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Applied Statistics with Normal vs. Purified Data of Ahmedabad City in Gujarat, India

KEYWORDS: Total Dissolved Solids (TDS), High Desirable Limit (HDL) and Maximum Permissible Limit (MPL)

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ABSTRACT *The microorganisms present in water cause harmful effects in human body. The presence of bacteria and pathogenic (disease-causing) organisms can prove fatal and hence is a matter of great concern when considering the safety of drinking water. The pathogenic organisms can cause intestinal infections, dysentery, hepatitis, typhoid fever, cholera, and other illnesses. The paper discusses results of physicochemical analysis done on various water samples taken from different sources like Tube well and municipality in Ahmedabad, Gujarat, India compared with water purified data collected from Eureka Forbs Pvt. Ltd. The water samples collected from different regions of Ahmedabad were found to have significant impurities, considerable deterioration and remarkable variation. The study contains municipality and tube well collected data vs. water purified data from Eureka Forbs Pvt. Ltd. of the year 2010 and 2011. From the results we can conclude that, both Municipality and Tube well data shows not good quality water and TDS level from both the water is major lies in between High Desirable Limit (HDL) and Maximum Permissible Limit (MPL) we need to purify the water. After RO purifier we got TDS level around 128.16 which is very good quality water for drinking purpose. So our conclusion from this study is we need to purify water with the RO system for drinking purpose especially in Ahmedabad city.*

Introduction
Water plays an essential role in human life. Although statistics vary, the World Health Organisation (WHO) reports that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water (WHO, 2012). Normally water is often used for domestic purposes especially for drinking. Water is the source of all biological lives and their sustenance too. Water for different purposes has its own requirements for the composition and purity and each body of water has to be analysed on a regular basis to confirm the suitability. Drinking contaminated water can cause diarrhoea, cholera, dysentery, and various other diseases like Typhoid, Amoebiasis, Jaundice, Enterobacteriaceae, etc. reported by Arvnabh et al. in 2010. Water contamination can be caused by different types of pathogens (disease causing organisms).

Water contamination is a normal process and we cannot stop that. For getting pure water we need to purify that water through different filtration procedures. Filtration is a process of removing particulate matter from water by forcing the water through a porous media. This porous media can be natural, in the case of sand, gravel and clay, or it can be a membrane wall made of various materials. Sometimes, large particles are settled before filtration; this is called sedimentation. The size of materials that can be removed during filtration depends upon the size of the pores of the filter. Generally we are using three main filtration procedures, Ultrafiltration, Nanofiltration and Reverse Osmosis. These three types of filtration have different membrane filters working differently.

Ultrafiltration (UF) is a variety of membrane filtration in which hydrostatic pressure forces a liquid against a semi permeable membrane. Suspended solids and solutes of high molecular weight are retained, while water and low molecular weight solutes pass through the membrane. This separation process is used in industry and research for purifying and concentrating macromolecular (10^3 - 10^6 Dalton) solutions, especially protein solutions. Neither microfiltration nor ultrafiltration can remove dissolved substances unless they are first adsorbed (with activated carbon) or coagulated (with alum or iron salts).

Nanofiltration (NF) is a relatively recent membrane filtration process used most often with low total dissolved solids water such as surface water and fresh groundwater, with the purpose of softening (polyvalent cation removal) and removal of disinfection by-product precursors such as natural organic matter and synthetic organic matter. Nanofiltration removes most organic molecules, nearly all viruses, most of the natural organic matter and a range of salts. Nanofiltration removes divalent ions, which make water hard, so nanofiltration is often used to soften hard water.

Reverse osmosis (RO) is a membrane-technology filtration method that removes many types of large molecules and ions from solutions by applying pressure to the solution when it is on one side of a selective membrane. The result is that the solute is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. This membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as the solvent) to pass freely. In reverse osmosis, the two solutions are still separated by a semi-permeable membrane, but pressure is applied to reverse the natural flow of the water. This forces the water to move from the more concentrated solution to the weaker. Thus, the contaminants end up on one side of the semi-permeable membrane and the pure water is on the other side.

Total Dissolved Solid (TDS)
Total dissolved solids (TDS) comprise inorganic salts and small amounts of organic matter that are dissolved in water. The principal constituents are usually the cations calcium, magnesium, sodium and potassium and the anions carbonate, bicarbonate, chloride, sulphate and, particularly in groundwater, nitrate (from agricultural use). Total dissolved solids in water supplies originate from natural sources, sewage, urban and agricultural runoff and industrial wastewater. Concentrations of TDS in water vary owing to different mineral solubilities in different geological regions. Alone, a high concentration of dissolved solids is usually not a health hazard. In fact, many people buy mineral water, which has naturally elevated levels of dissolved solids.

The United States Environmental Protection Agency (EPA), which is responsible for drinking water regulations in the United States, includes TDS as a secondary standard, mean-

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ing that it is a voluntary guideline in the United States. While the United States set legal standards for many harmful substances, TDS, along with other contaminants that cause aesthetic, cosmetic and technical effects, has only a guideline. In a study by the World Health Organization, a panel of tasters came to the following conclusions showing in Table 1 about the preferable level of TDS in water:

Table 1 Rating Scale of TDS level for Drinking water by United States Enviornmental Protection (EPA).

Level of TDS (milligrams per litre)	Rating
Less than 300	Excellent
300 - 600	Good
600 - 900	Fair
900 - 2000	Poor
Above 2000	Unacceptable

However, a very low concentration of TDS has been found to give water a flat taste, which is undesirable to many people. Increased concentrations of dissolved solids can also have technical effects. Dissolved solids can produce hard water, which leaves deposits and films on fixtures, and on the insides of hot water pipes and boilers. Soaps and detergents do not produce as much lather with hard water as with soft water. As well, high amounts of dissolved solids can stain household fixtures, corrode pipes, and have a metallic taste. Hard water causes water filters to wear out sooner, because of the amount of minerals in the water.

Water treatment facilities can use reverse osmosis to remove the dissolved solids in the water that are responsible for elevated TDS levels. Reverse osmosis removes virtually all dissolved substances, including many harmful minerals, such as salt and lead. The most important aspect of TDS with respect to drinking water quality is its effect on taste. The palatability of drinking water with a TDS level less than 600 mg/L is generally considered to be good. Drinking water supplies with TDS levels greater than 2000 mg/L are unpalatable to most consumers. Concentrations of TDS above 500 mg/L result in excessive scaling in water pipes, water heaters, boilers and household appliances.

Kiran et al. in the year 2011 were collected different samples of ground water from the locations of Deesa Taluka of Gujarat state of India and analyzed for their physicochemical parameters like Temperature, Colour, Odour, Turbidity, Electrical Conductivity, pH, TDS, Total Alkalinity and concentrations of ions like Fluorides, Calcium, Magnesium and Nitrate. They suggested that water samples were violating the desirable limits and so water quality should be monitoring continuously for the welfare of the human being. Physicochemical analysis such as Temperature, pH, Dissolved Oxygen, TDS, Chlorides, Total Alkalinity, Calicium and Magnesium Hardness, Sulphate, Phosphate, Nitrate and Fluoride of bore wells and lacks drinking water has been checked from 22 sampling stations of Nadiad territory area to assess water quality index reported by Dave et el. in 2010. In the year 2011 physicochemical and bacteriological analysis was done on various water samples taken from different areas of Ahmedabad city. Results were suggested that the water needs to be treated before using it for domestic purposes including drinking by Saxena et al. in 2011.

Materials and Methods

Ahmedabad is the largest city in Gujarat state and sixth largest city (metro city) in India with a population of almost 5 million. It is located on the bank of Sabarmati River at an elevation of 55 meters (180 ft). It is located at 23.030 N and 72.580 E. It has a dry climate. Its highest recorded temperature is 48° C and lowest is 15°C. The average rainfall is 932 mm. Total 56 water samples were collected from municipal and tube well sources in the morning and labeled appropriately from the different areas of Ahmedabad city in the year 2010. Total 14 water samples were collected from municipal and tube well sources in the morning and labelled appropriately. They were from Amraiwadi (3), Maninagar (3), Jashodanagar (3), Hatkeshwar (2) and Vatva (3) areas in 2011. In the year 2011 especially in monsoon season the 15 water samples were collected in the morning by students from their homes from the tap and labeled appropriately which later on brought to K. K. Shah Jarodwala Maninagar Science College laboratory from the different area of Ahmedabad city.

Sample were analysed for various physico-chemical characteristics by standard method in the K. K. Shah Jarodwal Maninagar Science College, Maninagar, Ahmedabad laboratory suggested by Sunilkumar et al. in 1998. The colour, test and odour were reported by direct seeing, smelling and tasting the water sample before chemical analysis. The chemical parameters analyzed were total hardness (TH), calcium hardness (CH), magnesium hardness (MH), chlorinity (CHL), salinity (SAL), Electrical conductivity (EC), Total Dissolved Solids (TDS) and pH. Here we consider TDS as we need to compare that data with purified data.

Eureka Forbs company rank amongst India's Most Admired Consumer Durable Companies and amongst the Best Employers in Asia and India. Pioneers & leaders in water and air purification systems, vacuum cleaners and security systems, company introduced direct selling in India. Eureka Forbs is now one of the largest direct selling companies in the world. With total employee strength exceeding 10,000 including an 8000 strong direct sales force, have operations across 550 plus cities/towns in India.

We collected data from one of the nearest centre of Gujarat University. As we have already discussed in the introduction among three filtration techniques Reverse Osmosis (RO) is best. We collected 50 water sample data of different areas of Ahmedabad city with and without RO system used. Data shows the values before RO system used and after RO system used. Representatives went door to door and collect the data of water sample and checked TDS and suggest the purifier system to the customer.

Results & Discussion

Data Analysis of Year 2010

In the year 2010 we have 56 water samples from the different areas of Ahmedabad city of physicochemical parameter TDS. We have 40 samples from Municipality and 16 samples from Tube well. From the collected data we can say that there are 19 areas where water is within Highest Desirable limit (HDL) of the Beauro of Indian Standard for Drinking Water IS 10500 that is 500 mg/l. That means Bapunagar,Ghodasar, Isanpur, Khokhara, Maninagar, Naroda, Narol, Odhav, Shah-a-alam and Shubhasbridge-RTO are the areas where Municipality drinking water is within the desirable range of drinking water. 21 samples were between HDL and Maximum Permissible Limit (MPL) is rest of them and none of them are above MPL. Mean value of TDS from municipality collected data is 644.9 and minimum value of the data is 175 as well as maximum value is 1619. We can see that collected data from Tube well showing higher value of TDS compared to Municipality. Table 2 shows that there is only one sample who is within the HDL that area is Amraiwadi and one sample from Bopal shows very high TDS 4620 mg/l from Tube well data. There are 14 samples that are between HDL and MPL. Mean value of Tube well data is 1236.4 which is almost double from municipality data. Minimum value of Tube well data is 168 and maximum value is 4620 which is again out of Maximum permissible limit of drinking water.

Table 2 TDS values with their range and Mean, Minimum and Maximum values.

	Municipality	Tube well
Mean	644.9	1236.4
Minimum	175	168

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Maximum	1619	4620
No. of samples below HDL	19	1
No. of samples between HDL and MPL	21	14
No. of samples above MPL	0	1

So based on the data of 2010 we can say that municipality data shows good TDS values compared to Tube well data. So basically water from Municipality has lower value of TDS compare to Tube well water.

Data Analysis of Year 2011 Data

Table 3 shows overall report of 14 sample data of physico-chemical parameter TDS (mg/l) during the year 2011 of different areas of Ahmedabad city. It shows that there are only 5 samples that are within the Highest Desirable Limit which are Amraiwadi, Jashodanagar, Maninagar (3 samples). There are 9 samples that are between the HDL and MPL. There is no sample above the MPL which shows good quality of water. Mean of the data is 695.5 having minimum and maximum values 154 and 1400 respectively.

Table 3 Physicochemical parameter TDS data from different areas of Ahmedabad city during year 2011.

No. of samples below HDL	5
No. of samples between HDL and MPL	9
No. of samples above MPL	0
Total Sample	14
Mean	695.5
Minimum	154
Maximum	1400

Data Analysis of Year 2011 (Monsoon Data)

Students of K. K. Shah Jarodwala Maninagar Science College collected 15 water samples from their home and analyze at college. Table 3.5 shows the area wise data of Ahmedabad city during monsoon season in the year of 2011.

Table 3.5 TDS data of 15 samples of different areas of Ahmedabad city during monsoon season of 2011.

No.	Area	Source	TDS	8	Isanpur	Municipal	175
1	Amraiwadi	Municipal	294	9	Jashodanagar	Tube Well	896
2	Bapunagar	Municipal	203	10	Khokhra	Municipal	228
3	Behrampura	Municipal	497	11	Maninagar	Municipal	462
4	Danilimda	Municipal	840	12	Odhav	Tube Well	438
5	Gita Mandir	Municipal	497	13	Shah-e-alam	Municipal	1127
6	Ghodasar	Municipal	1036	14	Vatva	Municipal	1400
7	Gomtipur	Municipal	483	15	Vejalpur	Municipal	1820

Table 3.6 shows that 8 out of 13 samples of municipality were within the highest desirable limit of drinking water standard those areas are Amraiwadi, Bapunagar, Behrampura, Gita Mandir, Gomtipur, Isanpur, Khokhra and Maninagar. Rest of the samples from municipality were between the HDL and MPL shows in Table 3.5. None of them are above MPL. We have only two samples from Tube well shows that one is within HDL and one is between HDL and MPL. None is above MPL. Mean value, minimum and maximum values of municipality data of monsoon season shows 697.08 mg/l, 1820 mg/l and 175 mg/l respectively. Similarly for Tube well data Mean value, maximum and minimum values are 667 mg/l, 896 mg/l and 438 mg/l respectively. Which proves that municipality and tube well data were well within the highest desirable limits of drinking water standards.

Table 3.6 Mean, minimum and maximum values of TDS for different areas of Ahmedabad city in the monsoon season of year 2011.

	Municipality	Tube well
Mean	697.08	667
Minimum	175	438
Maximum	1820	896
No. of samples below HDL	8	1
No. of samples between HDL and MPL	5	1
No. of samples above MPL	0	0

Data Analysis of year 2012

In the year 2012 Eureka Forbs Company went door to door and collects 50 water samples for the analysis and analyzes physicochemical parameter TDS based on that water samples from the different areas of Ahmedabad city. Table 3.7 shows the TDS data from the Eureka Forbs Company of year 2012.

Table 3.7 Data of physicochemical parameter TDS (mg/l) of Ahmedabad city during year 2012.

No.	TDS (mg/L) From RO	Input TDS	No.	TDS (mg/L) From RO	Input TDS
1	96	1120	26	105	1240
2	106	1214	27	146	1610
3	123	1357	28	175	1860
4	170	1860	29	115	1320
5	95	970	30	119	1475
6	103	1241	31	120	1280
7	90	1324	32	132	1410
8	99	1347	33	173	1895
9	150	1647	34	140	1658
10	98	1210	35	92	1000
11	135	1560	36	140	1645
12	107	1274	37	104	1250
13	114	1300	38	155	1670
14	152	1750	39	176	1920
15	95	1200	40	179	1880
16	102	1345	41	168	1755
17	92	1155	42	164	1810
18	115	1354	43	99	1100
19	103	1287	44	110	1245
20	164	1854	45	132	1490
21	110	1350	46	112	1365
22	170	1860	47	104	1280
23	150	1640	48	110	1240
24	184	2100	49	111	1265
25	138	1627	50	166	1310

From the table 3.5 we have data before Reverse Osmosis procedure done and after the procedure of 50 water samples of Ahmedabad city. We can see from the data that before RO TDs level is very high almost 1458.38 (mg/l) and after RO purifier we have mean value of TDs is 128.16 which is in desirable limit of drinking water standards.

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Conclusion

Water purification is a must doing procedure for drinking purpose of water. As there are lot of pollutants in the drinking water we must do it properly to get pure drinking water. We have data for the year 2010, 2011, 2011(monsoon) and 2012 of water sample of Ahmedabad city. From the results and discussion we can say that from the year 2010 we have good quality water from municipality but not from tube well so we can suggest having water from municipality because Tube well data has high TDs level that can create problems to our health. From 2011 data we can say that there are five samples that are within the highest desirable limit and nine samples are between the HDL and MPL. That shows water is not that much good for drinking purpose and needs to be purified. In the year 2011 monsoon season we have very small samples from Tube well that shows good TDS level. So from monsoon season we can say that municipality and Tube well data are almost same so we can use both type of water but still need to purify water as TDS level is between HDL and MPL have large samples.

As we have discussed that both Municipality and Tube well data shows not good quality water and TDS level from both the water is major lies in between HDL and MPL we need to purify the water. As a water purifier company we have selected Eureka Forbs to purify our water samples. As we have seen after RO purifier we have TDS level around 128.16 which is very good quality water for drinking purpose. So our conclusion from this study is we need to purify water with the RO system for drinking purpose especially in Ahmedabad city.

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REFERENCE

1. Mishra A., Bhatt V. D., Sevak N., Shah P., Patel K and Patel C. 2010. Comparative study of physic-chemical and microbial parameters on lotic and ground waters in selected outlying areas of central Gujarat. Journal of Chemical and Pharmaceutical Research. 2(4): 174-177 | 2. Kiran V. Mehta, July –Sep 2011. Physicochemical and statistical evaluation of ground water of some places of Deesa Taluka in Banaskantha district of Gujarat state (India). International Journal of ChemTech Research. 3(3): 1129-1134. | 3. Dave R. S., Machhar M. T., Patel A. M., Chuhan N. B. And Acharya D. G. 2010. Physisco-chemical analysis of drinking water of Nadiad region (North Gujarat). Der Pharma Chemica. 2(2): 157-162. | 4. Saxena N., Misra S. N. And Shukla R. N. 2011. Physicochemical and Bacteriological analysis of water quality under different environmental condition. Journal of Chemical and Pharmaceutical Research. 3(2): 162-167. | 5. Sunilkumar, M., & Ravindranath, S. 1998. Water Studies: Methods for Monitoring Water Quality. Centre for Environment Education (CEE), Ahmedabad. |