

The Effect of Suspended Solids on Disinfecting Process for Drinking Water in Peshawar Valley

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Summary: Drinking water samples were collected from consumer tap at 12 different locations in Peshawar valley during the month of August and September 2003. In Peshawar, the subsoil water is used for drinking and other purposes and supplied to the consumers through underground distribution lines. Chlorination is the disinfecting practice carried out by water management authorities in the area. These samples were examined for the presence of residual chlorine, microorganisms and related parameters. On the basis of this study, it was evaluated that a lot of suspended matter is present in most of the samples, which may be due to geographic nature of the area where heavy rain is common during the monsoon that alters the suspended matter composition of water or may be due to leakage in the old corroded distribution lines, providing an opportunity to both microorganisms and suspended matter to penetrate in the distribution circuit. The suspended matter imparts turbidity, which shields microorganisms against disinfection by adsorbing chlorine at their surface and unavailable for the purpose. Statistical findings show that increase of one unit in the suspended matter causes an increase of 3.74 units in coliform bacteria.

Introduction

Water is essential for life. It has been estimated that man can survive for about 20 days without food but starts struggling for life without water just after one day [1]. Our planet has a lot of water. Fresh water comprises about 2.5 percent of the world's total volume of water. Most of the amount is in the form of ice or snow and lies deep in underground aquifers present in the remote locations. Less than one percent of the world's fresh water is readily available for human use [2]. Fresh water is used for drinking, domestic, agricultural, power generation and industrial processes [3]. Despite its availability in limited amount and its vital role in the maintenance of life, fresh water has a potential risk of pollution.

Water pollution is generally a state of deviation, from the pure conditions, whereby its normal functions and properties are affected [4]. There are various sources of water pollution i.e. natural, industrial, agricultural and domestic.

Peshawar valley had been selected for the study in consideration because of its geographical nature and huge population growth rate of 3.62 % [5]. In Peshawar, mostly the subsoil water is used for drinking purposes supplied by Peshawar Development Authority, Municipal Corporation,

Town committee and Cantonment Board to the area under their jurisdiction.

Studies have been carried out by different research workers on the water quality evaluation of different areas of N.W.F.P. including Peshawar. S. Khan and F. Khan reported that the valley has excellent water deposits; however, the same quality is not maintained at the consumer's tap [6]. Khan *et al.*, found that water of most areas of N.W.F.P. was contaminated due to the presence of bacteria [7]. Rahman and Khan studied the physicochemical parameters of portable water of Peshawar at source point only and found that all the parameters studied were within the recommended limits and incidents of water born diseases were not associated with water at source point [8]. F. Khan and S. Khan reported statistically that the aesthetic parameters are deviated seriously during the supply process [9].

The data available from a previous research are a useful tool for public awareness and also provide useful information to the water management authorities for future planning. However, no attention has far been paid to the ineffectiveness of disinfecting processes employed for water purification in the area.

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Table-1: Observed Parameters at all Locations

S.No.	Location	Sample date	T (°C)	TSS (ppm)	Cl (ppm)	NO ₃ ⁻ (ppm)	T.C. MPN/100ml	F.C. MPN/100ml
1	Peshawar Univ. Campus	Aug.01,2003	21	10	0	6.1	9	0
2	University Town	Aug.04,2003	23	13	0.2	4.3	0	0
3	Sufaid Dari	Aug.08,2003	23	17	0	7.2	27	12
4	Peshawar Board (Tajabad)	Aug.11,2003	23	19	0	7.8	7	7
5	Defense Colony (Ladies Club)	Aug.15,2003	22	17	0.4	3.9	0	0
6	Army Flats	Aug.18,2003	21	19	0.2	4.1	0	0
7	Itihad Colony	Aug.22,2003	23	14	0.2	3.2	0	0
8	Shami Road	Sept.01,2003	22	34	0.2	7.0	130	18
9	Sadar Stadium	Sept.04,2003	22	42	0.2	8.9	182	27
10	Latif Abad	Sept.07,2003	22	47	0.4	7.2	96	12
11	Chowk Yadgar	Sept.12,2003	22	53	0.2	8.7	157	21
12	Gulbahar	Sept.17,2003	22	39	0.2	7.6	129	12

T = Temperature; TSS = Total Suspended Solids; Cl = Residual Chlorine; NO₃⁻ = Nitrate; T.C. = Total coliform; F.C. = Fecal coliform.

The present work aimed at studying interference of suspended matter in the disinfecting process for water purification and at providing reasons for the ineffectiveness of the same in the study area, despite regular chlorination, which is not only a laborious practice but also an economic burden.

Results and Discussion

In Table 1, the observed parameters i.e. temperature, total suspended solids (TSS), residual chlorine, nitrate, total coliform and fecal coliform of all samples are given. Temperature values of all the 12 samples were in the range of 21 – 23. Looking at the residual chlorine contents only three samples were found to possess absolutely having no chlorine. These samples were collected from the locations of Peshawar University Campus, Sufaid Dari and Peshawar Board. Due to the absence of residual chlorine, growth of bacteria was not checked, which may be the cause of presence of both total and fecal coliforms in the samples collected from Sufaid Dari and Peshawar Board, entering the distribution line either at the source point or more commonly due to leakages during distribution. Total coliform was present where fecal coliform was absent in the sample collected from Peshawar University, which showed that the microorganisms may be entering the water at the source point only and the distribution line was safe because of the absence of fecal coliform, which entered the distribution line from sewerage due to leakage. Nitrate contents in the water samples collected from these three locations were also found to be considerably high i.e. Peshawar Board 7.8 ppm, Chowk Yadgar 8.7 ppm and Sadar Stadium 8.9 ppm, which may be due to the presence of bacteria and nature of commercial and trade

activities including fruits and vegetable business in the area.

Four samples collected from University Town, Defense colony, Army Flats and Itihad Colony showed no coliform organisms in them, which may be due to the presence of residual chlorine in the samples in the range of 0.2 – 0.4 ppm and total suspended solids in the range of 13 – 19 ppm. Nitrate content was also sufficiently low, in the range of 3.2 – 4.3 ppm. The remaining samples collected from the most congested locations of Peshawar including Shami Road, Sadar Stadium, Latif Abad, Chowk Yadgar and Gulbahar showed a serious phenomenon. All these 5 samples contained the residual chlorine in the range of 0.2 – 0.4 ppm but still both total and fecal coliform were present in these samples in very high proportions. The TSS of these samples were also found to be relatively high in the range of 34 – 53 ppm, which may be either due to heavy rains of monsoon common in these days, which bring lots of suspended matter to these subsoil water deposits or leakages in the underground distribution system. During the examination of residual chlorine in these samples, it was observed that the response toward Ortho-Tolidine was considerably delayed, which may be due to the adsorption of free chlorine on the surface of suspended particles that impart turbidity and shielding effect to microorganisms by making chlorine unavailable for disinfecting purposes [10]. Similarly, the nitrate content of the samples collected from these locations was in the range of 7 – 8.9 ppm, which is very close to the upper admissible limit i.e. 10 ppm, recommended by World Health Organization (WHO), for drinking water [11].

Nitrate content greater than 10 ppm is the major cause of methemoglobinemia in neonates [11].

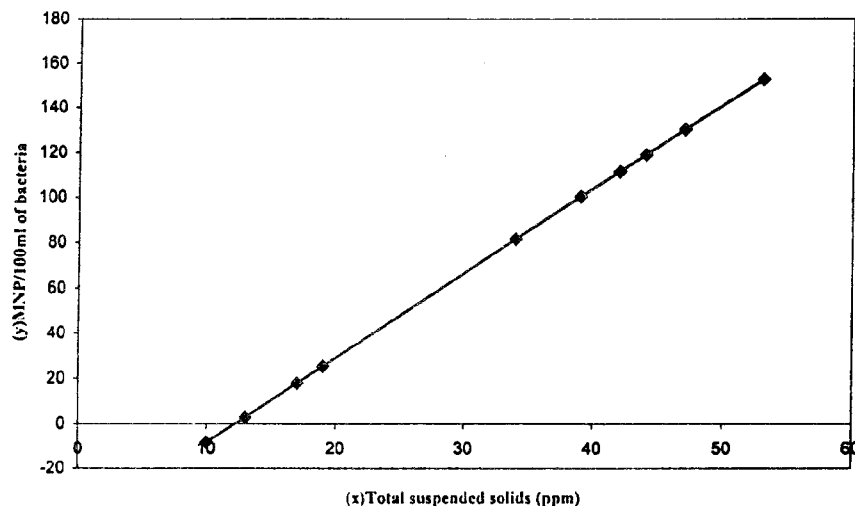


Fig. 1: Scatter plot of Bacteria vs Total suspended solids

Such high level of nitrate in the samples may be due to the presence of bacteria in the sample as bacteria may cause the production of nitrates from the decomposition of vegetables and plants [11]. These are the most densely populated locations of the city and center of commercial and trade activities, offering great burden on natural resources.

Considering the statistical portrait of the collected samples by applying simple regression and correlation analysis, good correlation coefficient may be observed between suspended solid and bacterial count. The data reveal that an increase in suspended solid propagates bacteria. i.e. for one unit raise in TSS an increase of 3.74 units may take place in the MPN/ 100 ml of total coliform shown by the slope of Fig 1. The good correlation coefficient and regression equation between suspended solid and bacterial growth proved that the solid suspended particles may play an important role in the growth of bacteria through shielding effect against disinfection.

Experimental

Twelve locations were randomly selected in the study area in order to get the statistical portrait of the total area. Three samples were collected from each location according to WHO recommended procedure [11] and their mean values are incorporated in the observation Table 1. Temperature was recorded at the spot with the help of an ordinary centigrade scale thermometer. Standard method [12] was used for the determination of suspended solids. Spectroscopic method was used for the determination

of nitrate contents using Hitachi-U2000 spectrophotometer [13]. Residual or free chlorine contents were determined through calorimetric method [10] using standard chemical inc. (USA) chlorine tester. The MPN/100ml (Most probable number) for both total and fecal coliforms in each 100ml of the sample was determined by standard multiple fermentation method [12]. The data collected from all the twelve samples were investigated for finding correlation between suspended solids and effectiveness of water chlorination by using simple regression and correlation analysis [14].

Conclusions

On the basis of this study, it was concluded that the local authority has been carrying out chlorination but the results are not obtained in most of the locations due to the presence of suspended matter in high proportion especially during monsoon. In most of the samples, the added chlorine is adsorbed at the surface of these suspended particles and made unavailable for disinfecting the water. This problem is one of the major reasons of periodic outbreaks of water born diseases in the study area during monsoon despite chlorination for water purification [15].

It is therefore recommended to replace the old and corroded distribution lines and suspended solids must be removed through filtration or other technique prior to chlorination in order to achieve an effective disinfection of drinking water within the limits of

chlorine recommended by WHO i.e. less than 0.5 ppm for the protection of the residents of the area from water born diseases. Moreover, chlorination of highly turbid water is not only of no use but also causes toxicity and is a great economic loss [11].

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