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PHYSICOCHEMICAL AND MICROBIAL ANALYSIS OF GROUND WATER NEAR MUNICIPAL DUMP SITE FOR QUALITY EVALUATION

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Abstract: The present proposed research study is aimed at characterization of ground water samples collected near Municipal dump site during Pre and Post seasons for assessing its quality for drinking and domestic utility. The physicochemical parameters analyzed include pH, EC, TDS, TH, TA, Co_3^{-2}, HCO_3^-, Cl^-, SO_4^{-2}, PO_4^{-3}, Na, K, Ca^{+2} and Mg^{+2}. pH ranges in the permissible limits while TDS in majority samples exceeded the permissible limits of IS:10500-1992. The higher values of Total Hardness and Ca ion concentration indicate that the waters were not suitable for domestic use. Though the values of SO_4^{-2}, are within the permissible limits, the waters are not suitable for drinking or domestic purposes due to the presence of soluble solids. Further the waters were analyzed for bacterial species. *E Coli, Klebsiella, Pseudomonas, Proteus and Enterobacter* were identified and their presence indicates the bacterial contamination. Hence these waters are unsuitable for drinking as well as for domestic purposes and are to be perfectly treated, if necessary for consideration for utility.

Keywords: Ground water, Characterization, Parameter, Bacteria, Health.

INTRODUCTION

Ground water contamination is mainly due to industrialization and urbanization and leads to environmental consequences [1]. Municipal dump yards pose serious environmental concerns not only on the surroundings but also the nearby residents. Open dump yards or landfills are mostly common practices for municipal solid waste management in many parts of the World [1,2]. Dump yards were identified as significant threat to the ground water resources [3]. By solid waste dumps, surface as well as ground water resources will be contaminated. Generation of leachate from the dump yard and its effect on ground and surface water are the main environmental concerns prevailing in the landfills [4,5,6,7]. Assessment of ground water contamination by leachate near a Municipal solid waste land fill has been studied [8] and the analytical results of the study revealed that the leachate from the land fill has a minimal impact on the ground water resources and the presence of *enterobacter* in ground water samples indicated the contamination. A research study [9] has been carried out in which ground water samples were collected during Pre and Post Monsoon seasons around the refuse dump were characterized for various physicochemical parameters and the research results confirmed the unsuitability of waters for human consumption. The studies[10] on assessment of Ground Water Quality near a Municipal Landfill in Akure, Nigeria, indicated that majority of boreholes were strongly polluted and the water requires treatment before use. A Research study [11] on ground water quality assessment near Mehmood Boti Land fill, Lahore, Pakistan revealed that the ground waters were not potable within WHO guidelines particularly in Post season due to high bacterial contamination which leads to many water borne diseases. A study [12] has also been carried out on ground water quality evaluation near dump yards to find out the degree of ground water pollution and bacterial contamination

Keeping in view of the health of the public residing in the vicinity of dump site in Pithapuram Municipal Town in East Godavari District of Andhra Pradesh, the present research study is proposed to estimate the levels of chemical as well as bacterial contamination of ground water collected around a radius of 2 km of the dump site as a center by carrying out Physicochemical and microbial characterization to suggest the concerned authorities for initiating remedial measures to control the contamination levels for safeguarding the health of the public.

MATERIALS AND METHODS

The study area selected is presented in diagram-1 and East Godavari region which is situated along the northern coast of Andhra Pradesh between the latitudes 17.11° N and longitude 82.26° E . Ground water samples collected around the dump site around a radius of 2km towards East, West, North and South directions. The details of sampling code and the sampling locations are presented in Table-1.

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Table.1: Details of Sample code and Sample location

Sample Code	Sample location
GW-1	S. W. School (West)
GW-2	Near Store(1km)
GW-3	Ramalayam (2km)
GW-4	Temple (North)
GW-5	Shopping Complex (1km)
GW-6	Gopalbaba Ashramam (2km)
GW-7	Near Dump Yard (East)
GW-8	Residential house (1km)
GW-9	Near Church (2km)
GW-10	Brick Factory (South)
GW-11	Railway Gate (1km)
GW-12	Durga Temple (2km)

Containers made of polythene were employed for sampling of ground water and preserved for analysis as per the standard procedures [13]. The ground water samples were analyzed for physicochemical parameters which include pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Alkalinity (TA), Total Hardness (TH), Ca, Mg, Na, K, Chloride, Sulphate and Phosphate. pH was determined by pH meter (Global-DPH 505, India-Model) and conductivity measured by the digital conductivity meter (Global-DCM-900-Model), TDS determined from the relation TDS= Electrical conductivity(EC) x0.64. Total Hardness, Total Alkalinity and Chloride were estimated by Titrimetry. Sulphate and Phosphate measured by Spectrophotometer (Vissican167, Systronics), Na and K by Flame photometry (Systronics). The ground water samples were analyzed for physicochemical parameters and the analytical data is presented in Table 2 & 3 respectively.

Table.2: Physicochemical Characteristics of Ground Water

Sample Code	Type of source	pH		EC (µmhos/cm)		TDS (mg/l)		TH (mg/l)		TA (mg/l)		CO_3^{-2} (mg/l)		HCO_3^- (mg/l)	
		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
		Pre	Post	pre	Post	pre	Post	pre	Post	pre	Post	Pre	Post	Pre	Post
GW-1	BW	8.2	8.5	816	523	522	335	700	800	560	900	160	200	400	700
GW-2	OW	7.1	7.9	1211	757	775	485	800	900	360	500	BDL	BDL	360	500
GW-3	OW	7.3	8.0	1474	968	943	620	500	1300	260	700	BDL	BDL	260	700
GW-4	BW	7.4	7.9	1550	1030	992	659	700	1600	420	800	BDL	BDL	420	800
GW-5	BW	7.1	7.7	1052	781	673	500	500	1100	320	600	BDL	BDL	320	600
GW-6	BW	7.0	7.6	2280	1750	1459	1120	2000	1800	360	700	BDL	BDL	360	700
GW-7	OW	7.4	7.9	830	863	531	552	600	1500	360	500	BDL	BDL	360	500
GW-8	OW	7.2	8.2	845	683	541	437	600	1600	340	700	BDL	BDL	340	700
GW-9	OW	7.6	8.3	5220	4130	3341	2643	1000	1200	1000	1400	BDL	200	1000	1200
GW-10	BW	7.0	8.2	1620	668	1037	427	900	1300	400	600	BDL	BDL	400	600
GW-11	OW	7.3	7.2	3740	1680	2394	1075	3100	1500	700	600	BDL	BDL	700	600
GW-12	OW	8.0	8.1	1570	669	1005	428	500	1200	320	600	BDL	BDL	320	600

BW: Bore Well; OW: Open Well

Table.3: Physicochemical Characteristics of Ground Water

Sample Code	Type of source	Na (mg/l)		K (mg/l)		Ca^{+2} (mg/l)		Mg^{+2} (mg/l)		Cl^- (mg/l)		SO_4^{-2} (mg/l)		PO_4^{-3} (mg/l)	
		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
		pre	Post	pre	Post	pre	Post	pre	Post	Pre	Post	pre	Post	pre	Post
GW-1	BW	39	12	3.0	0.8	160	80	73	146	14	71	99	10	0.1	0.3
GW-2	OW	79	17	2.2	0.5	200	80	73	171	57	106	102	36	0.3	0.6
GW-3	OW	54	22	1.6	0.5	120	120	49	244	28	71	102	52	0.8	1.3
GW-4	BW	97	20	15.6	3.4	80	40	122	366	14	35	115	63	1.3	1.6
GW-5	BW	49	15	3.1	0.7	160	80	24	220	57	106	105	42	3.8	4.2
GW-6	BW	115	28	0.9	0.3	240	160	342	342	269	284	158	199	3.9	4.5
GW-7	OW	45	16	19.7	3.7	80	80	98	317	14	106	98	51	3.2	3.9
GW-8	OW	46	14	3.5	0.9	160	120	49	317	15	71	102	25	10.4	13.2
GW-9	OW	115	35	100	66.3	80	40	195	268	567	496	166	221	6.1	7.4
GW-10	BW	44	13	20.6	5.4	80	40	171	293	14	35	108	66	15.2	16.9
GW-11	OW	115	27	4.1	2.8	280	80	586	317	638	213	154	106	9.7	11.4
GW-12	OW	47	14	4.7	1.3	80	40	73	268	14	71	105	55	16.6	17.2

BW: Bore Well; OW: Open Well

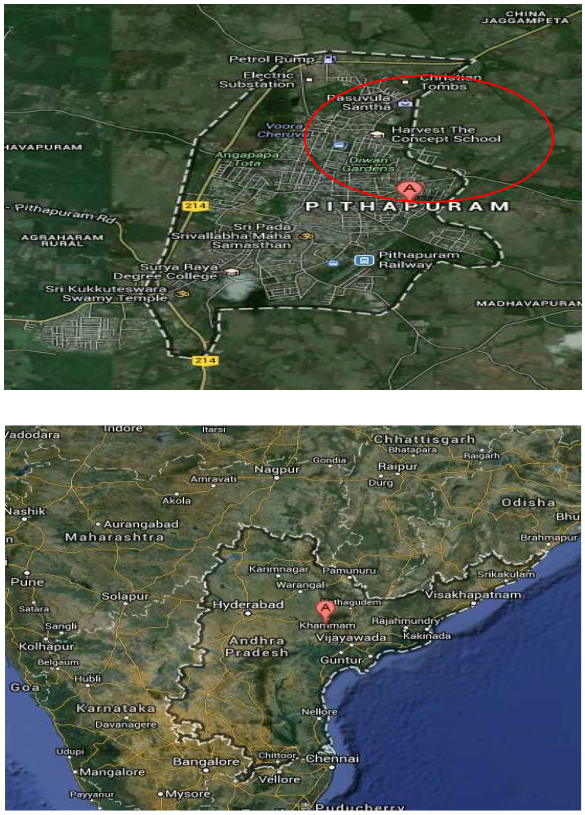

Diagram.1: Study Area Map

Bacterial Analysis:

The ground water samples were collected in sterilized containers [14] and immediately transported to the laboratory for the bacterial analysis. The Most Probable Number (MPN) technique was employed for the enumeration for the *Coliform* count in water samples [15,16]. This involved the presumptive test using lactose broth and Nutrient agar, confirmatory test using Eosin Methylene Blue (EMB) agar, pure colonies of the isolated were subjected to Grams stain, motility, Indole, Methyl red, Voges-Proskuer test, Citrate utilization tests, Urease test, Catalase and Oxidase tests [17].

Further the ground water samples were analyzed for microbial analysis and the details of the analytical data is presented in table 4 and the identified bacteria are presented in photographs-2(a), 2(b), 2(c), 2(d) and 2(e) respectively.

Table.4: Microbial analytical data of ground water samples

Sample Code	Bacterial Species Identified											
	MPN Count/100ml		*E coli*		*Klebsiella*		*Pseudo monas*		*Proteus*		*Enterobacter*	
	Pre	Post	pre	Post	pre	Post	pre	Post	Pre	Post	Pre	Post
GW-1	23	17	+ ve	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve
GW-2	0	2	- ve	+ ve	- ve	- ve	+ ve	- ve	+ ve	- ve	- ve	- ve
GW-3	540	110	+ ve	+ ve	+ ve	+ ve	- ve	- ve	+ ve	- ve	- ve	- ve
GW-4	240	140	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve	- ve	+ ve	+ ve
GW-5	5	21	- ve	- ve	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve	- ve
GW-6	0	4	- ve	- ve	- ve	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve
GW-7	49	80	+ ve	+ ve	- ve	- ve	+ ve	- ve	+ ve	+ ve	- ve	- ve
GW-8	2	11	- ve	- ve	- ve	- ve	+ ve	+ ve	+ ve	- ve	- ve	- ve
GW-9	33	50	+ ve	+ ve	+ ve	+ ve	- ve	- ve	- ve	- ve	- ve	- ve
GW-10	0	2	- ve	- ve	- ve	- ve	+ ve	- ve	+ ve	- ve	- ve	- ve
GW-11	10	0	- ve	- ve	+ ve	- ve	- ve	- ve	+ ve	+ ve	- ve	- ve
GW-12	110	90	+ ve	+ ve	- ve	- ve	- ve	- ve	+ ve	- ve	- ve	- ve

Photograph: Bacterial species identified

2(a) E coli *2(b) Klebsiella* *2(c) Pseudomonas* *2(d) Proteus* *2(e) Enterobacter* (fish eye colonies)

RESULTS AND DISCUSSIONS

pH: pH levels of the Pre Monsoon period range from 7.0-8.2 while pH of Post Monsoon samples range from 7.2-8.5 indicating slight alkaline nature. Though the pH levels are within the permissible limits (6.5-8.5) of IS: 10500-1992, the waters are found to be with slight to moderate alkaline nature.

Electrical Conductivity (EC): EC values of Pre Monsoon water samples range from 816-5220 µmhos/cm while Post Monsoon samples EC levels range from 523-4130µmhos/cm.

Total Dissolved Solids (TDS): The TDS levels of Pre Monsoon water samples range from 522-3341 mg/l and exceeded the permissible limit 500 mg/l of IS:10500-1992. While the TDS levels of Post Monsoon samples range from 335-2643 mg/l, and the TDS levels of five Post Monsoon samples are within the permissible limit while the levels of other 7 samples exceeded the permissible limits. Due to higher levels of TDS, these waters lose palatability and may cause gastro intentional irritation.

Total Hardness (TH): The Total Hardness levels of Pre Monsoon water samples range from 500-3100 mg/l and exceeded the permissible limit(300mg/l) of IS:10500-1992 while in case of water samples collected during Post Monsoon season the TH levels range from 800-1600 mg/l and exceeded the permissible limits. The values indicate that the waters lie under classification of very hard nature and may cause encrustation in water supply structure and adversely effect on domestic use.

Total Alkalinity: The Total Alkalinity values of water samples of Pre Monsoon period range from 260-1000 mg/l and the levels exceeded the desirable limit(200mg/l) IS:10500-1992 while the Total Alkalinity of Post Monsoon water samples range from 500-1400 mg/l. In both the seasonal samples TA values exceeded the desirable limit. The higher levels of TA impart bad taste to waters and hence become unpleasant for consumption.

Carbonate (Co_3^{-2}) Alkalinty: One sample (GW-1), is observed within carbonate alkalinity in the samples collected during Pre Monsoon samples while in remaining samples TA values are observed at BDL. However in water samples of Post Monsoon season the water samples GW-1&9 observed with carbonate alkalinity while others were observed with BDL levels of carbonate alkalinity.

HCo_3^- Alkalinity: Bi Carbonate alkalinity of water samples collected during Pre Monsoon season range from 260-1000 mg/l. Out of 12 samples 10 samples were observed with bicarbonate alkalinity within permissible limits (500mg/l) of IS: 10500-1992. While in other 2 samples the HCo_3^- levels exceeded the permissible limits. In case of water samples collected during Post Monsoon period HCO_3^- levels range from 500-1200 mg/l. In case of 2 samples the bicarbonate level reached the threshold value while in other samples HCo_3^- levels exceeded the permissible limits.

Na & K: Sodium ion concentration in ground waters collected during Pre Monsoon period range from 39-115mg/l while Na levels in water samples collected during Post Monsoon period range from 12-35mg/l. Na levels in water samples in Pre Monsoon period are comparatively higher than the Na levels present in waters of Post Monsoon season. Potassium levels in ground waters collected during Pre Monsoon period range from 0.9-100mg/l. In only one sample (GW-9) the levels were higher compared to the K levels in remaining water samples. Potassium levels range from 0.3-66.3mg/l in Post Monsoon water period. Higher levels of Na and K during Pre Monsoon season may be due to excess ground water exploitation in the study area locations and the higher levels of Na & K may also indicate the leaching and dissolution of secondary salts in the pore spaces.

Ca^{+2} & Mg^{+2}: The Pre Monsoon water samples were observed with Calcium ion concentration ranging from 80-280mg/l while the Post Monsoon water samples were observed with Calcium ion levels from 40-160mg/l. In both seasonal groundwater samples, the Calcium ion levels exceeded the permissible limit (75mg/l) of IS: 10500-1991. Magnesium levels in Pre Monsoon water samples range from 24-586 mg/l only in one sample(GW-5), Mg level is within the permissible limit(30mg/l) of IS: 10500-1992 while in other 11 groundwater samples the Mg level exceeded the permissible limit. While the Mg ion levels in Post Monsoon water samples range from 146-366 mg/l and exceeded the permissible limit. The higher levels of Ca & Mg may be due to the seepage of industrial and domestic water or due to cationic exchange with Sodium.

Chloride: Chloride level in ground waters collected during Pre Monsoon season range from 14-638 mg/l. In case of samples (GW-6,9&11), Chloride levels exceeded the permissible limit of (250mg/l) of IS: 10500-1992 while remaining 5 samples were observed with Chloride levels within the permissible limit. In case of water samples collected during Post Monsoon season, Chloride levels range from 35-496 mg/l. Only in case of 2 samples (GW-6&9) the Chloride levels are on the higher side of the permissible limit while in case of the remaining samples, Chloride levels were within the permissible limit. The higher Chloride levels in Post Monsoon water samples may be due to lack of proper leaching during Monsoon period.

Sulphate: Sulphate levels in groundwater collected during Pre Monsoon period range from 98-158 mg/l while the levels in Post Monsoon water samples range from 10-221 mg/l and all the values are within the permissible limit(200mg/l) of IS: 10500-1992.

Phosphate: Phosphate levels in Pre Monsoon water samples range from 0.1-16.6 mg/l. The Phosphate levels in 5 groundwater samples (GW-8,9,10,11&12) exceeded 5mg/l. Phosphate levels in Post Monsoon water samples range from 0.3-17.3mg/l. The Phosphate levels in 5 groundwater samples (GW-8,9,10,11&12) exceeded 5mg/l. Excess Phosphate levels may be due to the discharge of agricultural runoff from the nearby agricultural active zones.

The ground waters in the study area were found to contain MPN count and besides bacterial species. During Pre Monsoon season the samples GW-1,3,4,7,9 & 12 were found to contain *E Coli* while in Post Monsoon the samples Gw-1,2,3,4,7,9&12 were found to contain *E Coli*. During the Pre Monsoon the samples GW-1,3,5,9 & 11 were observed with bacterial spp. *Klebsiella* while in the Post Monsoon period 4 samples GW-3,5,6&9 were found to be with *Klebsiella*. During the Post Monsoon the samples Gw-2, 6, 7, 8 & 10 were found to contain *Pseudomonas* while in Post Monsoon only one sample Gw-8 was found to contain the bacterial spp *Klebsiella*. During the Pre Monsoon the samples Gw-2, 3, 7, 8, 10, 11 & 12 were found to contain *Proteus* while in Post Monsoon 2 samples Gw-7&11 were found to contain the *Proteus*. During both the seasons Pre & Post Monsoon only 1 samples Gw-4 was found to contain the *bacterial spp. Enterobacter*.

CONCLUSION

The levels of pH in majority of ground water samples indicate slight to moderate alkaline nature. Higher values of TDS indicate the presence of soluble salts in waters due to which the palatability decreases and hence these waters may cause gastrointestinal irritation. A higher value of Total Hardness and Calcium concentrations imparts encrustation in water supply structure and can cause adverse effects on domestic use. The higher values of Total Alkalinity change the taste of these waters and hence the waters become unpleasant for consumption. Chloride levels in only three Pre Monsoon water samples and two Post Monsoon samples exceeded the permissible limit and hence these waters may affect the taste, corrosion and palatability of these waters making the waters unsuitable for consumption. Sulphate levels were within the permissible limit indicating the non-discharge of industrial waste waters into the ground water sources. Phosphate levels in 5 ground water samples each in Pre and Post Monsoon seasons exceeded 5mg/l indicating the discharge of agricultural runoff into the ground water source at that location The presence of bacterial species load of *E. coli, Klebsiella, Pseudomonas, Proteus and Enterobacter* can also cause severe health hazards like stomach cramps, diarrhea, vomiting, fever, urinary tract infection, pneumonia, hepatic infections, bacterimia, skin and soft tissue and opportunistic infections on burns, wounds and also blood related infection. Based on the chemical and bacteriological contamination status of the ground waters, it is concluded that these ground waters are mostly unsuitable for human consumption. Effective monitoring of ground water quality is frequently suggested to safe guard the health of the public residing in the surroundings of the dump site.

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