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Research Paper

Assessment of Ground Water Quality in Meerut Cantonment

Medical Science

KEYWORDS : Ground water, Quality parameters, Seasonal variation.

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ABSTRACT

Background:

Residents in Meerut Cantonment have suffered from health problems due to consumption of contaminated drinking water in recent past. In this study some physical, organoleptic, chemical and microbial quality parameters were assessed in ground water source over three seasons.

Method:

Meerut drinking water is met by ground water drawn through 32 deep borewells. Raw water is collected from all these 32 borewells over one year during peak of winter, summer and monsoon seasons and analyzed for physical, organoleptical, chemical and microbial parameters at laboratories. Results were compared using WHO standards guideline values and statistically analyzed for seasonal variations.

Results:

The results show that all the parameters were within permissible limits. There were no significant seasonal variations found in concentration of water quality parameters of ground water in Meerut Cantonment.

Conclusion:

The ground water drawn from deep water table through tubewells was found to be without any contamination at Meerut. The increase in the morbidity during recent past was mainly due to contamination during distribution through water pipelines. Some of the water pipelines are very old and prone to corrosion. Distribution system of water supply should be closely monitored from pump houses to consumer ends. Corroded and old water pipelines in Meerut Cantonment and other similar stations need to be replaced in phased manner by concerned authority.

Introduction

Water intended for human consumption should be both safe and wholesome i.e. free from pathogens & harmful chemical substances, pleasant to taste and usable for domestic purposes.[1] Ground water is an important water source in both urban and rural areas of Meerut in Uttar Pradesh state of India. These sources are under threat from pollution either from human activities like low level of hygiene practiced in developing countries or other environmental conditions affecting health and wellbeing. Even if source of water supply and its treatment are of high standard, water pollution may still occur as often happens due to fault in distribution system like corrosion of water pipelines, leaking joints and cross connection between water supply pipes and sewage drainage pipes. Residents in this area have suffered from health problems due to consumption of contaminated drinking water in recent past. No proper assessment of quality parameters of water source have been carried out for this area since the period of installation. Further, analytic results of the study may be useful to plan the corrective remedial measures by concerned authority for ensuring safe drinking water supply to the consumers to prevent water borne health problems. In addition, results may be useful to form the baseline data for future monitoring of the ground water to estimate any change in qualitative physical and chemical parameters in Meerut Cantonment. In this study, levels of some physical, organoleptical, chemicals, residual pesticides, biochemical and microbial water quality parameters in ground water taken through bore wells located in cantonment area of Meerut were assessed. The effects of seasonal variations on the concentration on these parameters were also evaluated.

Material and Methods

The study was conducted in Meerut Cantonment area of UP state. The Meerut Cantt area is spread over 10 sq km and has a number of stagnant water bodies, industrial units and the Abu Nallah where all the effluents are drained off. Cent percent of Meerut drinking water need is met by ground water drawn through a total of 32 deep bore wells. Raw water samples were collected from all 32 borwells pumping stations over a period of one year during peak months in three different climatic seasons i.e. summer, rainy, and winter seasons using two types of containers- sterilized (autoclaved) glass bottles for microbial analysis and pre-cleaned 5 liters food grade plastic containers for chemical analysis. Bottles/ containers containing water samples were closed with stopper, sealed, and marked properly and dispatched to laboratories within 6 hours of collection. Analyses of water samples for microbial examination were carried out by laboratory of service hospital. Physical, Organoleptical and Chemical Examinations were carried out by recommended standard methods[2] at ISO 9001-2000 certified and accredited private reference laboratory recognized by Govt of India. Results received were entered in MS office excel sheet software, analyzed and compared with WHO Guideline Values[3,4] for drinking water. The Manual published by Indian Council of Medical Research[5] of Govt. of India suitable of Indian conditions for drinking water was also kept in view while analyzing the results. Paired T test used for testing the hypothesis for seasonal variation.

Results and Discussion

Untreated ground water samples procured from a total of 32 deep bore wells located in Meerut Cantonment areas during peak of winter, summer and monsoon seasons were examined for physical, organoleptical, chemical and microbial qualities. Mean values of water quality parameters are depicted below

Physical quality of water:

Mean value of physical parameters of ground water are shown in Table1.

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Table1- Mean values of Physical parameters of ground water

Parameter	Mean Value Winter Season	SD Winter Season	Mean Value Monsoon Season	SD Monsoon Season	Mean Value Summer Season	SD Summer Season	WHO Standard desirable	WHO Standards permissible
Colour	<5 TCU	-	<5 TCU	-	<5 TCU	-	5 TCU	15 TCU
Odour	unobjectionable	-	unobjectionable	-	unobjectionable	-	unobjectionable	unobjectionable
Taste	agreeable	-	agreeable		agreeable	-	agreeable	agreeable
Turbidity	<1 NTU		<1 NTU		<1 NTU		1NTU	5 NTU
pH	7.496	0.136	7.39	0.148	7.539	0.19	6.5-8.5	6.5-8.5
Total Hardness (mg/L)	254.062	26.094	241.858	27.864	241.061	32.614	300	600
TDS (mg/L)	322.656	32.483	282.344	27.732	335.468	31.757	600	1000

In this study, analysis of ground water samples for physical quality during winter, monsoon and summer seasons gave pH (7.39-7.54), indicating slight alkalinity. Total dissolved solids varied between 282.3 mg/l during monsoon to 335.5 mg/l during summer, which were within permissible limits. Other physical parameters like colour, odour, turbidity and total hardness were found within desirable limits. Adekunle et al[6] observed in their study that most of the parameters increased during rainy season over the dry period pointing to infiltration from storm water.

Mean Values of General Chemical Parameters (generally not of health concern at levels found in drinking water) of Ground Water:

Mean Values of General Chemical Parameters (generally not of health concern at levels found in drinking water) of Ground Water are depicted in Table 2

Table 2- Mean value of General Chemical parameters of ground water

Parameter	Mean Value Winter Season	SD Winter Season	Mean Value Monsoon Season	SD Monsoon Season	Mean Value Summer Season	SD Summer Season	WHO Standards desirable	WHO Standards permissible
Copper (mg/L)	BDL	-	BDL	-	BDL	-	0.05	2.0
Iron (mg/L)	0.211	0.058	0.146	0.155	0.154	0.052	0.3	1.0
Manganese (mg/L)	BDL	-	Absent	-	BDL	-	0.05	0.1
Nitrate (mg/L)	2.606	0.599	Absent		2.418	0.374	50	50
Fluoride (mg/L)	0.6	-	0.6	-	0.6	-	1.0	1.5
Zinc (mg/L)	0.09	0.093	Absent		0.09	0.052	0.5	4.0
Aluminum (mg/L)	BDL	-	BDL	-	BDL	-	0.1	0.2
Chloride (mg/L)	23.25	7.396	25.257	6.206	24.783	5.002	250	1000
Selenium (mg/L)	ND	-	ND	-	ND	-	0.01	0.01
Sulfate (mg/L)	5.365	3.149	13.958	9.001	4.549	2.396	200	400
Alkalinity (mg/L)	288.375	19.226	158.883	11.597	314.612	20.372	200	600
Calcium (mg/L)	62.725	8.175	62.375	7.734	55.682	9.558	75	200
Magnesium (mg/L)	23.11	3.668	20.994	3.516	24.235	4.399	30	100
Phenolic Compounds (mg/L)	Absent	-	Absent	-	Absent	-	0.2	0.2
Mineral Oil (mg/L)	Absent		Absent		Absent		0.01	0.03
Anionic Detergents (mg/L)	Absent	-	Absent	-	Absent	-	0.2	1.0
Boron (mg/L)	ND	-	ND	-	ND	-	0.5	0.5
Barium (mg/L)	ND	-	ND	-	ND	-	0.7	0.7
Molybdenum (mg/L)	BDL	-	BDL	-	BDL	-	0.07	0.07
Sulfide (mg/L)	BDL	-	BDL	-	BDL	-	0.05	0.1

Winter season: Monsoon season p=0.21873; Winter season: Summer season p=0.55238; Summer season: Monsoon season p=0.25781.

In this study, alkalinity levels were found to be 288.37 mg/l during winter and 314.61 mg/l during summer exceeding desirable limits (200mg/l), but values were within permissible limits. Sulfate ions were more during monsoon season (13.96 mg/l) as compared to that of winter (5.36 mg/l) and summer seasons (4.54 mg/l).Increase in total dissolved solids may be mainly due to saline water intrusion and increase in salts like carbonates, bicarbonates, sulfate, calcim, chloride, sodium, potassium and other ions during rainy season. A study carried out by Yerima et al[7] revealed evidence of pollution from both chemical and biological sources as high level of nitrite (16 mg/l), manganese (0.9 mg/l) and E coli (4.o n/l)found in their study. High value of TDS reduces water utility for drinking, irrigation and agriculture purposes.[8,9] Although values of sulfate were within desirable limits, high concentration of sulfate has laxative effects which are enhanced when sulfate consumed with magnesium. Water containing magnesium sulfate (1000mg/l) acts as a purgative in human adults.[10] Magnesium concentrations were detected as 23.11 mg/l during winter, 20.99 mg/l during monsoon and 24.32 mg/l during summer seasons; these were within acceptable limits. All other chemical parameters which included copper, iron, manganese, zinc, aluminum, selenium, boron, barium, molybdenum were within desirable limits. Phenolic compounds, mineral oil and anionic detergents were found to be absent in all samples analyzed during three seasons. Fluoride concentration was detected as 0.6 mg/l during winter, monsoon and summer seasons which were within desirable limits. High concentration of fluoride causes dental fluorosis, while low causes dental caries.[11] Hence, it is desirable to maintain optimum concentration of fluoride in drinking water (0.5-0.8 mg/l).

Mean Values of Toxic Chemical Parameters of Ground Water:

Mean Values of Toxic Chemical Parameters of Ground Water are depicted in Table 3.

Table 3- Mean values of Toxic Chemical parameters of ground water

Parameter	Mean Value Winter Season	Mean Value Monsoon Season	Mean Value Summer Season	WHO Standards guideline value
Mercury (mg/L)	ND	ND	ND	0.006
Cadmium (mg/L)	BDL	BDL	BDL	0.003
Arsenic (mg/L)	BDL	BDL	BDL	0.01
Cyanide(mg/L)	BDL	BDL	BDL	0.07
Lead (mg/L)	BDL	BDL	BDL	0.01
Chromium (mg/L)	BDL	BDL	BDL	0.05

Polynuclear aromatic hydrocarbons (mg/L)	ND	ND	ND	0.0007
Pesticides (mg/L)	ND	ND	ND	0.001
Nickel (mg/L)	BDL	BDL	BDL	0.07
Polychlorinated biphenyls (mg/L)	ND	ND	ND	
Chloroform (mg/L)	ND	ND	ND	0.3

In the present study, concentrations of toxic chemicals which included mercury, cadmium, arsenic, cyanide, lead , chromium, polynuclear hydrocarbons, pesticides, nickel, poly chlorinated biphenyls and chloroform, analyzed for ground water at thirty two pump houses during winter, monsoon and summer seasons, were beyond detectable limits/ non detectable range in all water samples. These findings were in concordant with findings of other similar studies carried out by workers in India.[12,13] In absence of effective sewage disposal, concentrate of TDS and related salt was reported to be high in a study carried out by Aksoy and Scheytt in Turkey[8] and authors expected the same to show an increase further over the time, if effective collection and treatment of sewage is not installed on priority.

No residual pesticide was found in the study. These findings are in concordant with the results of other study.[13]

Bacteriological quality parameters of ground water:
Bacteriological quality parameters of ground water are shown in table 4.

Table 4- Mean values of Microbial quality parameters of ground water

Parameter	Mean Value Winter Season	Mean Value Monsoon Season	Mean Value Summer Season	WHO standards Guideline value
Coliform (MPN/100ml) SD	2.406 0.499	2.594 0.559	2.531 0.507	-
E. coli culture	Nil	Nil	Nil	Nil in any 100ml of water
S. faecalis	Nil	Nil	Nil	Nil in any 100ml of water
Cl. perfringens	Nil	Nil	Nil	Nil in any 100ml of water

In this study, the bacteriological counts for indicator bacteria at source in untreated water in the study were found to be within acceptable limits.[5,14] These findings are similar to study carried out by Yerima et al[7] in in Nigeria. Wright et al[15] from their meta-analytic study reported that the bacteriological quality of drinking water significantly declined after collection in many setting. The extent of contamination after water collection varied considerably between settings but it was proportionately greater where faecal and total coliform count in source water was low.

Seasonal variation in quality of ground water parameters:
In this study, data of parameters of quality of water collected during peak of winter, summer and monsoon seasons were analyzed and found no significant difference in the quality of ground water. Since the sources of water in Meerut Cantonment are deep tubewells, no water pollution in the ground water found during three seasons in the year affecting the concentration of water quality parameters. These findings are in concordant to other studies carried out in India.[13] The difference in results of the present study as compared to that carried out by Adekunle et al[6] may be due to closeness of wells near polluting sources in their study.

CONCLUSION:
The ground water drawn from deep water table through tubewells was found to be without any contamination at Meerut. The increase in the morbidity during recent past was mainly due to contamination during distribution through water pipelines. Some of the water pipelines are very old and prone to corrosion. Distribution system of water supply should be closely monitored from pump houses to consumer ends. Corroded and old water pipelines in Meerut Cantonment and other similar stations need to be replaced in phased manner by concerned authority.

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