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Analysis of bottled water samples in and around Pune region

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Abstract
The packaged drinking water of different brands is commonly used nowadays. People are conscious about their health and prefer drinking bottled water thinking it to be safe. But, the question is whether it is really safe. The study in the present paper deals with analysis of water using various parameters. All brands available and used in and around Pune region is taken for the analysis. The potability of these water samples is tested by monitoring various physico-chemical parameters and comparing them with the permissible and desirable limits as per the BIS standard specifications.

Keywords: Drinking water, Chemical parameters, hardness, phosphates, nitrates, sulphates

1. Introduction
Water is one of the prime necessities of life. We can hardly live for a few days without water. In a man's body, 70-80% is water. Cell, blood and bones contain 90%, 75%, and 22% water respectively. Drinking water is water intended for human consumption for drinking and cooking purposes from any source. The suitability of drinking water is decided from the recommended daily intakes of each element set at national and international levels. Many essential nutrients are taken from water; high level of these causes toxic effects while lower levels can have adverse effects on humans. Thus, a continual improvement in the quality of water for purposes of drinking, domestic consumption, personal hygiene and certain medical situations is among the top challenges of the world [1]. Contaminants are substances that are dissolved in water and make it unfit for use [2]. Some contaminants can be easily identified only by assessing the taste, odour and turbidity of the water because pure water remains tasteless, colourless and odourless. However, most cannot be easily detected and require testing to reveal whether the water is contaminated. Physico-chemical parameters of water are important to determine the quality of drinking water.

2. Experimental
The water samples of different brands were quantitatively analyzed using standard procedures by APHA (American Public Health Association) [3] used for the following parameters. Permissible limits for drinking water quality according to American Public Health Association (APHA), World Health Organization (WHO) [4], Indian Standard Institution (ISI) [5], Central Pollution Control Board (CPCB) [6] and Indian Council of Medical Research (ICMR) are compared in this article.

2.1 pH: Measurement of pH is done with the help of digital pH meter (Equiptronics model no. EQ-615). The standardization of pH meter(APHA) is done using 0.05M potassium hydrogen phthalate. The pH of six branded samples of cold drinks is measured using the standardized digital pH meter. 50ml of each cold drink sample is taken in a beaker and pH of the sample is measured by dipping the glass electrode.

2.2 Conductivity: The conductivity of the samples is measured with digital conductometer (Equiptronics model no. EQ-665). The standardization of conductometer is done using standard operating procedure (APHA). The conductance of all water samples is measured using the standardized digital conductometer in the range of µmho/cm. The 50ml of each sample is taken in a beaker and conductance is measured using conductivity cell.

2.3 Chlorides: The concentration of chlorides present in the sample is measured using Argentiometric titration method [4] using potassium dichromate indicator. The water samples

were analyzed for the chloride content by taking 25ml of sample in a conical flask, 2-3 drops of potassium dichromate indicator and it is titrated against 0.01M Silver nitrate till the solution changes colour from yellow to brick red colour.

2.4 Alkalinity

The concentration of hydroxides, carbonates and bicarbonates present in the water sample is measured by acid titration method. 25 ml of the given water sample is pipetted out into a conical flask. Two drops of phenolphthalein indicator is added and titrated against 0.02 N H_2SO_4. The end point is the disappearance of pink colour. The titre value is noted and phenolphthalein alkalinity is calculated using this reading. 2-3 drops of methyl orange indicator is added to the same solution after the phenolphthalein end point and the titration is continued until the solution becomes orange. The total titre value is noted for calculation of total alkalinity.

2.5 Calcium: Detection of calcium content is done using a complexometric titration using EDTA and murexide indicator. 25 ml of water samples were taken in a conical flask, 5 ml of NaOH buffer (12-13) and murexide indicator is added in it. The titration is done using 0.01 M EDTA till colour of the solution changes from pink to Purple.

Table 1: Quantitative analysis of different parameters of various brands of bottled water samples

	pH	Conductivity (µmho/cm)	Chlorides (ppm)	Phenolph-thalein Alkalinity mg/L	Total Alkalinity mg/L
Permissible limits	6.5-8.5 BIS, CPCB	2000 BIS, CPCB	250 BIS, WHO	-	600 mg/l CPCB
Brand 1	5.93	1973	291.1	0	56
Brand 2	5.50	232	215.84	0	36
Brand 3	4.56	136	191.7	0	24
Brand 4	4.25	128	180.34	0	16
Brand 5	4.55	161	239.98	0	12
Brand 6	5.25	150	151.94	0	28
Brand 7	4.76	132	198.8	0	12
Brand 8	4.58	241.0	887.5	0	20
Brand 9	5.04	68	778.1	12	100
Brand 10	4.48	31	575.1	0	60
Brand 11	4.65	156	852	4	32
Brand 12	4.64	141	830.7	12	52
Brand 13	5.12	89	915.9	8	36
Brand 14	4.59	17	873.3	16	56
Brand 15	6.41	980	639	0	36
Brand 16	8.27	475	887.5	0	60.0

2.6 Magnesium: Magnesium concentration is detected using a complexometric titration using ethylene di-amine tetra acetic acid and erichrome black T-indicator. 25 ml of water samples were taken in a conical flask, 5 ml of Ammonium buffer (10-11) and murexide indicator is added in it. The titration is done using 0.01 M EDTA till colour of the solution changes from pink to Purple.

2.7 Nitrates: The concentration of nitrates in the samples is detected spectrophotometerically at 220nm. Detection of nitrates from water samples is analyzed by taking 10ml of sample in a test tube, 1ml of 1N HCl is added to it and absorbance of the solution is noted at 220nm using a spectrophotometer (Shimadzu UV-1600).

2.8 Sulphates: The concentration of sulphates in the samples is detected spectrophotometerically at 420nm. Detection of sulphates from branded water samples are analyzed by taking 10ml of sample in a test tube, 1g of BaCl is added to it and absorbance of the solution is noted at 420nm using a spectrophotometer (Shimadzu UV-1600).

Table 2: Quantitative analysis of different parameters of various brands of bottled water samples

	Nitrates (ppm)	Sulphates (ppm)	Phosphates (ppm)	Calcium (ppm)	Magnesium (ppm)
Permissible limits	**50-100 BIS, WHO**	**150-400 BIS, CPCB**	**-**	**40–80 ppm**	**20–30 ppm**
Brand 1	-	294	4.063	43.2	253.44
Brand 2	-	119	2.8354	33.6	86.4
Brand 3	-	76	2.7468	52.8	57.6
Brand 4	-	234	2.7594	48.0	40.32
Brand 5	-	167	2.7341	81.6	63.36
Brand 6	-	98	2.9367	100.8	72.0
Brand 7	-	142	2.8607	72.0	60.48
Brand 8	-	224	2.7848	76.8	72.0
Brand 9	-	53	2.6582	57.6	80.64
Brand 10	-	213	2.6962	105.6	77.76
Brand 11	55.33	107	2.7848	67.2	100.8
Brand 12	42.53	173	2.7341	28.8	77.76
Brand 13	-	150	2.7721	57.6	51.84
Brand 14	-	91	2.8101	48.0	74.88
Brand 15	-	109	2.7721	19.2	92.16
Brand 16	-	569	2.8101	168.0	449.28

2.9 Phosphates: The phosphates are determined phosphovanadomolybdate spectrophotometric method. 25 ml of water sample is taken and a complex of phosphovanadomolybdate formed between the phosphate, ammonium vanadate and ammonium Molybdate is bright yellow in colour. Its absorbance can be measured at 480 nm and concentration of phosphorous and phosphate is calculated.

3. Results and Discussion

Sixteen brands of bottled water samples were quantitatively analyzed for pH, conductivity, chlorides, alkalinity, calcium, magnesium, total hardness, nitrates, sulphates and phosphate. The results for all the parameters are tabulated in Table.3.1 shown below and are compared with the permissible limits given by BIS, CPCB and WHO [4-7].

The examination of results reveals that the pH values range from 4.25-8.27. All the samples except two falls in the acidic range and are lower than the permissible limit. Acidic water has been shown to have no effect on health, or in some cases it may have a negative effect on health and is not a good source of healthy minerals. Conductivity of the samples is found to range from 17-1973 µmhos and are in the permissible limit below 2000 µmhos. Mostly conductivity in bottled water samples show lower values, these results clearly indicate that water in the study area was not considerably ionized and has the lower level of ionic concentration activity due to small dissolved solids.

Alkalinity of water may be due to the presence of one or more of a number of ions. These include hydroxides, carbonates and bicarbonates. Samples analyzed for alkalinity show very low values of total alkalinity from 12-100 mg/L as compared to permissible limit. Minerals like calcium are 30% easier for the body to absorb from water than they are from food. If your water is alkaline, you get healthy minerals in it, if your water is acidic, you can absorb toxins like mercury from it. Alkaline water is better than acidic water for calcium nutrition. From 16 total analyzed samples when compared to permissible limit, the calcium content in four of the samples are higher, three are lower and remaining are in the limit. Inadequate intakes of calcium have been associated with increased risks of osteoporosis, nephrolithiasis (kidney stones), colorectal cancer, hypertension and stroke, coronary artery disease, insulin resistance and obesity [8, 9]. Most of these disorders have treatments, but not cures. Magnesium concentrations in all the samples are above the permissible limit then the recommended dose by bureau of Indian standards (BIS). Magnesium is the fourth most abundant cation in the body and the second most abundant cation in intracellular fluid. Magnesium deficiency has been implicated in the pathogenesis of hypertension, with some epidemiological and experimental studies demonstrating a negative correlation between blood pressure and serum magnesium levels. Increased intake of magnesium salts may cause temporary diarrhoea, but seldom causes hypermagnesaemia in persons with normal kidney function [10, 11]. Public drinking water standards require chloride level not to exceed 250 mg/l. Six bottled water samples are found to have chlorides in the permissible limit while, remaining ten have very high value of chlorides in it. Chlorine alone as (Cl_2) highly toxic, and it is often used a disinfectant. In combination with a metal such as sodium, it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life. Higher level of chlorides affects the palatability of drinking water[12]. When nitrate level in drinking water exceeds 50 mg/l, drinking water becomes the main source of total nitrate intake. The presence of nitrate indicates an old contamination provided nitrites are absent. Excess concentration of nitrate causes disease. Methemoglobin destroys the ability of red blood cell to transport oxygen [13-14]. This condition is especially serious in babies under three months of age. It causes a condition known as methemoglobinemia or “blue baby disease”. The samples when analyzed showed an absence of nitrates in all samples except two samples which showed a permissible level of nitrate in it. Nitrogen is essential for all living things: animals and plants. Nitrogen forms a part of the proteins and DNA that are found in cells. Animals get nitrogen by eating plants and other animals. [11] Seven of the water samples when analyzed for its sulphate content were found to have low levels and one of it has a very high concentration compared to the permissible limit. Sulphates in excess concentration gives a bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odor from hydrogen sulphide gas formation. Taste affected; laxative effect or gastro intestinal irritation. Phosphates in all the samples were found in a normal phosphate concentration. No exact permissible limit is set for it as no health effects are yet been determined due to phosphate[15].

4. Conclusion

The above study reveals that although bottled water is considered to be pure and healthy for drinking it is not recommended as it does not contain essential nutrients up to the necessary levels and daily consumption of it may cause severe health issues.

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