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SEASONAL VARIATION IN DRINKING WATER QUALITY OF SELECTED BOREWELL WATERS IN VARIOUS REGIONS OF KOLHAPUR CITY

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Abstract:
Kolhapur is developed city suffering from pollution problems, present study has been made to investigate seasonal variation in quality of water by physico-chemical and microbiological analysis in Urban, Slum, Agriculture and Industrial regions of Kolhapur city. The samples were collected in summer, rainy and winter season and analysed for pH, Dissolved oxygen (DO), Biological Oxygen Demand (BOD), Total Hardness, MPN for faecal coliform/ 100 ml SPC of Total Coliform E.coli /ml and *Salmonella* sp./ ml.

The microbiological analysis reveals that majority of borewell water is feacaly contaminated and bacterial contamination increases during rainy season.

Keywords: feacal coliform, *E. coli*, MPN, SPC, *Salmonella* sp.

Introduction

Water is priceless gift from nature which is plenty on the earth from which only 1% is available as surface and ground water (Kothandarman *et. al.*, 1997). Underground water is source of fresh water which is essential for domestic, industrial and agricultural need.

The rapid growth of urbanization and industrialization has adversely affected the ground water quality (Jain *et. al.*, 2003). Kolhapur is agro-industrial city suffering from pollution problems. The developmental activities such as industries, metal processing units, transportation, agriculture are polluting surface and ground water. Water supply to Kolhapur is mainly from river Panchaganga but now-a-days river Panchaganga is severely polluted because of direct discharge from Jayantinala, domestic waste from urban region, industrial waste, agricultural run off containing chemical fertilizers as nitrate, phosphate, urea, some pesticides, herbicides seep into ground water by process of leaching.

Generally, ground water recharged by leakages from river channels, so ultimately bore well water is also contaminated. Hence, even today the residents of Kolhapur having no access for safe and clear water, so they use borewell water as alternate source for domestic and drinking purpose. People from slum region suffers from water born diseases like dysentery, diarrhea, jaundice, typhoid because of faecaly contaminated water from bore well.

Safe drinking water is basic need for human health and well being. It is accepted by World Health Organization (WHO, 2001). So the present study is an attempt to estimate the seasonal variation in drinking water quality of bore well water in Kolhapur city.

Material and Method

The samples from selected borewell of urban, industrial, agricultural and slum regions of Kolhapur city, were collected in pre-cleaned plastic cans for assessment of water quality during summer, rainy and winter season and analysed for pH using pH meter (Hanna Model Champ) at site only. Dissolved Oxygen (DO) determined by wrinkler's idometric method and Biological Oxygen Demand (BOD) estimated by incubation at 20°C for 5 days and Total Hardness estimated by EDTA titration method

The microbiological parameter such as MPN of coliform (Most probable number) by multiple tube fermentation technique with Mac-Conkey's broth (Hi-media). SPC of total coliform (Standard plate count) estimated by Pour plate technique using nutrient agar method. Isolation of *Escheria coliform* (*E. Coli*) bacteria estimated with endoagar medium. *Salmonella* sp. isolated with Bismuth sulphite agar medium by four quadrant method and incubated at 37°C for 24 hrs. (APHA, 1995). The seasonal variation of physico-chemical and microbiological parameter are depicted in Table No. 1.

Results and Discussion:

The Seasonal variation in physico-chemical and microbiological parameters of borewell water of various regions are depicted in table No. 1.

The limit of pH value for drinking water is specialized at 6.5 to 8.5 (WHO, ICMR 1975). pH has no direct adverse effect on human health (Khadson and Kadu, 2003).

pH of borewell water is increases during rainy season in all regions of Kolhapur city.

Dissolved oxygen was maximum in rainy season (4.25 ± 0.94 to 6.4 ± 0.66 mg/L) than winter and summer season in all water samples

which might be due to percolation of rainy water rich DO content (Koshy and Nayer, 1999). Rising temperature causes low solubility during winter and summer season (Gyananath *et al.* 2000).

Pollution due to sewage and domestic waste seepage (Hedge *et al.* 1992, Olaniya *et al.* 1977, Pradhan *et al.* 1998).

BOD is one of the most significant water quality parameter to assess the pollution load in water. BOD is amount of oxygen required by microorganism for biodegradation of organic matter present in water (U.S.E.P.A., 1983).

BOD is maximum in summer season and minimum in winter season in borewell water samples of all regions.

Total Hardness is the property of water which prevent lather formation with soap and increases boiling point of water (Mohan *et al.*, 2000). Hard water is unsuitable for drinking and domestic purpose, reports indicate that it hazard in heart disease (Peter 1974). Hardness of water is hazard to both heart and kidney problem (Keller 1979).

In present investigation the total hardness water was maximum in summer season in all sites of four regions as 414.55 ± 51.74, 464.33± 71.87, 386.53 ± 105.31 and 431.88 ± 91.54 in Urban, industrial, slum and agricultural region respectively. The higher seasonal value is in summer is mainly due to rising temperature thereby increasing solubility of calcium, magnesium salts. Similar result reported by Garg *et al.* (1999).

The minimum total hardness of water reported in winter season may be due to increased level of water table after percolation of rainy water and dilution of ionic constituents.

In present study all borewell water samples cross the desirable limit of WHO and ISI (300 mg/L).

Microbiological analysis is an important study to ensure the safety of potable water, monitoring the water quality for domestic industrial and drinking purpose. The quality of water acting as major factor determining of welfare of society. Most probable number of coliform (MPN) is important microbioogical parameter from public health point of access contamination of drinking water with sewage or excretory waste (Trivedi and Goel, 1986).

In the present study MPN of coliform value beyond the safe limit of WHO standard. It was maximum in rainy season than winter and summer season.

SPC is standard plate count method used for enumeration of microorganism. It helps in the measurement of the density of coliform bacteria. In present study SPC/ml increases during rainy season than winter and summer season in all sampling sites.

Detection of *E. coli* always includes high probability for occurrence of pathogen excreated via faces (Lund, 1996 and Clark, 1990). *E. coli* reported in borewell water of slum region near the public toilet during rainy season, may be due to percolation of faecal organism through soil stratas (Rawat, 2003).

Table 1: Seasonal variation in physico-chemical and Microbiological analysis of Bore well water in various regions of Kolhapur city.

Parameters	Site Seasons	Urban	Industrial	Slum	Agricultural
pH	S	7.07± 0.19	7.22 ± 0.22	6.94 ± 0.517	6.78 ± 0.45
	R	7.39 ±0.59	7.35 ± 0.43	7.22 ± 0.295	7.56 ± 0.7
	W	6.66 ± 0.58	6.97 ± 0.28	6.95 ± 0.88	7.29 ± 0.35
Dissolved Oxygen (DO)	S	2.76 ± 0.3	2.01 ± 0.8	2.42 ± 0.40	4.05 ± 0.81
	R	4.25 ± 0.94	4.92 ± 1.09	5.26 ± 1.25	6.40 ± 0.66
	W	2.92 ± 0.2	2.63 ± 0.7	2.32 ± 0.61	4.86 ± 1.74
Biological Oxygen Demand (BOD)	S	3.03 ± 1.2	32.0 ± 12.0	10.0 ± 1.1	30.66 ± 8.08
	R	1.1 ± 1.02	4.0 ± 0.3	0.8 ± 0.1	14.0 ± 0.49
	W	Nil	Nil	Nil	2.75 ± 0.96
Total Hardness (mg/L) as $CaCO_3$	S	414.55±51.71	464.53±71.87	386.53±108.3	431.88±91.54
	R	337.69±33.17	337.92±58.26	280.76±56.07	424.60±45.06
	W	316.91±51.88	388.08±24.23	226.99±78.64	350.79±45.64
MPN/ 100ml faecal coliform	S	45	40	60	Nil
	R	70	110	85	45
	W	45	Nil	40	Nil
SPC/ml	S	12200	6300	Nil	170
Total coliform	R	1700	3100	800	2000
	W	3000	Nil	Nil	Nil
E. coli	S	Nil	Nil	02	Nil
	R	Nil	Nil	10	Nil
	W	Nil	Nil	Nil	Nil
Salmonella sp./ml	S	Nil	Nil	02	Nil
	R	Nil	Nil	10	10
	W	Nil	Nil	Nil	Nil

Salmonella sp. are gram negative non-spore forming bacilli, occurrence of *Salmonella* in water causes typhoid fever. In present investigation *Salmonella* sp. are detected in slum and agriculture region in rainy season. The highest microbial contamination was observed during rainy season. According to standard limit of WHO & BIS all bore well samples were above the permissible limit.

All water samples were contaminated by faecal coliform bacteria during rainy season than winter and summer season, Our finding were closely agreement with (Garg 2003).

According to Isolation hospital record most of patients suffers by gastrointestival disorders in rainy season.

Conclusions and Recommendations

From the assessment of few physico-chemical and microbiological parameters it is concluded that the bore well water in four regions is unfit for drinking purpose.

Low Dissolved oxygen and high Biological oxygen demand is observed in all samples. Total hardness values were beyond the standard limit of WHO, ICMR & ISI.

All bore well water showed MPN of faecal coliform, SPC of total coliform, *E. coli* in slum region is beyond the limit of WHO standard in rainy season.

Salmonella sp. observed in slum and agriculture region in rainy season is positively correlated with hospital record. Most of the bore well (Hand pump) of Municipal Corporation are located at improper location near public toilet, solid dump, garbage dump etc.

Hence, over all quality of bore well water is rated as very poor from WQI and unfit for human consumption.

Therefore, it is recommended that constant monitoring and treatment of ground water is essential. If this is not possible, it is recommended that this water is not suitable for drinking purpose.

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