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Physico-Chemical Analysis of Groundwater, RO Water, RO Waste Water and Conservation Strategies

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Abstract - *Water is the most essential component for life and in this challenging time of water stress conditions, our major concern is to have safe and contaminants free water. In order to achieve that, people are majorly dependent on RO treated water. The major disadvantage of RO units is the amount of water discharge as waste. For every unit of unfiltered water, only 25% is obtained as treated while 75% goes as waste water. So, our aim was to focus on the utilization of RO waste water for improving the urban waste water management. The paper presents comparative analysis of the physicochemical property of Ground water, RO water and RO waste water on the basis of this analysis and obtained values, effective ways of conservation and reusability in household and agriculture are recommended while considering their permissible limits.*

***Key Words*: Potable Water, Physico-chemical Analysis, RO, conservation.**

1. INTRODUCTION

Water is one of the fundamental sources of life. As such 71% of Earth's surface is covered with water of which less than 3% is fresh water and out of this 2% is frozen in the form of ice caps and glaciers, only the remaining 1% is accessible for daily consumption in the form of surface and sub surface water (1). Agra falls under semi-arid habitat and on the side of Yamuna basin and has sediments which comprises of sand, silt, clay and kankar. The population of this region is facing problems with availability of drinking water problems due to salinity in ground water from ancient times. Agra has a semi-arid climate which borders the humid subtropical climate. The monsoon in Agra is very light as compared to the rest of the nation. The average rainfall between June and September is 628.6 mm. (2).

Alarmingly, in most of the RO based water purifiers for every unit of raw water only about 25% is obtained as pure water and 75% is rejected as waste. Here a comparative analysis of groundwater, RO water and RO waste water was made to estimate the different physico chemical parameters. As we are already in water stress situation (3), the need of the hour is to conserve water alone with its purification and employ efficient conservation strategies. With the increased in awareness about various water borne diseases and disorders, the demand for reliable water treatment system is increasing not only in metro cities but also in small towns and rural parts of the country. According to the Consumer goods and retail, India residential water purifier market was valued at $391.4 million in 2019 and is projected to grow at CAGR of 13.3% and reach $818 million by 2024.

S.No.	Parameters	Unit	BIS-ISI
1.	pH		6.5 to 8.5
2.	Turbidity	NTU	5-10
3.	Electrical conductivity	µS/cm	-
4.	Total Dissolve Solids	mg/l	200-600
5.	Total Hardness	mg/l	200-600
6.	Calcium Hardness	mg/l	75-200
7.	Magnesium Harness	mg/l	30-100
8.	Total Alkalinity	mg/l	200-600
9.	Chloride	mg/l	250-1000
10.	Nitrate	mg/l	45
11.	Fluoride	mg/l	1-1.5
12.	Sodium	mg/l	250-1000
13.	Potassium	mg/l	10

Table 1. Permissible limits of drinking water (4).

2. MATERIALS AND METHODS

The three types of water sample were taken for this study: Ground water, RO water and RO waste water from the same source of water supply. The analysis was from two different sources, one from Home installed RO unit (HU) and another from a local Public RO water distributer (PU) in Agra city, Uttar Pradesh, India.

One litre of the water sample was collected from the respective source in the USP Class VI autoclavable plastic bottles which are chemically inert (5). In this study, the method adopted for sampling was the grab sample method.

2.1. Physicochemical Characterization

The procedures for testing physicochemical parameters of water were according to "Standard methods for the

examination of water and waste water" (6) and the methods used are to conduct the experiment are tabulated in Table 2. All the tests were performed in the NABL (National Accreditation Board for Testing and Calibration Laboratories) certified level II laboratory of Central Water Commission (CWC), Government of India.

	Physicochemical Parameters	Analytical Method
A.	**Physical**	
1.	Temperature	Mercury Thermometer
2.	pH	Potentiometric
3.	Electrical Conductivity	Conductivity Meter
B.	**Chemical**	
1.	Turbidity	Nephelometric
2.	Total Dissolve Solids	Gravimetric Method
3.	Total Hardness	Complexometric titration
4.	Total Alkalinity	Complexometric titration
5.	Fluoride	SPANDS Method
6.	Sodium	Flame emission photometric
7.	Potassium	Flame emission photometric

Table 2: The tested physico-chemical parameters (6).

3. STATISTICAL ANALYSIS

The data obtained experimentally was analyzed statistically through Mean and Standard Deviation using Graph Pad Prism Software.

4. RESULTS AND DISCUSSION

The result of the physiochemical parameter tested for the ground water, RO water and RO waste water are tabulated in table 3. The result shows the concentration of each parameter at different stages during purification of ground water through RO unit and indicates toward the idea of conservation of RO waste water.

4.1. Temperature

It is a critical parameter which influences the physico-chemical and biological activities of water (7). The temperature of water mainly depended on the meteorological conditions and geographical location. The temperature of all the samples range from10.1-12.1°C is related to the climatic conditions of Agra in winter season during the time of study.

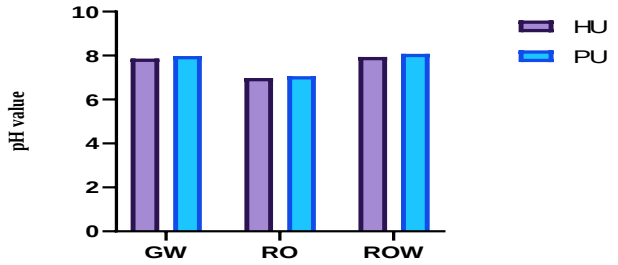
4.2 pH

It is an important operational water quality parameter of water which states the acidity/basicity of the water. From the observed values, it can be seen that the RO waste water is more basic than the Ground water (Table 3, Graph 1). On analyzing both the sample, it can be seen that pH level of RO

S.No.	Parameters ↓	Unit ↓	GW	RO	RW	GW	RO	RW
1.	pH		7.87	6.98	7.94	7.98	7.06	8.08
2.	Electrical Conductivity	µS/cm	2120	1092	1912	1029	120.1	1827
3.	Turbidity	NTU	1.9	1	1.9	2.5	0.4	2.5
4.	TDS	mg/l	1490	105	1890	1380	132	1698
5.	Total Hardness	mg/l	948	132	1376	576	20	632
6.	Calcium Hardness	mg/l	38.6	9.6	20.8	43.2	4.8	20.8
7.	Magnesium Hardness	mg/l	204.48	25.92	317.76	112.32	11.92	139.68
8.	Total alkalinity	mg/l	234.8	182.2	346.4	355.6	234.8	428.6
9.	Chloride	mg/l	152	87.4	93.1	401	36.1	70.3
10.	Nitrate	mg/l	49	3.5	69	66	9.4	71
11.	Fluoride	mg/l	1.1	0.13	1.3	1.2	0.096	1.3
12.	Sodium	mg/l	324.12	41.06	344.52	322.02	34.63	357.72
13.	Potassium	mg/l	3.06	0.34	2.72	4.56	0.44	5.4
			Public Distributer: RO Plant Unit (PU)			Home Installed RO unit (HU)		

Table 3: Physico- chemical parameter values of Ground water (GW), RO water (RO) and RO waste water (RW)

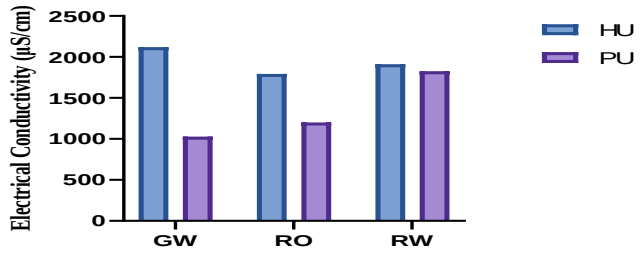
waste water increase by 1% from the ground water and is almost in the range. That comes under the permissible limit for different water usage like agriculture, automobile laundry B, household chores, etc.



Graph 1. pH of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

4.3 Electrical conductivity

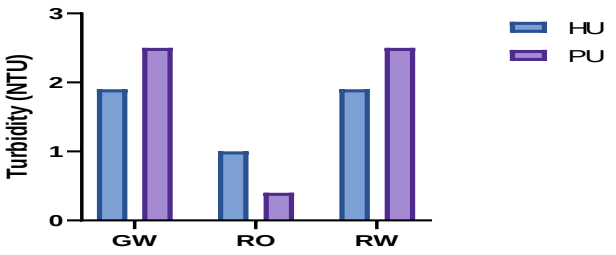
It is the measure of the saltiness of water. EC below 800 µS/cm is been considered to be good for drinking water (8). EC is contributed by number of ions and which is directly related to TDS. In PU sample unit has very high EC and even after RO treatment by the local vendor its quality is not good enough for drinking. The HU sample unit produces low EC of 120.1 µS/cm which is fit for drinking (Table 3, Graph 2). Though the waste effluent from the unit has high EC and the ground water has high EC, due to which dilution of the waste effluent from these plants cannot help in decreasing its EC. The RO discharge can be used only for purpose like agriculture, car wash, floor mopping, cleaning and flushing toilets.



Graph 2. Electrical Conductivity of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

4.4. Turbidity

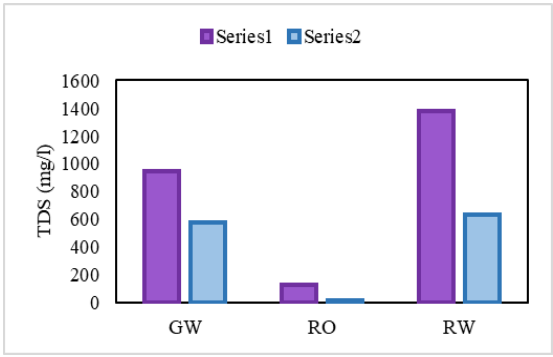
It is the measure of colloidal matter and it is dependent on the quantity of suspended particles. On analyzing the obtained values of both the RO plant, it can be seen that the values are in the permissible range mentioned in Table 1, Graph 3. So, in terms of these it can be used any purpose including the potability.



Graph 3. Turbidity of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

4.5. Total Dissolve Solids

It is a very important parameter for the usability of water. Water is polar in nature because of which it has the ability to dissolve wide range of inorganic and some organic minerals and salts such as: Nitrate, Fluoride, chloride, Sodium, Potassium, calcium, bicarbonates, chloride, magnesium, sulphates etc. and the concentration of these minerals in water is responsible for taste and color of water. The acceptable permissible range for TDS value is up to 600 mg/l (Table 1). In first sample, the TDS value is high even after RO treatment by PU while in case of HU RO unit produced water with TDS 77.4 mg/l (Table 3, Graph 4) which is in the range of permissible limit and under the excellent category i.e., under 300 mg/l. RO discharge has high TDS value. So, it can be used for different purpose like agriculture where TDS up to 2100 mg/l is permissible (9) automobile laundry (1200-1500 mg/l) TDS can be safely used, floor mopping, bathroom uses.

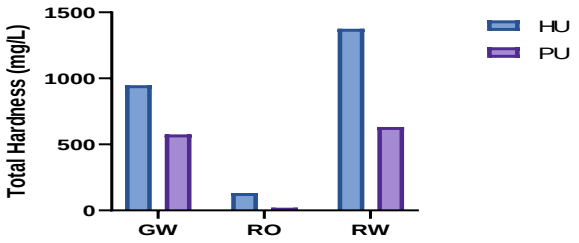


Graph 4. Total Dissolve Solids of Home Installed RO unit (HU, series 1) and Public Distributer: RO Plant Unit (PU, series 2).

4.6. Total Hardness:

It is the measurement of dissolved calcium and magnesium in the water. It is a very important parameter in considering health which indicate its role in health-related problems like heart problems, kidney stones, cancer, cerebro-vascular mortality, Alzheimer, bone mineral density, digestive health and constipation, reproductive health (10). The permissible

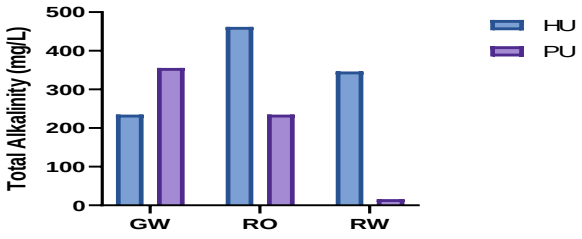
limit of total hardness given by BIS is 200-600 mg/l. On analyzing the PU sample results, it was seen the value of ground water and RO waste water were higher than permissible limit while the RO treated water was below the lower limit of permissible range which rises the health concern regarding the deficiency. In the case of HU, the value obtained for ground water lies within the permissible limit.



Graph 5. Total Hardness of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

4.7. Total Alkalinity

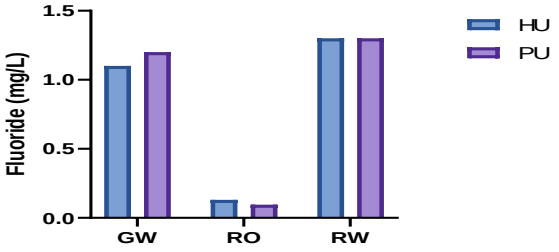
It is the measure of ions which neutralize the H+ in water, ions like bicarbonate, carbonate and hydroxide, respectively. It affects the taste of water. The RO treated water of both samples are in the range of permissible range. While the level of RO waste water was 48% and 21% more than ground water of public distributer RO and home installed unit (Table 3, Graph 6). The alkalinity higher in water causes scaling and its lower level is more likely to be corrosive in nature. Alkaline water with up to pH 8.5 is beneficial in many ways like cooking, cleaning as alkaline water has the ability to break down oil and grease stains. When used with general washables, the properties of alkaline water may allow you to use less detergent. So, it will be beneficiary for wallet, vehicle clean, the electrolyzed water has the ability to get rid of dirt, clay, salt, asphalt, rust and oxide.



Graph 6. Total Alkalinity of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

4.8. Fluoride

It is also an important parameter of water as it is been reported that drinking fluoridator water helps the teeth to be strong and it reduces the chances of cavity by 25% in all age group (11). Water is the major dietary source of fluoride (12). In the other way, it can cause negative impact also like tooth enamel and skeletal fluorosis on prolonged high concentration by consuming water with higher level of fluoride them permissible limit, i.e., 1-1.5 mg/ml. In both the samples, the ground water values come within the permissible limit i.e., 1.1 and 1.2 respectively. While in the case of RO water of both sample values were below the permissible limit which is not good for our health (12). The concentration of RO waste water was higher by 18% and 8% than the ground water in sample 1 and 2 respectively, still they fall under permissible limit (Table 3, Graph 7). So, this water can be used for various purposes like: washing clothes, automobile laundry, toilet flushes, floor mopping, and this water can also be reused for potable water.



Graph 7. Fluoride of Home Installed RO unit (HU) and Public Distributer: RO Plant Unit (PU).

5. CONCLUSION

In this study, it was seen that how enrich is RO discharge water in terms of the physical and chemical parameter concentrations. The discharge water may or may not be used for Potable water treatment unit. But this water can very effectively be used vividly for different purposes as discussed already. This is how we can conserve the water wastage from RO units as 75% of water discharges as waste. Also, with the help of bioremediation technology waste water can be reused for potable and other uses as per the requirements. For example, use of natural products like *Tridax Procumbens* extract, it helps in the reduction of fluoride in water; *Moringa oleifera* extract helps in the reduction of turbidity in water. Both of these extracts have medicinal uses also, which will be an addition benefit. This study encourages, effective management and conservation methods and techniques in these challenging times of water stress condition.

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