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Comparative Study of the Packaged Drinking Water Processed in Udupi District

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ABSTRACT

The geochemistry of various brands of bottled mineral waters available in Udupi during the season 2014-15 were evaluated for getting more coherent spatial information about the natural variation of element concentration in bottled waters found at the Udupi market. The objective of this study is to investigate the possible relationship between the ground water and the processed water, based on their dissolved mineral content. Results of chemical analysis shows that none out of twelve analyzed bottled waters from Udupi exceeds the permissible limits prescribed as per IS: 10500 norms, thus validating their suitability for human consumption.

Keywords-

Bottled water, Udupi district, Physico-chemical parameters

1. INTRODUCTION

Water is the basic necessity, an indispensable part of life on this planet and the most basic of all necessities [2]. Bottled water is the fastest growing alternative for drinking water vis-à-vis tap water/ boiled water. Some people drink bottled water as an alternative to other beverages; others prefer it because they like its taste or think it is safer than their tap water. Whether it is tap water or bottled water, safe drinking water is essential for good health.

For so many years it was thought that only the natural water is pure without any ingredients such as salts. From the last two decades the drinking water is chemically contaminated due to many reasons. So more importance is paid not only to bacteriological but also to the chemical composition of the drinking and mineral waters. (Chatterjee et al.,1995; Das et al., 1995;Barrett et al., 1998; Nkhuwa, 2003; Cavar et al., 2005) [8].

The focus of this paper is to find out the geochemical characteristics of bottled water available in Udupi district, Karnataka. Basically Udupi is a coastal region, so there may be chances of intrusion of salt water with the ground water. The present study is to assess major ion chemistry of ground water and bottled water to understand geochemical evolution of groundwater to bottled water.The contaminants present in ground water will make significant influences on the manufacturing of bottled water. The quality of water is characterized by a range of physical, chemical and biological parameters, which arise from a variety of natural and human influences. Considering this aspect the present study assesses the quality of groundwater and drinking water.

Water available from various sources like surface, ground or sea and subjected to treatments like filtration (aeration, membrane, sand), demineralization, mineralization, reverse osmosis etc. are called packaged drinking water. The packaged drinking water shall be filled in sealed containers of various capacities that are suitable for direct consumption without further treatment.

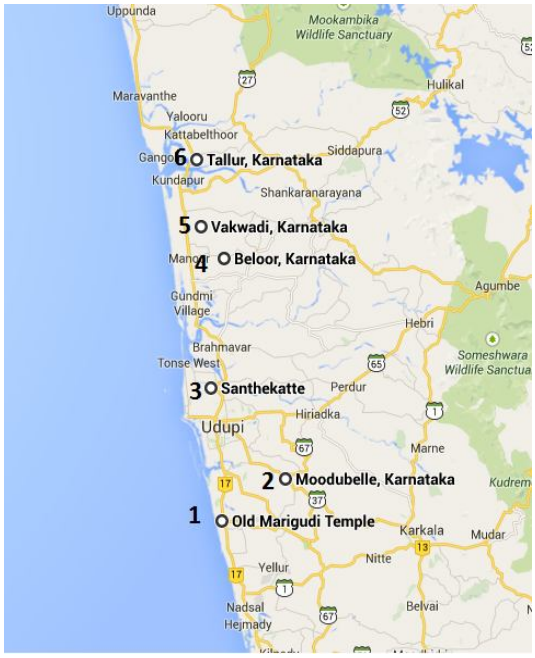

Figure 1. Map representing bottled units

2. SAMPLING AREA

The sampling was carried out in Udupi district. There are six bottling unit plants in Udupi. The raw water and the processed water were collected from the bottling unit during the monsoon season. We are not revealing the brand name of the packaged drinking water. So we are labelling the bottling unit as brand-1, brand-2, etc. up to brand-6. The location of the bottling plants are shown in the figure given below (Fig 1).

3. METHODOLOGY

The water samples from bore well and bottled water were collected in PET bottles and was analyzed for various parameters accordingly. The various brands of bottled water were readily available in the market and the bore well samples were collected from the bottling unit itself. The samples was acidified with ultra-pure Nitric acid (pH< 2) and stored in cool condition to prevent bacterial growth. The samples were analyzed for major ions and trace metals using Ion chromatography and Atomic absorption spectrometry.

3.1 Physico-Chemical Parameters

Physico-chemical parameters of each bottled water and bore well water samples should be analyzed. The parameters are temperature, pH, conductivity, hardness, etc.

3.2 Ion Chromatography

Following are the ions analyzed using Ion Chromatography

Major Ions – Ca^{+2}, Mg^{+2}, Na^{+}, K^{+} , Cl^{-}, SO_4^{2-}, F^{-}, NO_3^{-},PO_4^{3-}

It is a process that allows the separation of ions and polar molecules based on their affinity to the ion exchanger. The solution to be injected is usually called a sample, and the individually separated components are called analytes. Generally the minimum detectable concentrations are near to 0.1mg/L. It is often used in protein purification, water analysis, and quality control.

3.3 Atomic Absorption Spectrometry

Atomic absorption spectroscopy (AAS) is a spectro analytical procedure for the quantitative determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state. The trace elements found out using AAS are Co, Cu. Cd, Cr, Pb, Mn, Ni, and Fe.

4. COMMON TREATMENT PROCESS IN BOTTLED WATER INDUSTRY

The raw water for the bottling plants are ground water, either bore well or open well. The ground water contains bacteria like Shigella, Escherichia Coli, Vibrio, Salmonella, Coliform, Fecal Streptococci, Yeast and Mold etc. which cause symptoms such as nausea, vomiting, diarrhoea and stomach cramps. Due to this prime focus is given to the bacteriological tests rather than chemical treatments.

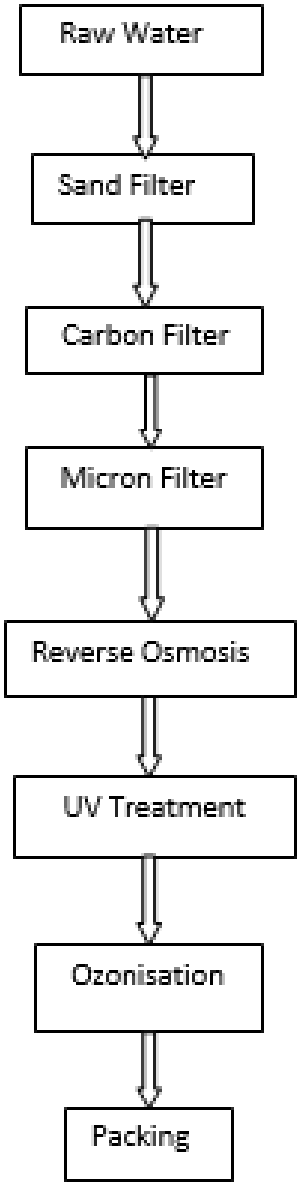

Figure 2. Flow chart of packaged drinking water treatment

Table 1: Results of Udupi packaged drinking water samples

	Brand-1		Brand-2		Brand-3		Brand-4		Brand-5		Brand-6	
Parameters	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated	Raw	Treated
pH	6.32	6.03	6.9	7.14	7.21	7.3	6.27	6.09	7.63	7.19	5.98	6.09
Conductivity (µS/cm)	101.2	16.79	236	15.18	285	35.8	66.4	18.88	371	22	38.5	18.88
TDS (mg/L)	47.6	7.77	117.8	7.38	139.5	17.25	36.5	8.97	178.8	10.25	18.6	8.97
Alkalinity as Bicarbonates (mg/L)	28.06	3.66	139.7	2.44	179.95	19.52	18.91	28.06	204.96	7.93	3.05	1.22
Cd(µg/L)	-	-	-	-	-	-	-		-	-	-	-
Co(µg/L)	6.9	2.7	1.3	5.2	4	1.3	19.2	17	-	-	-	-
Cu(µg/L)	12.9	6.2	11	3.1	11.7	9.7	7.8	5	8.7	7.1	9.9	9.2
Cr(µg/L)	33.5	26.2	29.8	24.6	32.7	19.7	9.4	5.2	33.5	23.5	33.8	19
Fe(µg/L)	-	-	52	-	144	-	6.2	-	24.1	-	-	-
Pb(µg/L)	-	-	-	-	-	-	-	-	-	-	-	-
Mn(µg/L)	8.9	4.4	49.7	4.6	120.1	12.5	14.6	13.8	18.2	6	13.2	12.4
Ni(µg/L)	-	-	-	-	-	-	-	-	-	-	-	-
Na(mg/L)	2.1812	1.8469	9.07	0.638	15.7841	4.6068	5.9877	12.8515	79.507	2.977	2.975	0.451
K(mg/L)	0.4621	0.3898	1.45	0.0634	6.9937	0.631	0.5491	-	5.355	0.176	0.362	0.061
Mg(mg/L)	4.9776	1.0122	31.2	0.122	28.1058	2.1052	3.5789	-	7.793	0.218	1.423	0.283
Ca(mg/L)	0.6682	0.141	12.79	0.036	10.2916	0.3147	0.5492	-	3.596	0.089	0.897	0.110
F(mg/L)	-	-	1.65	-	3.0864	-	-	-	1.423	-	-	-
Cl(mg/L)	27.734	2.6935	24.7	9	22.3051	2.047	27.5068	1.3076	44.329	1.793	18.069	7.179
NO_3 (mg/L)	8.8759	0.8228	-	-	-	1.3181	1.4693	-	-	-	7.160	3.533
PO_4(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
SO_3(mg/L)	27.078	1.5819	19.08	-	4.3336	-	1.0432	-	6.992	-	1.114	0.042

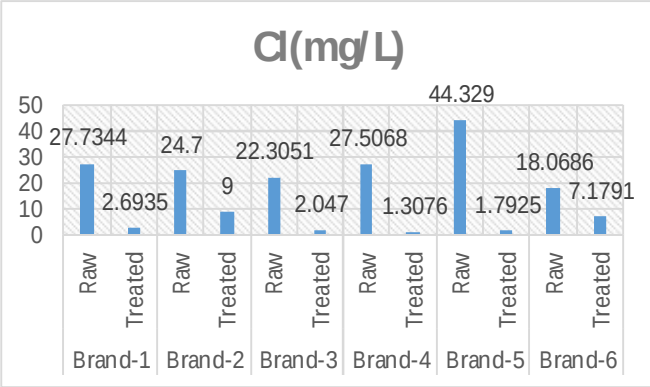

Figure 3. Graph representing Chlorides in Water samples

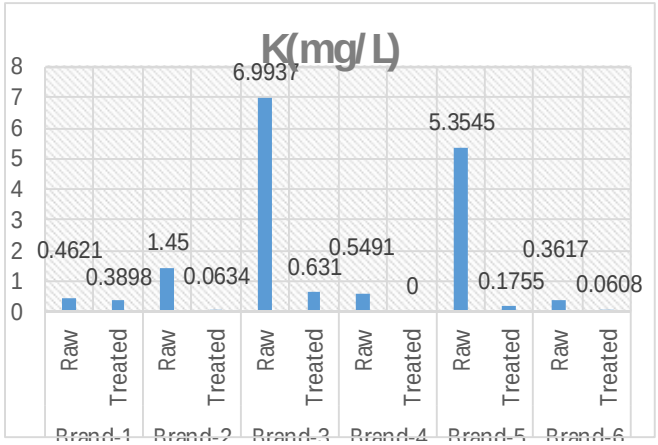

Figure 4. Graph representing Potassium in Water samples

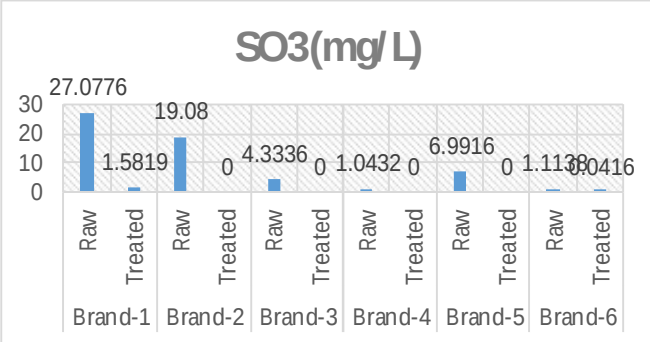

Figure 5. Graph representing Sulphates in Water samples

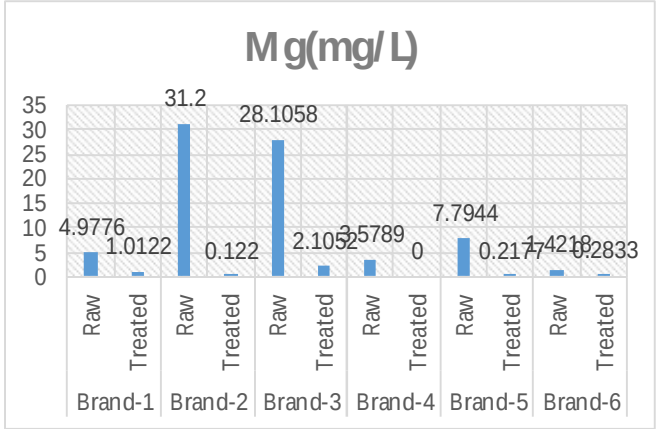

Figure 6. Graph representing Magnesium in Water Sample

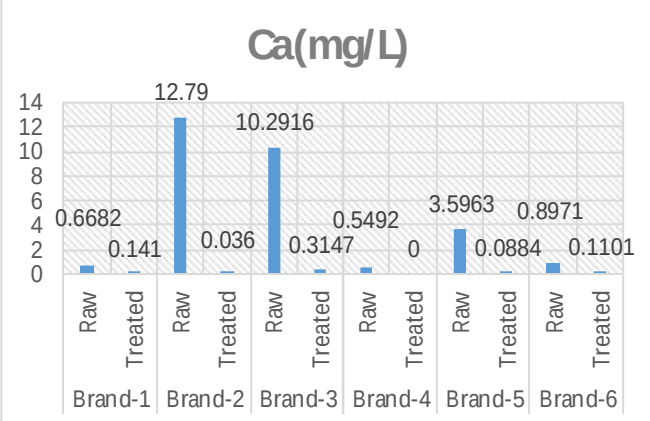

Figure 7. Graph representing Calcium in Water samples

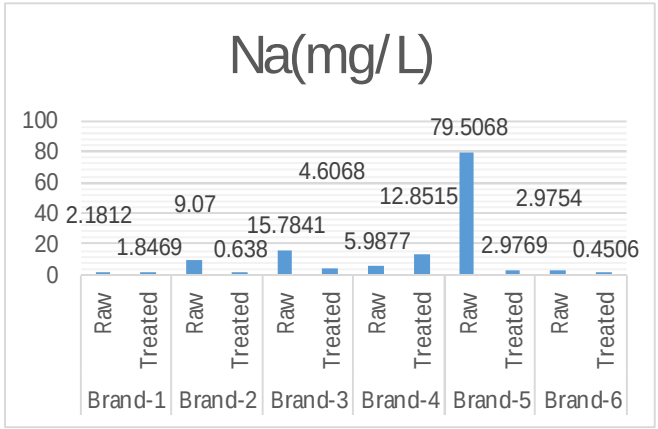

Figure 6. Graph representing Sodium in Water samples

5. RESULTS AND DISCUSSIONS

The analytical results for all the physico-chemical parameters for the monsoon water samples from the study area are presented in Table 1. The pH of the water samples range from 5.98 to 7.63. The lowest pH is noticed in the raw water sample collected from the bottling plant in Tallur. The normal range for pH in packaged drinking water as per the national standard should be between 6.5 and 8.5. All bottled water in Udupi are within the specified range of pH.

Alkalinity is the measure of the ability of water to neutralize acids. It is generally associated with hardness, high pH values and excessive dissolved solids, all of which may be undesirable. HCO3 should not exceed 200 milligrams per litre. All the brands were found well below the permissible limit.

Sodium is an essential mineral in our daily life. It is commonly found in the form of sodium chloride (salt). Salt has no smell and it dissolves easily in water and gives water a salty taste at levels greater than 180 milligrams per litre. All the brands were found well within the maximum permissible limit for sodium as per the national standard [6].

Calcium and Magnesium are important minerals in water, but their abundant level leads to hardness in water. According to Indian Standard Specifications IS: 10500 for drinking water, the desirable limits for Ca and Mg are 75 and 30 mg/L respectively. All the brands were found to be much lower than the desirable limits.

Chloride may be injurious to some people suffering from diseases of the heart or kidneys. Sulphate is a naturally occurring substance that contains sulphur and oxygen. Sulphate is generally considered to be non-toxic. But the consumption of drinking water contains high amount of sulphates leads to intestinal discomfort, diarrhea and consequently dehydration. If fluoride exceeds 1.5 milligram/litre it may result fluorosis, pitting of tooth enamel and deposits in bones and fluoride should present 0.6 milligram/litre to prevent tooth decay and strengthening of skeleton. According to Indian standards desirable limit for chloride and sulphates are 250 and 150 mg/l respectively. All the brands were found well within the desirable limits.

Eight trace elements were analyzed in Atomic Absorption Spectrometry. Among these cadmium, nickel, and lead for both raw water and processed water are less than the detection limits. Iron content shows high value for raw water of brand-3(144 µg/L). After treating the iron brand -3 packaged water became less than detection limits. Manganese also shows comparatively high value for the brand-3 raw water (120.1µg/L). After processing it became 12.5µg/L. All the trace elements concentration of the raw water became less after treatment of all the packaged drinking water in Udupi district.

6. CONCLUSION

In this current study we compared the efficiency of treating raw water to packaged drinking water. This initial study can be the baseline data and also helps to check the quality of water to health related effects towards the packaged drinking water. From the available results, it is concluded that bottling plant at Kaup (brand-1) shows better treatment compare to all other plants in Udupi.

7. SCOPE FOR FUTURE STUDY

The analyzed bottled waters may be compared with other popular / multinational brands of packaged drinking water available in the market. Cost-effective and best available treatment techniques for the production of bottled water has to be explored.

8. ACKNOLEGEMENT

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