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KEYWORDS: Unnat Bharat Abhiyaan, Drinking quality, Most Probable Number

ANALYSIS OF PHYSIOCHEMICAL AND MICROBIAL PARAMETERS TO EVALUATE THE DRINKING WATER QUALITY IN FIVE DIFFERENT VILLAGES IN THE VICINITY OF SAPHALE, DISTRICT PALGHAR STATE MAHARASHTRA, INDIA.

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Abstract:

The drinking water quality was investigated in the suspected areas of five villages from District Palghar, Post Umbarpada, near Saphale . The objective was to investigate the source of safe and clean drinking water for the public health protection. The water samples from five villages named Sartodi, Karwale, Kandarvan, Ghatim and Navghar were analysed. These villages are adopted under "Unnat bharat Abhiyan" a programme of Higher Education, Ministry of Human Resource development. Ten water samples were collected and studied for Physiochemical and microbial Parameters to evaluate the drinking water quality The water samples were collected in the month of October and December.. Parameters such as pH, Conductivity, Total dissolved solid (TDS), Salinity, Total Hardness , Dissolved oxygen, and microbial activity were evaluated. The obtained values were compared with standard set of values by the world Health organisation (WHO) and local standards like National Drinking Water Quality standards (NDWQS). The values of most of the parameters found out of the safe limits set by WHO and NDWQS. Out of the eight locations only one location was found to be safe for drinking purpose. It is also important to study the other parameters like Biological and Chemical oxygen demand and heavy metal content of the water samples.

1.Introduction

Water is life of each living organism. Clean water can be considered as fundamental right of human being. Around 750 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation. As a result v around 6-8 million people die each year because of water borne diseases.[1] In India the ministry of Drinking water and Sanitation is primarily responsible for policy , planning , funding and coordination of the programmes for safe drinking water and Sanitation facilities. Accordingly Government is focussing on Swachh Bharat Mission (SBM-G) and national Rural Drinking Water programme (NRDWP). In the recent years the priorities of government has shifted to SBM-G than NRDWP, the share of allocation of budget for NRDWP has dropped (from 87% in 2009 to 31% in 2018-19) . In the same period, the share of allocation of SBM-G has increased from 13% to 69%.[2] In the current research activity we have focused on drinking water facility of five villages which are adopted by us since 2019. All the five villages have shown improving situation of Sanitary facilities but non-favourable situation of drinking water. The source of the drinking water is in the form of well and hand pumps i.e. mainly groundwater. The village Sartodi and Karwale has Karwale dam on its east side. The survey conducted for 790 houses indicated greater demand of safe and clean drinking water. The ground water always gets polluted due to contamination from agricultural chemicals like fertilizers, pesticides, faecal matter house hold waste etc. In India 70% water resources are contaminated with biological, organic and inorganic pollutants,[3]

A number of scientific protocols are available in literature survey to assess the contaminants in water.[4] [5] These procedure includes all the physical , chemical and biological parameters that needs to be studied to mark the quality of water for different purposes. These parameters affect the drinking water quality if their values are in the higher concentrations than the safe limits given by regulatory bodies like WHO and BIS [6]

E. coli is widely distributed in the intestine of humans and warm-blooded animals and is the predominant facultative anaerobe in the bowel and part of the essential intestinal flora that maintains the physiology of the healthy host. E. coli is a member of the family

Enterobacteriaceae , which includes many genera, including known pathogens such as Salmonella, Shigella, and Yersinia. In 1892, Shardinger proposed the use of E. coli as an indicator of fecal contamination. This was based on the premise that E. coli is abundant in human and animal feces and not usually found in other niches. Furthermore, since E. coli could be easily detected by its ability to ferment glucose (later changed to lactose), it was easier to isolate than known gastrointestinal pathogens. Hence, the presence of E. coli in food or water became accepted as indicative of recent fecal contamination and the possible presence of frank pathogens[14].

MPN(Most probable number) is a part of the harmonized compendial chapter on bacterial enumeration (USP, Chapter "Microbiological Examination of Nonsterile Products: Microbial Enumeration Tests," United States Pharmacopeia 32, vol. 1, pp 71-75, 2009a) and has been part of the "Microbial Limits Test" chapter in the United States Pharmacopeia (USP) since the chapter's inception in USP XVIII [15].Serial dilution tests measure the concentration of a target microbe in a sample with an estimate called the most probable number (MPN). The MPN is particularly useful for low concentrations of organisms (<100/g), especially in water. The basic assumptions of the MPN method are that bacteria follow Poisson statistics, and that a single viable cell with result in turbidity of the test media under the conditions used [16].

Since coliforms ferment lactose with production of acid and gas the medium use to contains lactose and a pH indicator for activity. It also contains an inverted Durham's tube to indicate the presence of gas formation. The medium used is lauryl tryptose broth with lauryl sulfate which suppress the growth of other organisms that may be present in water and thus make the medium more selective for coliform organisms. Change in color of medium to yellow and gas bubbles in Durham's tube indicate the presence of coliforms.

Table:1

IS 10500-2012	Nil/100 ml	
Risk/ Effect	Gastro intestinal tract infection	
Sources	Contaminated animal waste, sewage contaminated with faecal matter, household wastewater, polluted storm water and agricultural runoffs.	
Parameter	Max.allowable limit	Ill effects
TDS	2000mg/L	Undesirable taste
pH	6.5-8.5	Affect mucous membrane, bitter taste and affect aquatic life
Hardness	600mg/L	Lead to skin irritation and quality of food
Chloride ion	1000mg/L	High blood pressure,

2. Material and Methods

2.1. Study Area. The five villages identified for the study are from Palghar district, Post Umbarpada, on the east side of Saphale railway station of western railway line of Indian railway .Geographic location close to 190N, 720E. South side of the village Navghar and Ghatim is surrounded by Vaitarna creek whereas east side of these villages has Karwale dam. The main source of drinking water is use of hand pump and open well water as per the survey conducted for these villages under Unnat Bharat Abhiyaan

Table:2

Sartodi		Karwale		Kandarvan		Ghatim		Navghar	
HP	OW	HP	OW	HP	OW	HP	OW	HP	OW
42.1	24.6	17.2	58.2	56.3	4.0	48.7	20.9	77.0	15.6

* HP- Hand Pump (values in percentage)

* OW- open well (values in percentage)

2.2. Selection of Sampling Points. The villages selected do not have any industry, it has the land used for agriculture or forest land .The sanitary facilities have reached to almost 90% families with soak pit type of waste disposal. The percentage of land under irrigation and non-irrigation is as follows

Table:3

Sartodi		Karwale		Kandarvan		Ghatim		Navghar	
IR	NIR	IR	NIR	IR	NIR	IR	NIR	IR	NIR
56.3	43.7	9.5	90.5	66.7	33.3	88.5	11.5	71.6	28.4

* IR- Land under irrigation(values in percentage)
* NIR- Land under Non Irrigation (values in percentage)

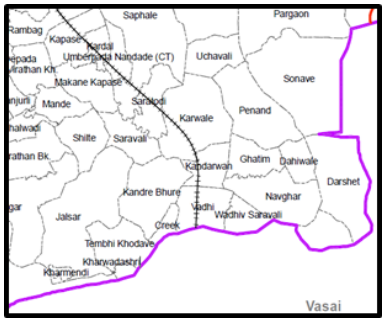
The sample collected from 10 locations, the details are as follows:

Identified water Resources Water Samples :

Table:4

Sample No	Sample Name	Sample Code
Sample 1	Sartodi Well	SAR-W
Sample 2	Karwale Grampanchayat Hand pump	KAR-H
Sample 3	Bogadipada Well	KAR-B-W
Sample 4	Patilpada Hand pump	KAR-P-H
Sample 5	Kandarvan Hand pump	KAN-H
Sample 6	Ghatim Well	GHT-W
Sample 7	Ghatim Hand pump	GHT=H
Sample 8	Navghar Hand pump 1	NAV-H1
Sample 9	Navghar Hand pump 2	NAV-H2
Sample 10	Navghar Well	NAV-W

Figure:01



2.3 Collection of samples:

Samples were collected from ten locations from 5 villages. The samples were collected in the month of October and December 2019.The water samples were collected in sterile plastic or glass bottles. The samples were analysed within 48 hours of the collection. The samples were analysed for chemical parameters such as pH ,Conductance , TDS ,Hardness ,Dissolved Oxygen , Salinity and microbial test.

2.4 Analytical Instrumentation:

2.4.1 Analysis of pH, Conductivity was carried out as per the standard protocol and methods. The pH of the water samples was measured by using a pH meter .The pH meter was standardised by using standard buffer solutions of pH 4, and 9.2.The values of each sample was measured by submerging combined glass electrode in each sample by holding it it in water for couple of minutes to observe stable reading.

The conductivity of the water samples was measured using conductivity meter. The probe was calibrated using standard solution of known conductivity. The conductivity of each water sample was measured carefully taking care of cross contamination by using de-ionised water.

2.4.2 Laboratory Analysis:

In the laboratory water samples were analysed to determine Total

Dissolved Solids (TDS), Total Hardness, Dissolved oxygen and Salinity of the water. The TDS determination was done by gravimetric analysis by taking 100 ml of sample water in previously weighted evaporating dish. [7] [12]

Total hardness was determined by the standard procedure using 10 ml of the water sample titrating against 0.05 M EDTA solution at pH 10 using Eriochrome Black T indicator, All the readings were taken in triplicate .[8][12]

The Winkler Method was developed in 1888 measures the concentration of dissolved oxygen. [9] The method was further modified in 1968 by Strickland and Parsons.[10][11][12] The oxygen present in water sample oxidises iodine ion to Iodine which is titrated against standard sodium thiosulphate solution using starch as an indicator. The amount of dissolved oxygen can be determined by using the relation: one mole of dissolved oxygen correspondence to four moles of thiosulphate. All the measurements are taken in triplicate.

The salinity of water sample or total Chloride contained of the sample by standard protocol based on Argentometric titration [10][12] the method used is Mohrs method that gives more accurate and precise readings. All the readings were carried out in triplicate .

- Microbial test for detection of fecal coliforms [intestinal organisms] present in drinking water was carried out by most Probable number method. If coliform are present in drinking water it indicates faecal contamination in the water source.Thus if coliforms are present, it means the water is not potable.

2.5 Procedure for MPN (17,18)

Bacteriological analysis was carried out for indicator organisms i.e. total and fecal coliform (E.coli) by most probable number (MPN) method

1. Fifteen tubes of lauryl tryptose broth arranged in three rows (5 tubes each).
2. First row containing 10 ml double strength lauryl tryptose broth which was inoculated with 10 ml of water sample.
3. Second row containing 10 ml single strength lauryl tryptose broth was inoculated with 1 ml water sample respectively.
4. Second row containing 10 ml single strength lauryl tryptose broth was inoculated with 0.1 ml water sample respectively.
5. The tubes were incubated in an incubator at 44°C for 24 hrs.
6. After incubation, the number of tubes in which lactose fermentation with acid and gas production has occurred was counted.
7. Finally, by referring to probability table (Mcrady table-(FDA Bacterial Analytical manual) the MPN of coliform in 100 ml water sample was been estimated

Observation and graphs:

Figure:02

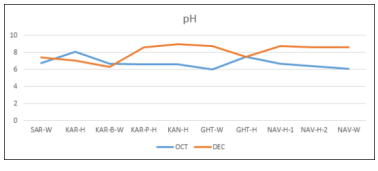


Figure:03

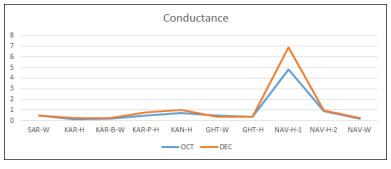


Table:05

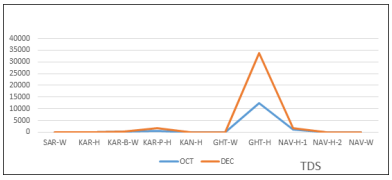
Total dissolved solid (TDS)		Total Hardness:	
Value (mg/ L)	Quality	Value (mg/ L)	Quality
Less than 300	Excellent	0-43	Soft
300-600	Good	43-150	Slightly Hard
600-900	Fair	150-300	Moderately Hard
900-1200	Poor taste	300-450	Hard
		More than 450	Very Hard

Table:06 and 07

TDS in mg/ L	Oct	40	30	130	570	32	28	12500	1100	52	43
	Dec	60	45	240	1620	40	40	33720	1700	80	60
Sample Code		SAR-W	KAR-H	KAR-B-W	KAR-P-H	KAN-H	GHTI-W	GHT-H	NAV-H1	NAV-H2	NAV-W

Hardness in ppm	Oct	160	48	80	176	176	272	224	704	256	64
	Dec	288	112	112	232	512	240	288	1184	560	208
Sample Code		SAR-W	KAR-H	KAR-B-W	KAR-P-H	KAN-H	GHTI-W	GHT-H	NAV-H1	NAV-H2	NAV-W

Figure:04 and 05



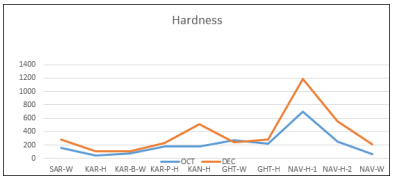


Table:8

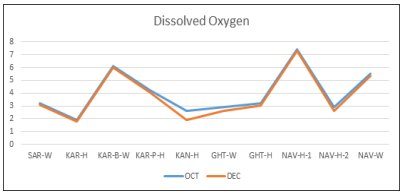
Dissolved Oxygen(D.O)		Salinity	
Value (mg/ L)	Quality	Value (mg/ L)	Quality
9.5-12	Excellent	Upto 2000	Acceptable
6.5-9.5	Good	Above 2000	Not accabale
4.0-6.5	poor		
0.0-4.0	Very bad		

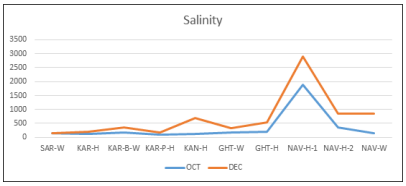
Table:9 and 10

Dissolved oxygen in ppm	Oct	3.23	1.9	6.14	4.2	1.9	3.23	7.43	2.9	5.5
	Dec	3.10	1.8	6.0	4.05	1.9	3.06	7.29	2.62	5.34
Sample Code		SAR-W	KAR-H	KAR-B-W	KAR-P-H	KAN-H	GHT-H	NAV-H1	NAV-H2	NAV-W

Salinity in mg/L	Oct	140.4	112.32	168.7	84.2	112.3	168.5	199.6	1881.3	365	140.4
	Dec	140.4	210.2	365	168.6	702	325.6	533.5	2892	842	842
Sample Code		SAR-W	KAR-H	KAR-B-W	KAR-P-H	KAN-H	GHTI-W	GHT-H	NAV-H1	NAV-H2	NAV-W

Figure:06 and 07



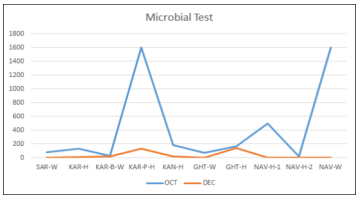


Results and Discussion: Table:11

Parameter	pH		Conductance [×10-3]		TDS		Hardness [ppm]		Dissolved Oxygen [DO]		Salinity [mg/1lit]		Microbial test	
Sample code	OCT	DEC	OCT	DEC	OCT	DEC	OCT	DEC	OCT	DEC	OCT	DEC	OCT	DEC
SAR-W	6.74	7.44	0.513	0.49	40	60	160	288	3.23	3.10	140.4	140.4	80	2
KAR-H	8.13	7.1	0.107	0.22	30	45	48	112	1.9	1.8	112.32	210.2	130	14
KAR-B-W	6.7	6.29	0.214	0.22	130	240	80	112	6.14	6.0	168.7	365	30	22
KAR-P-H	6.6	8.65	0.495	0.81	570	1620	176	232	4.2	4.05	84.2	168.6	>1600	130
KAN-H	6.66	9.01	0.723	1.04	32	40	176	512	2.6	1.9	112.32	702	190	17
GHT-W	6.03	8.74	0.495	0.37	28	40	272	240	2.9	2.6	168.5	325.6	70	4
GHT-H	7.5	7.52	0.397	0.38	12500	33,720	224	288	3.23	3.06	199.6	533.5	170	140
NAV-H-1	6.72	8.81	4.8	6.9	1100	1700	704	1184	7.43	7.29	1881.3	2892	500	2
NAV-H-2	6.41	8.65	0.915	0.96	52	80	256	560	2.9	2.62	365	842.4	23	2
NAV-W	6.13	8.65	0.179	0.24	43	60	64	208	5.5	5.34	140.4	842.4	>1600	2

The results of the analysis of water samples from ten different resources of five different villages adopted under the Ministry of Higher and Technical education "Unnat Bharat Abhiyaan" brings serious attention about demand of villagers for clean and safe drinking water supply. The water samples from the ten resources has collected in the month of October and December for the proposed study. Water resources like Kandarwan (HP), Karvale Patilpada(HP)Ghatim (W), Navghar (HP 1and 2), Navghar (W) are just above 8.5(alkaline). All these villages / resources are from south to north towards Vaitarna creek showing the trend in increasing pH from 6 to 9. The conductance values are high for Navghar (HP-1) for sample collected in October and December. The total dissolved solid is beyond acceptable limit for Kandarwan (H) sample collected in December, Navghar (HP-1and Ghatim (W)for water samples of October and December. The exactly same pattern of results is obtained for Total Hardness values. None of the resource provide soft water, the values are from slight hardness to more hardness accept Kandarwan(HP), Navghar (HP 1 and 2) which shows hardness beyond acceptable limit. Navghar (HP-1) is the only one source which shows Dissolved Oxygen Value in " Good" range(6.5-9.5), all othe resources shows DO values below 6.5. Salinity results indicate increasing values from North to south towards Vaitarna Creek.Navghar (HP-1) shows Salinity value above 2000mg/L. All the water resources indicate non potable nature due to high microbial load considering the results of MPN analysis.The MPN values are high for October 2019 due to heavy rainfall (Extended monsoon) which is the major reason of contamination. Though the extent of contamination was low as determined by low MPN values in December 2019 yet the samples were not safe for drinking purpose. As presence of fecal coliforms is a indication of fecal contamination of water, thereby making it unfit for human consumption. In summery we can say Navghar is facing more drinking water supply issue followed by Ghatim , Kandarwan . From south to north away from Vaitarna River the water quality is improving but not safe for drinking purpose. In the survey of Unnat Bharat Abhiyaan Navghar and Ghatim population has highlighted the drinking water issue which is scientifically proved by a Group of National Service Scheme (NSS) volunteers studying at Under graduate level under the guidance of their teachers from Microbiology and Chemistry department. The project is supported by Start DBT scheme of the institute.

Figure:08



Conclusion :

The greatest microbial risks are associated with ingestion of water that is contaminated with human or animal (including bird) faeces. Faeces can be a source of pathogenic bacteria, viruses, protozoa and helminths. Faecally derived pathogens are the principal concerns in setting health-based targets for microbial safety. Microbial water quality often varies rapidly and over a wide range. Short-term peaks in pathogen concentration may increase disease risks considerably and may trigger outbreaks of waterborne disease. The more frequently the water is examined for faecal indicators, the more likely it is that contamination will be detected. Frequent examination by a simple method is more valuable than less frequent examination by a complex test or series of tests. The nature and likelihood of contamination can vary seasonally, with rainfall and with other local conditions. Sampling should normally be random but should be increased at times of epidemics, flooding or emergency operations or following interruptions of supply or repair work [19].

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