct and significant relationship between the number of heterotrophic bacteria and turbidity, while there was no significant relationship between TC and turbidity. The relationship between heterotrophic bacteria and TC was also significant.

Acknowledgement

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