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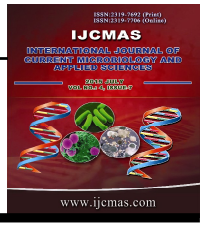

Original Research Article

Characterization of Waters from Rural Water Supplies (RWS) for Assessing Chemical and Microbial Contamination Status

P. Lakshmi Ganapati[1]*, T.Siva Rao[2], V.Ranga Rao[1] and P.V.S.Machi Raju[3]

[1]Department of Chemistry, Government College (A), Rajahmundry- 533101, A.P., India
[2]Department of Inorganic & Analytical Chemistry, Andhra University, Vizag-530003, A.P., India
[3]Department of Chemistry, Pragati Engineering College, Surampalem-533437, A.P., India
**Corresponding author*

Keywords

Parameter, Characterization, Drinking water, Metal ion, Bacteria

A B S T R A C T

Water pollution due to chemical constituents, Metal ions and micro organisms is one of the serious environmental problems, which has greatly impacted human health. The aim of the present study is to characterize the Rural Water Supply waters collected before and after treatment from Mandal Head Quarters of Iragavaram and Undrajavaram of Eluru Revenue division in West Godavari district during pre and post monsoon seasons to estimate the chemical contamination status and metal toxicity. The parameters characterized include pH, Electrical conductivity (EC), Total Dissolved solids (TDS), Total hardness (TH), Total Alkalinity (TA), Na, K, Calcium and Magnesium, Chloride, Sulphate, Nitrate, Fluoride, Phosphate and Metal ions Viz., Li, Be, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Rb, Sr, Ag, Cd, Cs, Ba, Tl, Pb and U. The waters are further characterized for identification of *Bacterial spps.* The research results revealed that the presence of higher levels of certain chemical parameters and presence of bacteria confirmed their unsuitability for drinking and domestic applications. The waters are to be treated by ultra and nano filtration techniques to reduce the total dissolved solids and disinfection and sterilization methods are to be applied for removing bacterial contamination before use of these waters for drinking and domestic purposes.

Introduction

Water plays a significant role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water (Cheesbrough, 2006). Human population growth poses a great pressure on supply of safe drinking water especially in developing countries (Okonko *et al.*, 2009). The quality of drinking water is a powerful environmental determinant of health (WHO, 2010). Drinking water quality management has been a key pillar of primary prevention and it continues to be the foundation for the control of water borne diseases (WHO, 2010). The safety of water supplies is of paramount public health importance. An estimated 13% of the world population lacked access to improved drinking-water

sources in 2008 [UNICEF and World Health Organization (WHO) 2011], and almost 10% of the total burden of disease worldwide could be prevented by improving drinking-water supply, sanitation, hygiene, and the management of water resources (Prüss-Üstün *et al.,* 2008). Inadequate quantity, poor quality of drinking water, and poor sanitation are the main reasons in incidence and prevalence of diseases in the world (WHO, 2004).

Water may contain toxic inorganic chemicals which may cause either acute or chronic health effect. Acute effects include nausea, lung irritation, skin rash, vomiting and dizziness, sometime death usually occurred. Chronic effect, like cancer, birth defects, organs damage, disorder of the nervous system and damage to the immune system are usually more common (Erah *et al.,* 2002). Inorganic chemicals like lead may produce adverse health effect which include interference with red blood cell chemistry, delay in normal physical and mental development in babies and young children, slit deficit in attention span, hearing and learning abilities of children and slight increase in blood pressure in some adults. Chemicals in water supplies can be related to health risks, generally when associated with long-term exposures (Thompson *et al.,* 2007).

Microbiological contamination is the largest cause of waterborne disease at a global scale. A more recent estimate (Witt, 1982), based on WHO reports suggests that 80% of all human illness in the developing world is associated with polluted water, and that most of those illnesses are caused by biological contamination. Water borne diseases such as cholera and typhoid often have their outbreak especially during dry season (Banu and Menakuru, 2010; Adenkunle *et al.,* 2004). Diseases due to drinking of contaminated water leads to the death of five million children annually and make 1/6 of the world population sick (Shittu *et al.,* 2008). The microbiological quality of drinking water has attracted great attention worldwide because of implied public health impacts (Amira, 2011).

Keeping in view the present scenario in water supply system in particular rural water supply in our country, the present research work is focused on characterization of waters for physicochemical parameters to assess the chemical contamination status and metal ions to estimate the metal toxicity and microbial (*bacteria)* analysis in waters to evaluate the microbial contamination and to suggest the concerned authorities for initiating the required remedial measures to safe guard the health of the public who consume these waters for drinking and domestic purposes.

Materials and Methods

The study areas selected for present research include the Revenue Mandal Head Quarters of Iragavaram and Undrajavaram of Kovvuru revenue division in West Godavari District, A.P, India. The details of sample code, sampling area, status, type of source and Coordinates of study area are presented in table 1. The study area maps are presented in figure 1.

Physicochemical characterization

RWS samples collected during pre and post monsoon periods are characterized for physicochemical parameters viz., pH, Electrical conductivity (EC), Total Dissolved solids (TDS), Total hardness (TH), Total Alkalinity (TA), Sodium, Potassium, Calcium and Magnesium, Chloride, Sulphate, Nitrate, Fluoride and Phosphate. pH determined by pH meter

(Global-DPH 505, India-Model) and Conductivity measured by the digital conductivity meter (Global-DCM-900-Model). TDS is determined from the relation TDS=Electrical conductivity (EC) X 0.64. Chloride, Total hardness, Total Alkalinity and Chloride are estimated by titrimetry. Sulphate and phosphate by spectrophotometer (Model-167, Systronics). Na and K by Flame photometer (Model-125, Systronics). The samples are analyzed as per the standard procedures (Ramteke and Moghe, 1998). The analytical data of physicochemical parameters are presented in table 2 & 3 respectively. The physicochemical parameters of drinking water samples before treatment (BT) and after treatment (AT) are represented graphically in figures 2 to14.

Characterization of metal ions

The treated water samples for metal ions are analyzed by employing Inductively Coupled Plasma Mass Spectrometry (ICP-MS) technique and the analytical data generated in ppb was converted to ppm and the details are presented in table 4.

Microbial (*Bacterial*) analysis

The drinking water samples after treatment are collected in sterilized containers and immediately processed for analysis for determining the MPN count by the most probable Number (MPN) technique. The enumeration for the Coliform count involves the presumptive test using lactose broth and Nutrient agar confirmatory test using Eosin Methylene Blue (EBM) agar, pure colonies of the isolated were subjected to Grams stain, motility, Indole, Methyl red, Voges Proskauer Citrate utilization (IMViC) tests, Urease test, Catalse and Oxidase test. The cultural, Morphological characteristics and the details of Biochemical characterization for identification of bacteria are presented in table 5. The identified *bacterial spp* are represented in figure 15.

Results and Discussion

p^H

Pre monsoon: p^H of waters before treatment in Iragavaram and Undrajavaram are 7.8 and 7.7 respectively, while the average p^H of waters after treatment is 8.1 for each.

Post monsoon: p^H of waters before treatment of the above two mandals are 7.8 and 8.2 respectively, while the average p^H of waters after treatment is 8.1 and 8.0 respectively. p^H levels of waters during pre and post monsoon seasons are within the no problematic range of drinking water standards (IS: 10500, 1992).

Electrical Conductivity (EC)

Pre monsoon: EC of untreated waters of Iragavaram and Undrajavaram are 2390 and 924 µmhos/cm respectively, while the average EC of treated waters is 2390 and 935.8 µmhos/cm respectively. Higher levels of EC in waters of Iragavaram and Undrajavaram indicate slightly saline nature.

Post monsoon: EC of untreated waters of the above two mandals are 2190 and 771 µmhos/cm respectively; while the average EC of treated waters is 1930 and 761.8 µmhos/cm respectively. Higher levels of EC in waters of Undrajavaram indicate slightly saline nature.

Total Dissolved Solids (TDS)

Pre monsoon: TDS of waters before treatment of Iragavaram and Undrajavaram are 1529.6 and 591.3 mg/L respectively. The average TDS is 1529.6 and 598.9 mg/L respectively in waters after treatment. TDS of waters from Iragavaram and

Undrajavaram are slightly higher indicating saline nature.

Post monsoon: TDS of waters before treatment of the above mandals are 1401.6 and 498.4 mg/L respectively. The average TDS is 1235.2 and 487.5 mg/L respectively in waters after treatment. TDS of waters from Undrajavaram are slightly higher indicating saline nature.

Total Hardness (TH)

Pre monsoon: TH of waters before treatment of Iragavaram and Undrajavaram are 300 and 200 mg/L respectively, while the average TH of waters after treatment is 300 and 200 mg/L respectively. TH of waters is within the permissible limit (IS: 10500-1992).

Post monsoon: TH of waters before treatment of the above two mandals are 600 and 500 mg/L respectively, while the average TH of waters after treatment is 550 and 425 mg/L respectively. TH of waters is on higher side of the permissible limit indicating the encrustation nature of waters.

Total Alkalinity (TA)

Pre monsoon: TA of untreated waters of Iragavaram and Undrajavaram are 610 and 854 mg/L respectively, while the average TA of treated waters is 1098 and 732 mg/L respectively.

Post monsoon: TA of untreated waters of the above two mandals are 1342 and 732 mg/L respectively, while the average TA of treated waters are 1189.5 and 793 mg/L respectively. TA of waters during pre and post monsoon from two mandal head quarters crossed the permissible limit and can cause unpleasant taste to waters.

Sodium (Na^+)

Pre monsoon: Sodium ion concentration of untreated waters of Iragavaram and Undrajavaram are 33.9 and 20.7 mg/L respectively, while its average concentration is 32.9 and 20.5 mg/L respectively in treated waters and the levels are within the permissible limit of WHO standards.

Post monsoon: Sodium ion concentration of untreated waters of the two mandals is 324.5 and 51.9 mg/L respectively. Its average concentration is 316.8 and 112.3 mg/L respectively in treated waters. In waters of Iragavaram sodium ion concentration is on the higher side of WHO standards, indicating the presence of salt content.

Potassium (K^+)

Pre monsoon: Potassium ion concentration of untreated waters of Iragavaram and Undrajavaram are 12.9 and 0.9 mg/L respectively. Its average concentration is 19.0 and 0.8 mg/L respectively in treated waters and the levels are within the permissible limit of WHO standards.

Post monsoon: Potassium ion concentration of untreated waters of the above mandals is 95.6 and 10.3 mg/L respectively. Its average concentration is 60.3 and 4.4 mg/L respectively in treated waters. In Iragavaram mandal K^+ ion concentration exceeded the permissible limit of WHO standards.

Calcium (Ca^{2+}):

Pre monsoon: Ca^{2+} of untreated waters of Iragavaram and Undrajavaram are 80 and 40 mg/L respectively, while its average concentration of treated waters is 40 mg/L in each. Calcium levels are within the permissible limit of drinking water standards.

Post monsoon: Calcium ion concentration of untreated waters of Iragavaram and Undrajavaram are 120 and 80 mg/L respectively, while its average concentration of treated waters is 90 mg/L in each.

Calcium levels in waters of Iragavaram and Undrajavaram are on higher side of the permissible limit of drinking water standards (IS: 10500-1992) and can cause encrustation on water supply systems.

Magnesium (Mg^{2+})

Pre monsoon: Magnesium ion concentration of waters from Iragavaram and Undrajavaram before treatment is 24.4 mg/L for each and its average concentration of waters after treatment is 48.8 mg/L and 24.4 mg/L respectively. Magnesium levels in waters of Iragavaram mandal exceeded the permissible limit of drinking water standards (IS: 10500-1992).

Post monsoon: Magnesium ion concentration of waters before treatment in both mandals is 73.2 mg/L, while its average concentration of waters after treatment is 79.3 and 42.7 mg/L in post monsoon season respectively. Magnesium concentration in waters of both mandals during post monsoon season crossed the permissible limit indicating the laxative nature of waters.

Chloride (Cl^-)

Pre monsoon: Chloride ion concentration of waters before treatment of Iragavaram and Undrajavaram are 212.7 and 141.8 mg/L respectively, while its average concentration of waters after treatment is 452.0 and 150.7 mg/L respectively. Chloride ion concentration in Iragavaram mandal is on the higher side of drinking water standards indicating the saline nature of waters.

Post monsoon: Chloride ion concentration of waters before treatment of the above mandals are 248.1 and 141.8 mg/L respectively, while its average concentration of waters after treatment is 221.6 and 53.1 mg/L respectively. Chloride ion concentrations in waters of both mandals are within the permissible limit of drinking water standards (IS: 10500-1992).

Sulphate (SO_4^{2-})

Pre monsoon: Sulphate of untreated waters of Iragavaram and Undrajavaram are 181 and 29 mg/L respectively, while its average concentration is 154.8 and 34.8 mg/L respectively in treated waters.

Post monsoon: Sulphate of untreated waters of the above mandals is 186 and 32 mg/L respectively, while its average concentration is 156.5 and 46.5 mg/L respectively in treated waters. Sulphate concentration of water samples collected before and after treatment in both mandals during both seasons is within the permissible limit of drinking water standards (IS: 10500-1992) indicating the non discharge of industrial effluents into the water body sources in the study area.

Nitrate (NO_3^-)

Pre monsoon: Nitrate of untreated waters of Iragavaram and Undrajavaram are 18 and 12 mg/L respectively, while its average concentration is 16 and 13.8 mg/L respectively in treated waters.

Post monsoon: Nitrate of untreated waters of the above mandals is 16 and 10 mg/L respectively, while its average concentration is 13.8 and 11 mg/L respectively in treated waters.

Nitrate concentration of water samples

collected before and after treatment in all study areas in both seasons are within the permissible limit of drinking water standards (IS: 10500-1992).

Table.1 The details of sample code, sampling area, status, type of source and Coordinates of study area

Study Area-2: Kovvuru Revenue Division					
Iragavaram Mandal Head Quarters					
Sample Code	Area of Sampling	Status	Type of Source	Latitude	Longitude
W-1	RWS storage	BT	GW	$16^0.69^1$ N	$81^0.70^1$ E
W-2	Tap at RWS station	AT	TW		
W-3	Near MRO office	AT	TW		
W-4	Ramalayam Street	AT	TW		
W-5	High school	AT	TW		
Undrajavaram Mandal Head Quarters					
Sample Code	Area of Sampling	Status	Type of Source	Latitude	Longitude
W-1	RWS storage	BT	GW	$16^0.74^1$ N	$81^0.20^1$ E
W-2	Ganesh temple	AT	TW		
W-3	Main road	AT	TW		
W-4	Bondavari street	AT	TW		
W-5	Tanuku Road	AT	TW		

W-1: Water sample before Treatment, W-2 to W-5: Water samples After Treatment
*GW-Ground water, TW- Treated (Tap) water, BT- Before treatment, AT- After treatment

Fig.1 Study areas maps

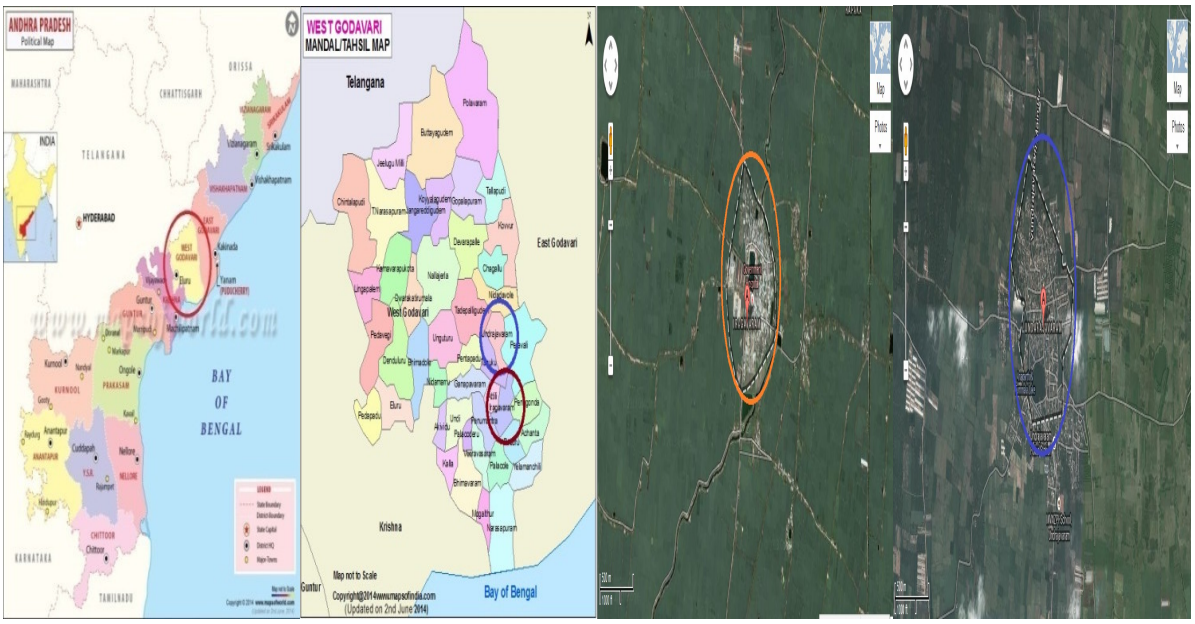

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Table.2 Physicochemical characteristics of RWS drinking waters of Iragavaram Mandal

Iragavaram Mandal Head Quarters															
Sample Code	Status	p^H		E.C (µmhos/cm)		TDS (mg/L)		TH (mg/L)		TA (mg/L)		Na^+ (mg/L)		K^+ (mg/L)	
		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
W-1	B.T	7.8	7.8	2390	2190	1529.6	1401.6	300	600	610	1342	33.9	324.5	12.9	95.6
W-2	A.T	8.4	8.1	2360	1970	1510.4	1260.8	300	500	854	1220	32.7	362.2	18.7	68.6
W-3		8.1	8.2	2460	2020	1574.4	1292.8	300	600	1220	1220	32.9	326.3	19.3	64.1
W-4		8.1	8.3	2340	2060	1497.6	1318.4	300	500	1220	1220	32.9	325.6	19.0	60.6
W-5		7.8	7.8	2400	1670	1536.0	1068.8	300	600	1098	1098	32.9	253.0	19.1	48.2
Average (AT)		**8.1**	**8.1**	**2390**	**1930**	**1529.6**	**1235.2**	**300**	**550**	**1098**	**1189.5**	**32.9**	**316.8**	**19.0**	**60.3**
Sample Code	Status	Ca^{2+} (mg/L)		Mg^{2+} (mg/L)		Cl^- (mg/L)		SO_4^{2-} (mg/L)		NO_3^- (mg/L)		F^- (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
W-1	B.T	80	120	24.4	73.2	212.7	248.1	181	186	18	16	0.54	0.52	ND	ND
W-2	A.T	40	80	48.8	73.2	283.6	212.7	110	114	17	15	0.48	0.46	ND	ND
W-3		40	80	48.8	97.6	248.1	248.1	169	172	16	14	0.45	0.42	ND	ND
W-4		40	80	48.8	73.2	638.1	212.7	164	168	15	12	0.42	0.40	ND	ND
W-5		40	120	48.8	73.2	638.1	212.7	176	172	16	14	0.40	0.42	ND	ND
Average (AT)		**40**	**90**	**48.8**	**79.3**	**452.0**	**221.6**	**154.8**	**156.5**	**16**	**13.8**	**0.43**	**0.42**	**ND**	**ND**

Table.3 Physicochemical characteristics of RWS Drinking waters of Undrajavaram Mandal

Undrajavaram Mandal Head Quarters															
Sample Code	Status	p^H		E.C (µmhos/cm)		TDS (mg/L)		TH (mg/L)		TA (mg/L)		Na^+ (mg/L)		K^+ (mg/L)	
		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
W-1	B.T	7.7	8.2	924	771	591.3	498.4	200	500	854	732	20.7	51.9	0.9	10.3
W-2	A.T	8.3	8.0	918	763	587.5	488.3	200	400	732	488	20.0	114.0	0.9	4.8
W-3		8.1	8.2	888	768	568.3	491.5	200	400	732	732	20.8	111.7	0.8	4.4
W-4		8.2	8.1	962	768	615.6	491.5	200	500	732	610	21.0	111.5	0.8	4.2
W-5		8.1	8.0	975	748	624.0	478.7	200	400	732	1342	20.3	112.0	0.8	4.3
Average (AT)		**8.1**	**8.0**	**935.8**	**761.8**	**598.9**	**487.5**	**200**	**425**	**732**	**793**	**20.5**	**112.3**	**0.8**	**4.4**
Sample Code	Status	Ca^{2+} (mg/L)		Mg^{2+} (mg/L)		Cl^- (mg/L)		SO_4^{2-} (mg/L)		NO_3^- (mg/L)		F^- (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
W-1	B.T	40	80	24.4	73.2	141.8	141.8	29	32	12	10	0.51	0.52	ND	ND
W-2	A.T	40	80	24.4	24.4	141.8	70.9	27	42	13	12	0.48	0.46	ND	ND
W-3		40	80	24.4	48.8	141.8	35.4	27	44	15	12	0.44	0.47	ND	ND
W-4		40	120	24.4	48.8	141.8	70.9	30	28	14	10	0.42	0.44	ND	ND
W-5		40	80	24.4	48.8	177.2	35.4	55	72	13	10	0.45	0.46	ND	ND
Average (AT)		**40**	**90**	**24.4**	**42.7**	**150.7**	**53.1**	**34.8**	**46.5**	**13.8**	**11**	**0.44**	**0.46**	**ND**	**ND**

Table.4 Metal ion concentration in treated RWS waters

Metal ion Concentration (ppm)	Sample location			
	Iragavaram		Undrajavaram	
	Monsoon		Monsoon	
	Pre	Post	Pre	Post
Li	0.01002	0.008662	0.002527	0.002734
Be	ND	ND	ND	ND
Al	0.007236	0.011945	0.01173	0.007389
V	0.051872	0.033932	0.010199	0.009531
Cr	0.000613	0.001467	0.000904	0.000809

Mn	0.003458	0.081334	0.001924	0.000662
Fe	0.004771	0.010495	0.009416	0.007609
Co	0.000069	0.000168	0.000016	0.00002
Ni	0.000542	0.001373	0.000606	0.000576
Cu	0.002013	0.002498	0.001776	0.001205
Zn	0.005698	0.011821	0.019277	0.00824
As	0.001543	0.001175	0.000195	0.000239
Rb	0.021992	0.009095	0.00315	0.002645
Sr	0.216148	0.328799	0.215314	0.273234
Ag	0.000054	0.000336	0.000039	0.000051
Cd	0.000058	0.000054	0.00003	0.000188
Cs	0.000001	0.000004	0.000012	0.000002
Ba	0.039902	0.044264	0.036706	0.031145
Tl	0.000011	0.000007	ND	ND
Pb	0.001331	0.001903	0.001189	0.004168
U	0.004661	0.005923	0.0016	0.00195

Table.5 The details of MPN count, cultural, Morphological characteristics and identified bacterial spps in treated drinking waters

Mandal Name	MPN Count/ 100 ml	No. of Bacterial Colonies	Bacterial Colony Morphology on EMB agar	Gram Stain	Motility	BIOCHEMICAL TESTS							*Bacterial Spps* Identified
						*(IMViC TESTS)				CA	OX	UR	
						I	MR	VP	C				
Iragavaram	>1800	1	Purple Centered	-ve	Motile	-	-	+	+	+	-	-	*Enterobacter*
		2	Pink mucoid	-ve	Non Motile	-	-	+	+	+	-	-	*Klebsiella*
Undrajavaram	540	1	Purple Centered	-ve	Motile	-	-	+	+	+	-	-	*Enterobacter*
		2	Light Pink	-ve	Motile	-	+	-	-	+	-	+	*Proteus*

*I = Indole, MR=Methyl red, VP=VogesProskauer, C=Citarte, CA= Catalase, OX= Oxidase, UR= Urease

Figures.2–14 Characteristics of RWS drinking waters (BT& AT) of Iragavaram and Undrajavaram Mandal Head Quarters

Fig.15 Photographs of identified bacteria

Enterobacter & Klebsiella

Enterobacter & Proteus

Fluoride (F^-)

Pre monsoon: Fluoride ion concentration of waters before treatment of Iragavaram and Undrajavaram are 0.54 and 0.51 mg/L respectively, while its average concentration of waters after treatment is 0.43 and 0.44 mg/L respectively.

Post monsoon: Fluoride ion concentration of waters before treatment of the above mandals is 0.52 mg/L for each, while its average concentration of waters after treatment is 0.42 and 0.46 mg/L respectively. Fluoride ion concentrations in waters of both mandals during both seasons are within the permissible limit of drinking water standards (IS: 10500-1992).

Phosphate (PO_4^{3-})

Phosphate ion concentrations are at ND level in untreated and treated waters of Mandal Head Quarters of Iragavaram and Undrajavaram of Kovvur Revenue Division during pre and post monsoon.

Metals ions: The concentration of metal ions viz., Li, Be, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Rb, Sr, Ag, Cd, Cs, Ba, Tl, Pb and U in waters collected after treatment during pre and post monsoon season are found to be within the permissible limits of drinking water standards (IS: 10500-1992).

Bacterial species Treated drinking water samples collected from Iragavaram and Undrajavaram mandal are observed with not only MPN count but with other pathogenic *bacterial Spps*. The water sample of Iragavaram mandal were found with *Enterobacter* and *Klebsiella spps while* Undrajavaram mandal water sample is observed with *Enterobacter* and *proteus Spps.*

p^H of waters during pre and post monsoon season of two mandals indicate high alkaline nature. Higher values of EC indicate the saline nature. Higher TDS revealed the presence of soluble solid matter in waters.Though Total Hardness of waters during pre monsoon season are with in the permissible limit, higher TH of waters of post monsoon season indicates the encrustation nature of waters and conformed the unsuitability of waters for domestic purposes during post monsoon season. Higher levels of Total Alkalinity indicate that waters unpleasent in taste and make the waters unsuitable for drinking and domestic purposes. Higher levels of Calcium in waters of post monsoon season indicates the encrustation nature of waters and their unsuitability for domestic purposes. Higher Magnesium levels indicate the Magnesium hazard of waters which can deplete the soil quality and consequently the crop yields will be reduced. Higher Chloride ion concentration in waters of Iragavaram indicates the saline and corrosive nature of the waters and waters are unsuitable for drinking purposes. Fluoride, Sulphate, Phosphate and Nitrate levels are below the permissible limit of drinking water standards indicating the non absence of contamination due to industrial effluents and agricultural runoffs from the surronding areas. Metal ion concentrations below the permissible limit of drinking water standards indicate the non toxicity of waters.The presence of MPN count indicate the microbial contamination of waters and pathogenic bacterial species viz., *Enterobacter, Klebsiella and Proteus, indicate* the bacterial contamination of waters with pathogenic bacterial species. Hence the waters may cause waterborne diseases like diarrhea, typhoid, Pneumonia, bacteremia, respiratory tract infections, urinary tract infections, skin and soft-tissue infections, ophthalmic infections, thrombophlebitis, cholecystitis and wound infections.

The research results revealed that the waters are chemically and microbiologically contaminated. Proper treatment like Ultra filtration and Nano filtration are to be employed for the removal of dissolved solids and desinfection and sterilization for the removal of Microbial contamination before considering the use of waters for drinking and domestic purposes.

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References

Adenkunle, L.V., Sridhar, M.K.C., Ajayi, A.A., Oluwade, P.A., Olawuyi, J.F. 2004. Assessment of the health and socio-economic implication of sachet water in Ibadan, Nigeria. *Afri. J. Biomed. Res.,* 7(1): 5–8.

Amira, A.A., Yassir, M.E. 2011. Bacteriological quality of drinking water in Nyala, South Darfur, Sudan. *Environ. Monit. Assess*, 175: 37–43.

Banu, N., Menakuru, H. 2010. Enumeration of microbial contamination in school water: A Public Health Challenge. *Health*, 2(6): 582–588. doi: 10.4236/health.2010.26086.

Cheesbrough, M. 2006. District laboratory practice in tropical countries, Part 2. Cambridge University Press. Pp. 143–157.

Drinking Water Specifications: IS: 10500, 1992 (Reaffirmed 1993).

Erah, P.O., Akujieze, C.N., Oteze, G.E. 2002. A quality of ground water in Benin City: A baseline study on inorganic chemicals and microbial contaminants of health importance in boreholes and open wells. *Trop. J. Pharm. Res.,* 1(2): 75–82.

Okonko, I.O., Ogunjobi, A.A., Kolawale, O.O., Babatunde, S., Oluwole, I., Ogunnusi, T.A., Adejoyi, O.D., Fajobi, E.A. 2009. Comparative studies and microbial risk assessment of a water samples used for processing frozen sea foods in Ijora- Olopa, Lagos State, Nigeria. *EJEAFChe.,* 8(6): 408–415.

Prüss-Üstün, A., Bos, R., Gore, F., Bartram, J. 2008. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva.

Ramleke, D.S., Moghe, C.A. 1988. Manual on water and waste water analysis, National Environmental Engineering Research Institute NEERI, Nagpur, India.

Shittu, O.B., Olaitan, J.O., Amusa, T.S. 2008. Physico-chemical and bacteriological analysis of water used for drinking and swimming purpose. *Afr. J. Biochem. Res.,* 11: 285–290.

Thompson, T., Fawell, J., Kunikane, S., Darryl Jackson, D., Appleyard, S., Callan, P. *et al.* 2007. Chemical safety of drinking-water: assessing priorities for risk management. World Health Organization, Geneva.

UNICEF and World Health Organization, 2011. Drinking water equity, safety and sustainability.

WITT, V.M. 1982. Developing and applying international water quality guidelines. *J. Am. Water Works Assoc.,* 74: 178–181.

World Health Organization (WHO), 2010. Guidelines for drinking-water quality. Recommendation, Geneva. Pp. 1–6.

World Health Organization, Guidelines for drinking—water quality, 3rd edn., World Health Organization, Geneva, Switzerland.