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# Effect of water quality and operational parameters on trihalomethanes formation potential in Dez River water, Iran

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ABSTRACT

This study assesses the influence of the total organic carbon (TOC) content, chlorine quantity, water temperature, bromide ion concentration, and seasonal variations on trihalomethanes (THMs) formation potential (THMFP) in Dez River water in Iran. The water temperature and TOC content had a significant effect on THMFP. Further, the experimental results showed that increasing the concentration of bromide ions enhances the formation of dibromochloromethane and bromoform. It was found that the THMFP in Dez River water during summer times was relatively higher than 100 μg/L, maximum contaminant level for THMs in drinking water. By increasing the reaction time until 80 h, the THMFP was gradually increased and reached to 177.4 μg/L. The most abundant fraction of natural organic matter in the river was hydrophobic acid fraction (49.4 μg/L). Overall, our study demonstrated that however the THMFP of Dez River water was relatively high but a usual waterworks could effectively reduce THMFP.
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## 1. Introduction

Water disinfection procedure using chlorine is a global practice for reducing the health risk of pathogenic growth in drinking water treatment processes. Despite the crucial importance of this strategy, several classes of undesirable disinfection by-products (DBPs) are usually identified in potable waters [1,2]. Chlorine reacts with natural organic matter (NOM) in raw water, resulting in the formation of trihalomethanes (THMs), haloacetic acids (HAAs), haloacetonitriles (HANs) and other chemical compounds [2]. Some epidemiologic studies [3] have shown an association between long-term exposure to DBPs and an increased risk of cancer, also a potential adverse effect on reproduction. The most prevalent classes of DBPs in chlorinated drinking water samples are THMs [4] that including chloroform (CFM), bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform (BFM). Since the THMs present a serious health risk to humans, the Environmental Protection Agency (EPA) has regulated the maximum contaminant level (MCL) for THMs of 80 μg/L [5]. THMs formation in drinking water depends on operational procedures implemented in water treatment plants (WTP), such as chlorine dose, contact time between chlorine and organic matter, pH, temperature, and others [6,7]. Further, THMs formation in the chlorinated water may significantly vary depending on the seasons and the geographical location of water resources [8]. For instances, in different geographical locations such as Spain, China, South Korea, Greece, and US the average of THMs in the water treatment plants was stated in the wide range of 9–129 μg/L [2,9–12]. Earlier studies by Chowdhury et al. [13], Roccaro et al. [14], Tokmak et al. [15], and Agus et al. [16] demonstrate that the higher values of NOM water content will result the higher concentrations of THMs. Although numerous studies have been focused on the THMs formation but some researchers [17,18] found that further study will still be needed before any definitive conclusions on the management of waterworks regarding the use of the result of those works. Moreover, most of the existing investigations at present have been performed over short monitoring times using a reduced number of experimental and operational WTP variables. In THMs research field, there is still a demand for reliable and robust data of THMs formation for managing the process involved in WTPs. Further, the investigation on THMs concentrations in drinking water resources and information about the THMs formation in Iranian water resources is rare.

Therefore, one year duration of analyzing the THMs in a typical Iranian water resource was designed in the present study to assess the effects of TOC content, chlorine dosage, water temperature, bromide ion concentration, seasonal variation, and reaction time on the THMFP in Dez River, the second largest river in Iran. Further, to assessing the capability of conventional water treatment plants, the fate of THMFP and dissolved organic carbon (DOC) fractions in a water treatment plant were tested. The results of this study will be beneficial for minimizing the THMs formation and for an optimal managing and designating of water treatment plants.

## 2. Materials and methods

### 2.1. Field sampling strategy

Dez River flows from central region to the southwest of Iran until it joins Karoon River which is finally poured in Persian Gulf. Its average flow rate is 246 $m^3/s$. The length of Dez River is 400 km. This river provides the drinking water for many cities, villages, and industries. Further, 23 WTPs feed by Dez River. One of the most important WTPs is that of Andimeshk city (WTPAC), which provides drinking water for one-half million capita. Samples were collected at the water intake of WTPAC, where water is pumped from the river to the WTPAC (Fig. 1). To investigate the occurrence of THMFP within the raw water of Dez River, an intensive sampling program was undertaken for one year between the beginning of October 2012 and the end of September 2013. For each month, 4 samples were taken, that is, totally 48 samples were collected from the WTPAC intake. Ten liters of water were collected at the WTPAC intake from a depth of approximately 50 cm below the water surface with a hand-held open-mouth bottle. All samples were shipped to the laboratory in coolers on ice within the same day and stored at 4 °C before further analysis.

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