BACTERIOLOGICAL ANALYSIS OF DRINKING WATER FROM URBAN AND PERI-URBAN AREAS OF PESHAWAR

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ABSTRACT

Objective: To determine bacterial loads and contaminants in drinking water in and around Peshawar as to form water quality guidelines for judgement of the acceptability of public drinking water supplies.

Material and Methods: A total of 224 water samples in an around Peshawar were assessed for bacteriological contamination.

Results: Ninety-two (81%) untreated and forty-two (19%) treated water samples were positive for coliforms. Faecal coliforms and faecal Streptococci were found in 52 and 12 numbers of samples respectively, indicating contamination of faecal origin, and inadequate treatment of water supplies. Escherichia coli was found in 43.28% of the samples, which is substantial indicator of faecal pollution.

Conclusion: It is desirable to disinfect all supplies of drinking water before distribution and consumption in view of its great public health significance.

Key words: Bacteriological analysis of water, Faecal contamination of water, Faecal coliforms organisms.

INTRODUCTION

The most common and widespread danger associated with drinking water is contamination either directly or indirectly by sewage or other wastes of human and animal origin. About 25 years ago, authoritative estimates indicate that each year some 500 million people were affected by waterborne or water associated diseases globally and as many as 10 million of those died. Recent reports of WHO, suggest 80% of all human illnesses in the developing world are caused primarily by biological contamination[1].

Faecal pollution of drinking water may introduce a variety of intestinal pathogens which may cause diseases from mild gastro-enteritis to sever and some-time fatal dysentery, diarrhoea, cholera, typhoid and hepatitis A etc. Other organisms naturally present in the environment and not regarded as pathogens, may also cause opportunist disease[3].

Ideally, drinking water should not contain any micro-organisms known to be pathogenic and it should be free from bacteria indicative of faecal pollution[4]. The majority of the population in developing countries is not adequately supplied with potable water and thus compelled to use unsafe water for domestic and drinking purposes[8]. This study was initiated to determine bacterial loads and contaminants in drinking water in and around Peshawar as to form water quality guidelines for judgement of the acceptability of public drinking water supplies.

MATERIAL AND METHODS

Sample Collection

Two hundred twenty four (224) water samples were aseptically collected in sterilized bottles from various sources in an around Peshawar. Sampling was done between June 2001 to October 2001 to make an assessment of the contamination of drinking water in and around Peshawar. All water samples from wells and municipal tape water supplies were immediately processed in Public Health Laboratory Deptt: of Community Medicine KMC within two hours after collection[2].

Sample Processing

A. pH of all water samples was recorded by means of pH meter.

B. Bacteriological Analysis

i. Presumptive test for coliforms (For untreated and treated water samples)

a. Untreated water samples

Multiple tube method was used for water analysis. Briefly, five tubes of double strength lactose broth (containing durham's tubes) were inoculated with 10 ml water sample in each tube and 5 tubes each with 1.0 ml and 0.1 ml sample respectively. After incubation at 37C° for 48 hours, the production of acid and gas was noted for positive tubes and most probable number (MPN) was calculated according to macCardy's table.

b. Treated water samples

In case of chlorinated or sand filtered water, 50 ml of double strength MacConcky broth was inoculated with 25 ml sample and incubated at 37C* for 48 years. The rest of the procedure was same as for untreated water samples.

ii. Confirmatory test for faecal coliforms.

One ml from each positive tube of presumptive coliforms was inoculated in Brilliant Green Lactose Bile Broth (BGLB) separately in each tube. After incubation at 44.5 C° for 24 hours change in color of the medium (Acidic) and gas formation was noted for five tubes. Positive tubes were further cultured on Eosine Methylene Blue (EMB) agar for isolation of faecal coliforms. Isolated colonies were confirmed by using biochemical tests of API-20 E system.

iii. Confirmatory Test For Faecal streptococci.

Positive tubes of presumptive coliform test were sub-cultured in glucose broth and incubated for 2 hours at 37C°. Sodium Azide (0.25 gm / 500 ml) was then added and incubation carried out at 44.5C° for further 48 hours. Positive tubes showing acid were sub-cultured on macConkey agar plates and incubated at 37C° for 24 hours. The presence of small red pin point colonies were indicative of Streptococcus faecalis Gram staining and the production of acid in manitol and lactose further confirmed their presence.

iv. Analysis of other enteric pathogens.

(Salmonella, Shigella and Vibrio spp)

Fifty ml (50 ml) of selenite broth and equal quantity of alkaline peptone water were inoculated with 25 ml water (in each bottle) after incubation for 16-18 hours at 37C°. The sub-cultures from the former were made on xylose lysine dextrose (XLD) agar plate and on thiosulphate citrate bile salt sucrose (TCBS) agar from the later respectively. Plates were incubated at 37C° for 24 hours and suspected colonies were identified biochemically and serologically.

RESULTS

The water samples analyzed in this study were exclusively for bacteriological contamination. The pH of water samples ranged between 7.0 to 7.4. The water samples were categorized in two groups. Out of 114 untreated water samples, 92 (81%) were positive for the presence of coliforms while out of 110 treated water samples 42 (38%) were positive for the same. (table 1)

Load of viable aerobic bacteria per ml of the water sample was determined. The samples showing no growth to < 10 and from > 10 to $<10^6$ count / ml were enumerated on solid plate count (SPC) as follows. (table 2)

The samples which were found positive for coliforms in presumptive test were further subjected to confirmatory tests. Out of 134 (60%) positive samples the E.coli was the major pathogen, 58 (43.28%) amongst the total bacterial isolates. The Streptococcus faecalis and Staph. aureus were 22 (16.41%) and 9 (6.71%) respectively. Other organisms were Pseudomonas spp. 25 (18.65%) and saprophytic / environmental organisms were 20 (14.92 %).

All the water samples investigated for presence of enteric pathogens like Salmo-

PRESUMPTIVE COLIFORM TEST FOR WATER SAMPLES. N=224.

TYPE OF WATER	POSITIVE	NEGATIVE	TOTAL
Untreated	92 (81%)	22 (19%)	114
Treated	42 (38%)	68 (62%)	110
Total	134 (60%)	90 (40%)	224

TABLE 1

VIABLE BACTERIAL COUNT OF DRINKING WATER COLLECTED FROM VARIOUS SOURCES IN AND AROUND PESHAWAR.

Standard plate count range / ml	Treated water samples	Untreated water samples	Total
No growth to <10/ml	68 /110 (62%)	22/114 (19%)	90/224 (40%)
$>10 - 10^3$	39/42 (92.85%)	29/92 (31.52 %)	68/224 (30.35%)
$>10^3 - <10^5$	3/42 (7.14%)	60/92 (65.21 %)	63/224 (28.12%)
$>10^5 - <10^6$	0/42 (0 %)	3/92 (3.26 %)	3/224 (1.33%)

TABLE 2

nella, Shigella and Vibrio cholera were found negative. (Table 3)

DISCUSSION

For the presumptive coliform test, the WHO guidelines for both treated and untreated water samples is 0/100 ml, but in occasional untreated water sample 3 coliforms /100 are allowed on the condition that these would not be found in consecutive water samples[1].

The coliform group is an indicator bacteria to evaluate the quality of drinking water and any presence of coliforms indicates the contact of water with sewage or inadequate treatment / post treatment contamination. In unpiped water supplies, sometimes upto 10 coliforms /100 ml are as allowed per WHO standards for tropical countries but this should not occur repeatedly; if occurrence is frequent and sanitary conditions cannot be improved, an alternative source must be found if possible[2].

In this study 81% of the untreated and 38% of the treated water samples were positive for most probable coliform numbers,

BACTERIAL ISOLATES RECOVERED FROM POSITIVE SAMPLES NO. 134

ISOLATE	NUMBER	PERCENTAGE
E.coli	58	43.28
Streptococcus faecalis	22	16.41
Staph. Aureus	9	6.71
Pseudomonas spp.	25	18.65
Salmonella, Shigella, Vibrio, Cholera (enteric pathogens)	NIL	0
Environmental Bacteria	20	14.92
Total	**134**	**100**

TABLE 3

showing a high contamination and risk to public health[5,6].

The detection of faecal (thermotolerant) coliform organisms provide definite evidence of faecal contamination and they are found in 43.28 % of the positive samples.

Search for Streptococcus faeclis is not carried out routinely. Its main value is when irregular types of coliforms, of faecal origin are detected in the water samples which is also indicative of faecal pollution. In the present study they are accounted as 16.41 % in the total positive samples.

On the standard plate count the number of colonies in most of the untreated water samples (Table 2) appeared very high, it is therefore desirable to disinfect all supplies of drinking water before distribution and considerable reliance should be placed on sanitary check and periodic bacteriological examination. The high percentage of E.coli (43.28 %) provides a definite evidence of faecal pollution, where as 6.71% of staph. aureus also predicts that the contamination has occurred. The Pseudomonas spp. are common inhabitant and their presence (18.65 %) is of significant value, determining the water pollution. The enteric pathogens such as Salmonella, Shigella and Vibro cholera could not be isolated, which otherwise have tremendous hazardous potential in the theme of public health and sanitation[5,6].

The environmental bacteria such as Alcaligenes spp. Acinetobacter spp. Bacillus spp. which are mostly saprophytic in origin were also recovered as (14.92%) indicating no treatment / improper treatment or post treatment contamination, their eradication is also essential for better sanitary value of drinking water supplies[9,10]. The above results suggest that efficient and proper sanitary check on drinking water supplies has to be executed regularly in view of its great public health significance and at the same time good observance of personal and household hygiene has to be emphasized[11]. Simple education on the problem along with practical steps at community and governmental level in addressing the issue must not be ignored[12].

CONCLUSION

The greatest threat posed to water resources arises from microbiological contamination which has long been a concern to the public health. Water contamination with potentially pathogenic microorganisms represent an obvious health risk. It is evident from the results that the people living in areas with low personal and household hygiene are greatly affected by a wide range of microbial contamination. Unless the situation is rectified on this count with particular reference to adequate adoption of sanitation measures for provision of potable water, the problem would not be over in the near future as wished.

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