

ORIGINAL ARTICLE

A survey on Drinking Water Quality, Water Consumption Pattern and Hygiene Practices of R.S. Pura Block, District-Jammu (J&K)

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ABSTRACT

The present study was carried out with the objective to determine the quality of Drinking Water, the Water Consumption Pattern and also to check the awareness status of people regarding hygiene in R.S.Pura block in Jammu district of J&K, India. The key findings of the survey revealed that the average water consumption pattern of R.S.Pura town is 16,000 Litres per month per household. The only source of water for the people of R.S.Pura town is ground water. Only 4% of the household surveyed are not well aware on the issues related to safe drinking water & sanitation practices and rest are well aware. 44% of the households are having water filters, 6% are giving boiling treatment, and rest are directly consuming the water without any kind of treatment. The total expenditure on water bills is nil. Physico-chemical parameters of the drinking water such as colour, odour, turbidity, pH, Electrical Conductivity, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Total Alkalinity, Hydroxide, Carbonates, Bicarbonates and Chloride were also analysed. The drinking water quality analysis revealed that P-alkalinity was altogether absent in all the water samples, indicating that bicarbonates ions are primarily responsible for contributing to the total alkalinity. The results indicated that water treatment is needed to bring the level of Total Hardness and Total alkalinity within the acceptable limit as laid in IS 10500:2012. However, no such treatment is needed for Calcium ions.

Keywords : consumption pattern, hygiene, P-alkalinity, bicarbonates, contaminants.

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INTRODUCTION

Water is an indispensable constituent for all living beings, having varied roles in human societies. Apart from drinking, it has multiple other uses like bathing, cleaning, cooking, agriculture, industrial applications, power generation etc [12]. Water covers nearly 71% of the Earth's surface but the percentage of fresh water which is actually available to humans is very low [8]. Groundwater is considered as the pure form of water when compared to surface water as it gets purified in the soil column through various processes like anaerobic decomposition, filtration and ion exchange [4]. Unfortunately, water resources are getting deteriorated because of the excessive applications of pesticides, chemical fertilizers, increased anthropogenic activities, industrial pollution, increasing consumption and urbanization, violation of Central Pollution Control Board's rules and regulations [7, 11]. In addition to this, landfills, improper sewer lines, improperly treated effluents, underground storage tanks, spills and leaching of toxic chemicals etc also aids in declining the quality of drinking water [5]. When heavy metals and trace elements enter the ground water, these may cause detrimental effects on human health because ingestion of such polluted water leads to the entry of heavy metals into the human body [6].

Consumption of contaminated water leads to a number of health issues such as water-borne diseases, kidney stones, gout, etc. Pollutants can have several chronic or acute toxic effects on living beings and can also cause alteration in the cell division rate, DNA structure and restrain the reproductive system [3]. As per the statement given by the WHO, nearly 80% of health related issues in humans are due to the use of the poor water quality [11]. Assessment of quality of drinking water at regular intervals of time is thus a necessity to reduce the deleterious effects of water pollution and also to find out the changes in the

water's ecosystem [14]. Regular monitoring of water quality parameters like pH, turbidity, total alkalinity, Total Hardness, Total Dissolved Solids, Calcium, Magnesium and other biological parameters is thus required to ensure its suitability for drinking and other domestic purposes [8]. Keeping track of drinking water from source to tap is a significant step towards hygiene safety [15].

According to a report of 2015, 663 million people do not have access to safe and clean drinking water and 2.4 billion have not improved sanitation facility. As revealed by National Family Health Survey(2015–16), only 48.4% of households in India have improved sanitation facility and 89.9% have improved sources of drinking water [9]. Without coping up with the problems of availability of safe drinking water and sanitation practices, there could be no improvement in the health sector of a nation [10]. As stated by the World Health Organization in its report, improved and upgraded water supply alone could result in the decrease of diarrhea-related illness cases by 6–25% [13]. The present study also aimed at determining the drinking water quality of the different locations of block R.S.Pura. The water samples were analysed for different physico-chemical parameters and the results were compared with drinking water standards of Bureau of Indian Standards (IS 10500: 2012). A sanitary survey was also conducted on water consumption pattern, water treatment expenses and the awareness level of people of R.S.Pura town.

MATERIAL AND METHODS

Study area

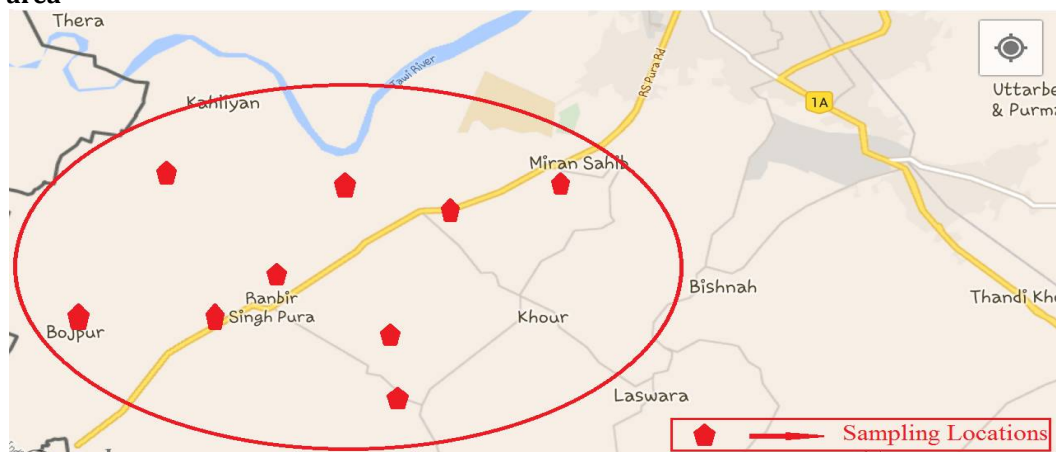


Figure 1. Map showing water sampling sites.

R.S.Pura is a town, a sub district and a notified area committee in Jammu district (J&K). It is a tehsil as well as a block of Jammu district, which is located at 32.63°N 74.73°E. The water samples for quality assessment were taken from different locations (Chakroi, Miran Sahib, Simbal, NariKheper, Kullian, Korotana, R.S.Pura, Salaama Chak) of block R.S.Pura in the month of April, 2016 (Figure 1). Samples were collected in 2.0 litre water cans, previously decontaminated through several washings with distilled water and disinfectant (10% HCl).

Methodology of Data collection

The statistical data pertaining to R.S. Pura block was obtained from the office of BDO (Block Development Officer). The data revealed that the number of households in R.S.Pura town are 2,865 and the total population of the town comes out to be 14,324. The survey took place in May, 2016 and was done using in-person interviews. The survey comprised all the age groups : 18- 25 , 25- 45 , 45- 65 , & above . The number of households surveyed were 50 which is equivalent to 1.74 % of the total households present in R.S.Pura town. The households were selected using stratified random sampling and were interviewed to check their awareness level on drinking water quality and hygiene practices. Template of the questionnaire used in the survey is given in Figure 2.

It has been concluded from the statistical data that on an average 1 household comprises of 5 persons which means 50 households represents 250 people on whole. The survey of each household is an overall representation of an average of 5 people. So accordingly, 50 households are representing the population of 250 people spread over different age groups and categories. Therefore, the survey for 50 households covers the views and opinions of 250 people on an average.

QA: Information about the household.	
1) Name	
2) Age (in years)	18- 25 () 25- 35 () 35- 45 () 45- 55 () 55- 65 ()
3) Gender of respondent	Male () Female ()
4) Location/Address	
5) Number of family members	
-Number of adult male	
-Number of adult female	
-Number of children	
6) Main income sources	
7) Your monthly income	
QB: Questions regarding drinking water.	
1) Main source of water in your household.	Handpump / Borewell Community well Supply water Tank Others
2) How much do you pay for it?	per month / per year =
3) Are you confident that the drinking water which you are having is suitable for drinking?	Yes () No () I do not know ()
4) Have you analysed your drinking water in a laboratory ?	Yes () No ()
5) Is there enough water for all your needs ?	Yes () No ()
6) Do you drink water without treatment?	
QC: About the cleanliness of water	
1) Generally, what does the water looks like?	Clear / Dirty
2) Generally, how does the water smell?	No Smell / Foul Smell
3) Generally, does the water have the taste?	Yes / Tasteless
4) Do you drink the water without treatment?	Yes/ No
5) If No, then how do you treat water?	Boil Add chlorine Use a water filter Let it stand & settle Other
QD: About the cost of water treatment	
1) If you are using water filters..how often you change your filters ?	
2) How much does a new filter charge ?	
3) How many litres of water do you boil?	
4) How much does that fuel (LPG/ Wood) costs?	
QE: About the Water consumption level	
1) Amount of water used for drinking/ cooking	
2) Amount of water used for bathing/ washing	
3) Amount of water used for sanitary activities	
4) Amount of water used for Plantation	
5) Water storage capacity of your house	
QF: Questions regarding sanitation- Hygiene	
1) Do you wash your hands before eating?	Yes/No
- With	Simple water () Handwash () Soap ()
2) Do you know, that if you don't wash your hands before eating, then thousands of bacterias& other	Yes/No

microbes can enter your system?	
3) Do you know , how drinking water quality and spread of diseases are related ?	
4) Thinking of all of the issues presently facing your community ,which one do you feel should receive the greatest attention from the village's leaders?	Health care
	Garbage and recycling
	Sewage treatment
	Drinking water
	Waste disposal
Signature _____	

Figure 2. Template of the questionnaire on Drinking Water quality, Water Consumption Pattern and Hygiene Practice.

Analytical techniques and methodology for testing the water quality

For determining the water quality parameters, APHA and IS protocols (Table 1) were followed [1, 2].

Table 1: Different water quality parameters and estimated standard methods.

S. No	Water Quality parameter	Unit	Test method	Reference method
1.	Colour	Hz	Nessler tube	IS: 3025 (Part 4)
2.	pH	-	Micro-processor based digital pH meter (Model No. 1013)	-
3.	Electric conductivity	μs/cm	Digital Conductivity Meter	APHA, 22 nd Edition: 2012
4.	Total dissolved solids	mg/L	-	IS: 3025 (Part 16)
5.	Total Alkalinity (as CaCO ₃)	mg/L	Acid Titration	IS: 3025 (Part 23)
6.	Carbonate (CO ₃ ²⁻) alkalinity	mg/L	-	APHA, 22 nd Edition: 2012
7.	Bicarbonate (HCO ₃ ⁻) Alkalinity (as CaCO ₃)	mg/L	-	APHA, 22 nd Edition: 2012
8.	Total Hardness	mg/L	EDTA Titration	APHA, 22 nd Edition: 2012
9.	Calcium hardness (Ca ⁺⁺)	mg/L	EDTA Titration	IS: 3025 (Part 40)
10.	Magnesium hardness (Mg ⁺⁺)	mg/L	EDTA Titration	IS: 3025 (Part 46)
11.	Chloride (Cl ⁻)	mg/L	Argentometric Titration	APHA, 22 nd Edition: 2012

RESULTS AND DISCUSSION

SURVEY FINDINGS :

The present study area which comes under R.S.Pura block of District Jammu was being surveyed for 50 Households and the results are shown in Table 2 and Table 3.

Table 2: Interpretation of survey questionnaire.

S.No	Gender	Water consumption (L/month)	Awareness on sanitation	Quality of drinking water	Monthly Income on water bills	Money spent on treatment	Total income spent (Rs per year)	Source of water
1	F	15000	Yes	satisfactory	Nil	Nil	Nil	Borewell
2	M	6000	No	satisfactory	Nil	Nil	Nil	Borewell
3	M	15000	Yes	satisfactory	Nil	1000	1000	Borewell
4	M	6000	Yes	satisfactory	Nil	Nil	Nil	Borewell
5	M	6000	Yes	satisfactory	Nil	1000	1000	Handpump
6	M	6000	Yes	satisfactory	Nil	Nil	Nil	Borewell
7	M	6000	Yes	satisfactory	Nil	1000	1000	Borewell
8	M	15000	Yes	satisfactory	Nil	Nil	Nil	Handpump
9	M	32000	No	satisfactory	Nil	Nil	Nil	Handpump
10	M	11000	Yes	satisfactory	Nil	1000	1000	Borewell
11	M	6000	Yes	satisfactory	Nil	1000	1000	Borewell
12	F	15000	Yes	satisfactory	Nil	600	600	Borewell
13	F	15000	Yes	satisfactory	Nil	1000	1000	Handpump

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14	M	11000	Yes	satisfactory	Nil	1000	1000	Handpump
15	M	6000	Yes	satisfactory	Nil	1000	1000	Borewell
16	M	32000	Yes	satisfactory	Nil	1000	1000	Borewell
17	M	6000	Yes	satisfactory	Nil	1000	1000	Borewell
18	F	32000	Yes	satisfactory	Nil	Nil	Nil	Handpump
19	M	6000	Yes	satisfactory	Nil	1000	1000	Borewell
20	F	6000	Yes	satisfactory	Nil	1000	1000	Borewell
21	M	15000	Yes	satisfactory	Nil	Nil	Nil	Borewell
22	M	11000	Yes	satisfactory	Nil	Nil	Nil	Borewell
23	M	6000	Yes	satisfactory	Nil	1000	1000	Handpump
24	M	11000	Yes	satisfactory	Nil	1000	1000	Borewell
25	M	11000	Yes	satisfactory	Nil	Nil	Nil	Handpump
26	F	32000	Yes	satisfactory	Nil	Nil	Nil	Borewell
27	M	32000	Yes	satisfactory	Nil	Nil	Nil	Handpump
28	F	32000	Yes	satisfactory	Nil	Nil	Nil	Borewell
29	F	15000	Yes	satisfactory	Nil	1000	1000	Borewell
30	F	15000	Yes	satisfactory	Nil	Nil	Nil	Handpump
31	M	11000	Yes	satisfactory	Nil	Nil	Nil	Borewell
32	M	11000	Yes	satisfactory	Nil	Nil	Nil	Handpump
33	M	15000	Yes	satisfactory	Nil	Nil	Nil	Handpump
34	M	15000	Yes	satisfactory	Nil	1000	1000	Borewell
35	M	15000	Yes	satisfactory	Nil	1000	1000	Handpump
36	F	15000	Yes	satisfactory	Nil	1000	1000	Handpump
37	F	32000	Yes	satisfactory	Nil	1000	1000	Borewell
38	F	32000	Yes	satisfactory	Nil	Nil	Nil	Tank
39	F	15000	Yes	satisfactory	Nil	Nil	Nil	Handpump
40	F	32000	Yes	satisfactory	Nil	500	500	Handpump
41	F	15000	Yes	satisfactory	Nil	1000	1000	Handpump
42	M	15000	Yes	satisfactory	Nil	Nil	Nil	Borewell
43	M	11000	Yes	satisfactory	Nil	800	800	Handpump
44	M	15000	Yes	satisfactory	Nil	Nil	Nil	Borewell
45	F	6000	Yes	satisfactory	Nil	Nil	Nil	Handpump
46	F	6000	Yes	satisfactory	Nil	Nil	Nil	Borewell
47	F	15000	Yes	satisfactory	Nil	Nil	Nil	Handpump
48	M	11000	Yes	satisfactory	Nil	Nil	Nil	Borewell
49	M	15000	Yes	satisfactory	Nil	800	800	Handpump
50	F	11000	Yes	satisfactory	Nil	Nil	Nil	Borewell

Table 3:Summarization.

Total water consumption by 50 households	7,46,000 L/month
	or 89,52,000 L/annum
Total money spent by 50 households (water bills + water treatment)	Rs 22,700/year

The Survey Questionnaire comprised of 30 questions which werecompartmentalized into the following heads, given below:

Average Water Consumption pattern

There were five questions in total which were related to the average water consumption pattern of the households and the results are given in Table 4 and Table 5. The average water consumption of whole R.S.Pura town came out to be 4,58,36,800 L/month.

Table 4: Water consumption pattern in the households of R.S.Pura.

No. of households	Water consumed (L/month)	Percentage of households	Total water consumption (L/month)
18	15,000	36%	2,70,000
13	6,000	26%	78,000
10	11,000	20%	1,10,000
9	32,000	18%	2,88,000

Table 5: Water consumption pattern of the whole R.S.Pura town.

No. of households	Average Water Consumption (L/month)
1 household	16,000 L/month
1 person	3,200 L/month
14,324 persons (Whole R.S.Pura town)	4,58,36,800 L/month

Awareness on Sanitation and water availability

The survey revealed that, out of 50 households, 48 households were well aware about the sanitary activities which means out of 250 people, 240 people were well aware about the sanitation & hygiene. However, 2 households were not well aware about the sanitation activities. It means, on an average 96% of the households of R.S.Pura town are aware and 4% of the households of R.S.Pura town are not well aware. From the statistical data, it was found that literacy rate of R.S.Pura block is 70%, and thus 2% of the households are still unaware of the sanitation. As far as the availability of water is concerned, it is available in enormous amount and people are having water in sufficient amount.

Source of water supply

There is handpump or borewell facility available in the R.S.Pura town. The survey revealed that no household in R.S.Pura town is using supply water. Out of 50 households, 30 households (60%) are using borewell water (400-600 feet) and 20 households i.e. 40% are consuming water from the handpump (40-60 feet). The only source of water is ground water.

Monthly income spent on the water bills

The survey revealed that in R.S.Pura, people are not paying any kind of water bills, because most of the households are having hand pumps at their homes. Out of the 50 households, not even a single household is paying water bills.

Money spent on the treatment of water

Out of the 50 households, 22 households (44%) are having water filters, only 3 households (6%) are giving boiling treatment, and 25 households are directly consuming the water without any kind of treatment. The whole R.S.Pura town is spending Rs 1,08,289.44 / month on water treatment (Table 6), which is mainly spent on replacing the water filters twice in an year. The pie chart representation of the results of the survey is shown in Fig. 4.

Table 6: Money being spent on water treatment.

No. of households	Expenditure on water treatment
50 Households (having 5 members)	Rs 22,700 / year
1 Household	Rs 454 / year
1 person	Rs 90.8 / year
1 person	Rs 7.56 / month
14,324 persons (whole R.S.Pura town)	Rs 1,08,289.44 /month

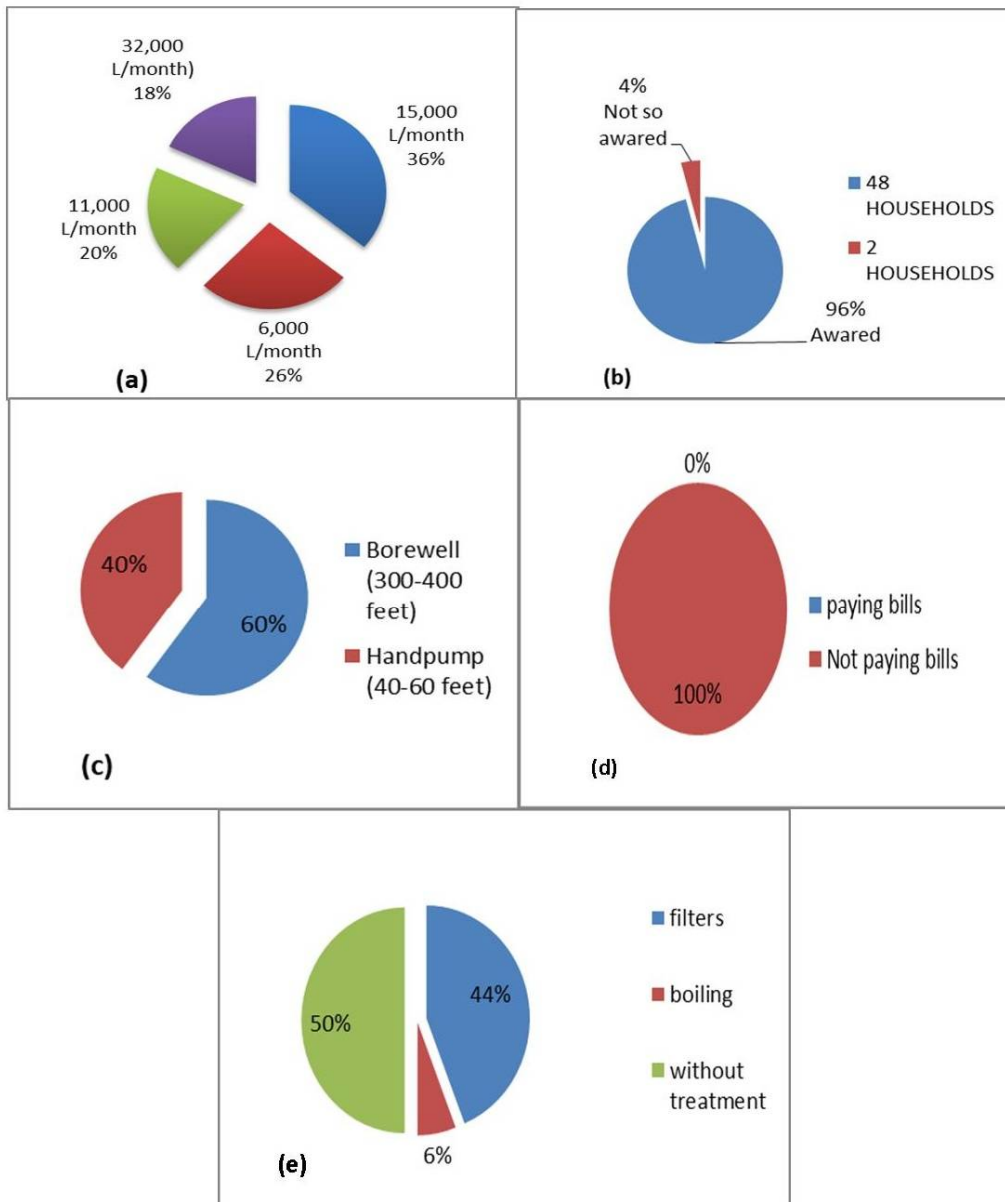


Figure 3. Pie chart representation of (a) Water consumption pattern (b) Awareness regarding sanitation (c) Source of water supply (d) payment of water bills (e) Types of water treatment being given.

DRINKING WATER QUALITY ANALYSIS :**Table 7:**Results of the Physical-chemical analysis of water samples at different locations of block R.S.Pura.

Water quality Parameter	LOCATIONS								
	Chakroi	Miran Sahib	Simbal	Nari Kheper	Kullian	Korotana	R.S.Pura Handpump (40-60 feet)	Salama Chak	R.S.Pura Borewell (300-400 feet)
Colour (Hz)	< 2 Hz	More than 5 and less than 10	More than 2 and less than 5	< 2 Hz	More than 25 and less than 30	< 2 Hz	More than 5 and less than 10	More than 2 and less than 5	< 2 Hz
Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity (NTU)	0.2	3.5	2	0.3	10	0.1	0.6	0.3	0.2
pH	6.96	7.64	7.86	7.05	7.80	7.80	8	6.9	7.75
Total Dissolved Solids (mg/L)	312	284	374	298	246	258	404	392	206
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	630	560	460	680	480	470	730	600	390
Total Hardness(as CaCO_3) mg/L	240	240	190	250	220	190	190	100	210
Calcium(as Ca^{++}) mg/L	74	28	40	52	52	44	28	52	48
Magnesium (as Mg^{++}) mg/L	12.15	41.31	21.87	29.16	21.87	21.87	29.59	7.29	21.6
Total Alkalinity (as CaCO_3) mg/L	850	380	400	660	480	410	400	570	310
Hydroxide (OH^-) mg/L	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Carbonates (CO_3^{2-}) mg/L	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Bicarbonates (HCO_3^-) mg/L	850	380	400	660	480	410	400	570	310
Chloride (as Cl^-) mg/L	14.2	35.5	35.5	14.2	7.1	7.1	78.1	14.2	14.2

Colour, Odour and Turbidity

The colour of water samples were determined by using the protocol IS: 3025 (Part 4). 44% of the samples analyzed showed the value below 2 Hz. However, for the rest 56% of the samples analysed ranged between more than 2Hz less than 5 Hz and more than 5Hz and less than 10 Hz successively, except for the water analysed from the Kullian location, where the value was more than the permissible limit and it is not complying as per IS 10500:2012.

The odour of all the 9 drinking /ground water sample was judged agreeable.

However, turbidity was reported below 1 NTU for 60% of the samples analysed, except for the Kullian location, where the level of turbidity was above the permissible limit and is not complying with IS 10500:2012. For the other 2 locations that is Miran Sahib and Simbal, the value of turbidity was recorded above the acceptable limit, but well below the permissible limit, as mentioned in IS 10500:2012.

pH, Electrical Conductivity and Total Dissolved Solids

The pH of all the 9 water samples analysed was well within the acceptable limit of IS 10500:2012. The pH value ranges between 6.9 to 8, indicating that p- alkanity was altogether absent in all the 9 samples and bicarbonates ions are primarily responsible for contributing to the total alkanity in the drinking water samples of R.S.Pura block.

The electrical conductivity values ranges between 390 -730 $\mu\text{S}/\text{cm}$. For the rest 7 locations, the conductivity value ranges in between 400-680 $\mu\text{S}/\text{cm}$.

The value of Total Dissolved Solids ranges between 206 mg/L to 404 mg/L. The level of Total Dissolved Solids in all the 9 locations analysed was well below the acceptable limit (500mg/L) as laid in IS 10500:2012. Hence, no specific chemical treatment is desired for controlling the level of TDS.

Total Hardness, Calcium, Magnesium and Total Alkalinity

The value of Total Hardness ranges in between 100mg/L to 250 mg/L. 44% of the samples analysed for the parameter Total Hardness, showed the level upto the acceptable limit. However, for the rest 56% samples analysed, the value of Hardness was above the acceptable limit but well below the permissible limit as laid in IS 10500:2012.

The level of Ca and Mg ions in all the 9 water samples analysed was well below the acceptable limit, except for 1 sample from the Miran Sahib location, where the level of Mg shot above the acceptable limit as laid in IS 10500:2012.

The value of total alkanity ranges between 310 mg/L to 850mg/L. 77% of the samples analysed for the parameter total alkanity showed the value above the acceptable limit (200mg/L) but well below the permissible limit (600mg/L) as mentioned in IS 10500:2012. However, for the samples analysed from the location NariKheper and Chakroi, the values of alkanity was exceeding the permissible limit.

Hydroxide, Carbonates, Bicarbonates and Chloride

Hydroxide, Carbonates were altogether absent in all the water samples analysed from 9 different locations in and around R.S.Pura block, giving an indication that bicarbonates ions are primarily responsible for contributing to the Total Alkanity in the drinking/ground water samples of R.S.Pura block. The value of Chloride ranges between 7 mg/L to 78 mg/L. The level of Chloride is well within the acceptable limit as specified in IS 10500:2012.

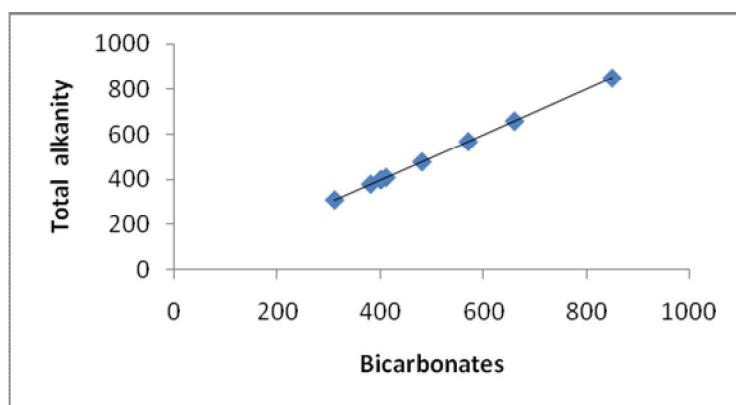


Figure 4.Graph showing correlation between bicarbonates and alkanity.

The graph (Figure 4) reveals that there is a strong (perfect) correlation between bicarbonates and alkanity, giving an indication that bicarbonates are solely responsible for contributing to the total alkanity in the hand pump/bore well water samples of the R.S.Pura block.

The results review that there is a negative correlation ($r = -0.51$) between TDS and Total Hardness. However, a slight positive correlation ($r = 0.18$) was recorded between Total alkanity and TDS.

CONCLUSION

The preliminary findings of the survey revealed that, the average water consumption pattern of R.S.Pura town is 16,000Litres per month per household. The statistical data depicted that the literacy rate of R.S.Pura town is 70%, but inspite of that, only 4% of the household surveyed are not well aware on the issues related to safe drinking water & sanitation practices. The total expenditure on water bills is nil. The whole R.S.Pura town is spending Rs 1,08,289.44 per month on water treatment, which is mainly spend on replacing the water filters twice in an year.P-alkanity was altogether absent in all the water samples analysed, indicating that bicarbonates ions are primarily responsible for contributing to the total alkanity. The level of TDS and Ca is well within the acceptable limit for all the water samples analysed of the R.S.Pura.The present study indicates that water treatment is needed to bring the level of Total Hardness and Total alkanity within the acceptable limit as laid in IS 10500:2012. However no such treatment is needed for Calcium ions.

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