ISSN: 2279 - 0594

Journal of Biomedical and Pharmaceutical Research

Available Online at www.jbpr.in

CODEN: - JBPRAU (Source: - American Chemical Society)

Index Copernicus Value: 72.80

PubMed (National Library of Medicine): ID: (101671502)

Volume 6, Issue 6: November-December: 2017, 10-16

Research Article

QUALITY ASSESSMENT OF DIFFERENT BRANDS OF PACKAGED DRINKING WATER AVAILABLE IN INDIAN MARKET

Versha P[1], Dharmender K[1], Vibhu P[2], Alok M[1] and Babita M[3]

[1] Department of Chemistry, Sardar Bhagwan Singh PG Institute of Biomedical Sciences & Research, Balawala, Dehradun, Uttarakhand, India.

[2] Dr.Rajendra Prasad Govt. Medical College, Kangra at Tanda (HP).

[3] Department of Chemistry GGM Science College Jammu

Received 08 Oct. 2017; Accepted 18 Nov. 2017

ABSTRACT

Objective: Water makes up more than two thirds of the weight of the human body. Water is important in homeostasis process to maintain the relatively constant temperatures within the body 80% of the diseases in India are water-borne. The exploration, exploitation and unscientific management of water resources in Dehradun have posed a serious threat of reduction in usage of this supply for drinking purpose thus leading to increased consumption of packaged drinking water.

Method: In present study five brands of packaged drinking water bottles sold in the market of Dehradun city of Uttarakhand were taken and analysed for quality parameters. Physical (colour, odour, taste, temperature conductivity etc.) chemical (hardness, tds tss, total alkalinity, cod, bod etc) and microbiological characteristics (colony count) of these brands were studied and compared to Dehradun supply water on the same lines. Studies were repeated to come to concurrent conclusion.

Results: Present study results showed that physical and chemical characteristics of the brands fulfill all the requirements and comply all standard values in comparison to water supply sample which was found to be unsafe for drinking purpose .Further All the brands were also tested for colony count for bacteria in bottles after 24 and 48 hrs of opening of the bottles.

Conclusion: All brands of packaged drinking water bottles sold in Dehradun city of Uttarakhand are reported to be safe to use in comparison to water supply sample of the city.

Keywords: Contamination, insecticides, pesticides and mineral bottled

1. Introduction

Water makes up more than two third weight of the human body. Water is important in homeostasis process to maintain the relatively constant temperatures within the body. In fact mankind survival depends on water and its proper utilization and management. No doubt it is plentiful in nature, occupying 71% of the earth's surface, only 1 % is accessible for human consumption but the quality of this 1 % drinking-water is a powerful environmental determinant of health, as it has an important impact on health of people. According to World Health Organization (WHO), mortality caused by water associated diseases is more than 5 million per year[1]. Market analysis states that 80% of the diseases in India are water-borne caused due to contaminants like mud, insecticides, pesticides, oils, excess of ions, unwanted minerals, algae, fungus, bacteria, viruses of other unicellular organisms etc. As response to the challenge of providing safe drinking water, recent years have witnessed emergence and tremendous growth of bottled water industry [2]. The global packaged drinking water market is forecast to have a value billions of dollars[3,4]. Mineral bottled water in India under the name 'Bisleri' was first introduced in Mumbai by Bisleri Ltd but now India is among the top ten countries in terms of bottled water consumption. Today, bottled water is one of

*Corresponding author: Versha P | E-mail: vershaparcha@gmail.com

India's fastest growing industrial sectors. The rise in the demand and availability of a large number of commercial brands of bottled water in the market have led to the prescription and enforcement of water standards which are prescribed for maximum permissible levels of different constituents. Dehradun capital of Uttarakhand India is situated at foot hills of shivalik and has a total area of 5203.35 acres including 939.041 acres of private land inhabited by the civil population. The exploration, exploitation and unscientific management of water resources in Dehradun have posed a serious threat of reduction in usage of this supply for drinking purpose thus leading to increased consumption of packaged drinking water. Hence, due to the scanty literature which is available, the present study was done with the aim of evaluating the physical and chemical characteristics of five brands of packaged bottled water which were sold in the market and compared them with water supply sample of Dehradun city (Balawala locality) and of ascertaining compliance with specified International (WHO/FDA/USEPA)[5] and Indian (BIS = IS10500 for bottled drinking water, IS14543 for drinking water) standards Dehradun .

2. Material and methods

Samples of five brands Bisleri, Aquafina,Kinley, Neir and Ganga (A, B C ,D ,E) of bottled water of 1 litres capacity and water supply of the area (F) were collected randomly from local Balawala shops.For analysis of physicochemical parameters, water sample was collected in PVC sampling bottle."Standard Methods for the examination of water and wastewater",[6-12] APHA, 1998) was followed to analyze most of the physicochemical parameters of water .Some parameters such as temperature, pH, dissolved oxygen (DO), hardness, were determined in site while other parameters were determined in the Uttarakhand Jal Sansthan board, Dehradun. These all parameters are discussed below:

2.1. Physical characterstics:

odour and taste: Odour and taste produced by the water are usually cased by the organic and inorganic compound that are dissolved or suspended in the water . taste and odour of all the brands were recorded.

Temperature: Temperature is a very important parameter as it affects chemical reaction rate, gas solubility, viscosity and density. Temperature of water was noted using thermometers.

pH: pH was measured by automatic digital pH meter. The pH meter was first calibrated with a standard buffer solution. The glass electrode was washed with distilled water. Then glass electrode was dipped in the beaker containing water sample until the reading stabilized at a certain point. Then pH reading was noted down.

Conductivity: The instrument used was digital conductivity meter. The conductivity meter was first calibrated with standard potassium chloride solution of 0.01N. Then reading was noted.

Turbidity: Turbidity expresses the optical property that causes light to scatter and absorb instead of transmitting it in a straight line. It is measured either Nephelometric Turbidity Unit(NTU) or Formalin Turbidity Unit(FTU) by turbidity meter.

2.2 Chemical characteristics

Total hardness:

Hardness is caused by the calcium and magnesium ions present in water. Total hardness was determined by EDTA method. This was done by titrating 100mL of sample in a conical flask and adding 1mL of buffer solution with Erichrome Black-T indicator against standard EDTA (ethylene diamine tetra acetic acid). The solution changed from wine blue at the end point. Total hardness might be caused by the sum of all metallic cations other than alkali metals and expressed as equivalent calcium carbonate concentration.

$$\text{Total hardness (as CaCO3), (mg/L)} = \frac{\text{ml of EDTA used} \times N \times 1000}{\text{Vol of sample}}$$

Calcium hardness

Calcium hardness was determined by the same procedure as total hardness. Taking 50mL

sample in a conical flask with 2mL of NaOH solution of 1N was titrated against EDTA solution using murexide indicator. At the end point, pink color changed to purple.

$$\text{Calcium, mg/L (as CaCO3)} = \frac{\text{Vol. of EDTA} \times N \times 40.08 \times 1000}{\text{Vol. of sample}}$$

Magnesium hardness

Magnesium salts occur in significant concentration in natural waters which may be calculated as the difference between total hardness and calcium hardness.
Magnesium hardness, mg/L (as CaCO3) = Total hardness – Calcium hardness

Total alkalinity: Total Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The alkalinity in water is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates etc.

Total alkalinity of water was determined by titrimetric method. 100mL sample in a conical flask with 2-3 drops of methyl orange was titrated against standard, 0.02N H_2SO_4. At the end point, yellow color was changed to pink color.

$$\text{Total Alkalinity (mg/L)} = \frac{a \times N \times 1000 \times 50}{\text{Vol. of sample}}$$

where, a= Volume of standard H_2SO_4 consumed in titration N= Normality of H_2SO_4 used.

Total solids (TS): Total solids were determined as the residues left after evaporation of the unfiltered sample. An evaporating dish of 100 ml capacity was ignited at 550 ± 50 ^oC in muffle furnace for half an hour, cooled in desiccator and weighed. 100 ml of unfiltered sample was taken and evaporated in an evaporating dish on a hot plate at 98 ^oC. The residues left were heated at 103-105 ^oC in an oven for one hour. The evaporating dish was then cooled in desiccators and weighed. TS was calculated as:

$$\text{Total solids in mg/l} = \frac{(A-B) \times 1000}{V}$$

Where, A = Final weight of the dish in gms. B = Initial weight of the dish in gms.
V = Volume of sample taken in ml.

Total dissolved solids (TDS): Total dissolved solids were determined as the residues left after evaporation of the filtered sample. As reported for TS, an evaporating dish of 100 ml capacity was ignited at 550 ± 50^0 C in muffle furnace for half an hour, cooled in desiccators and weighed. 100 ml of filtered sample was added to it and evaporated in a pre-weighed evaporating dish on the hot plate at 98 ^0C. The residue collected were heated at 103-105^oC in an oven for one hour and final weight was taken after cooling the evaporating dish in a desiccator and weighted. TDS was calculated as:

$$\text{Total dissolved solids in mg/l} = \frac{(A-B) \times 1000}{V}$$

Where, A = Final weight of the dish in gms. B = Initial weight of the dish in gms.
V = Volume of sample taken in ml.

Total suspended solids (TSS): It is the difference between the total solids and total dissolved soliods.

TSS (mg/l) = **TS** (mg/l) – **TDS** (mg/l)
Dissolved oxygen (DO) (winkler's method – apha, 1998): For the estimation of dissolved oxygen the water samples were poured with care in BOD bottles without bubble formation. The DO was then fixed at the station itself by adding 1 ml each of manganese sulphate ($MnSO_4$) and alkali-iodate (KI) reagents and brought to the laboratory. The precipitates formed were dissolved by adding 2 ml of concentrated sulphuric acid (H_2SO_4). 100ml sample was taken from this and titrated against 0.1N Sodium thiosulphate. Starch is used as an indicator to estimate iodine generated and the end point is noted as the solution turns from blue to colorless. The DO is calculated using following formula,

$$\text{DO mg/l} = \frac{B.R \times N \times 1000}{\text{Amount of sample taken}}$$

Where, B. R. = Burette Reading (Amount of titrant used). N = Normality of Sodium thio-sulphate.

Chemical oxygen demand (COD): The standard method for indirect measurement of the amount of pollution in a sample of water. The chemical oxygen demand test procedure is based on the chemical decomposition of organic and inorganic contaminants, dissolved or suspended in water. The COD is calculated using following formula,

$$COD\ (mg/L) = \frac{8000\ (ml\ blank - ml\ sample)\ x\ n}{V\ ml\ sample}$$

where, n= normality of ferrous ammonium sulphate.

Biochemical oxygen demand (BOD): Biochemical oxygen measures the amount of oxygen that microorganisms consumes while decomposing organic matter, & measures the chemical oxidation of inorganic matter. Typically the test for BOD is conducted over a five-day period. The BOD is calculated using following formula,

$$BOD\ (mg/l) = \frac{DO_1 - DO_2}{P}$$

Where, DO_1 = DO in water sample in 1st day
DO_5 = DO in water sample in 5th day
P = Decimal volumetric fraction

2.3 Microbiological analysis:

Preparation of media:

The pour-plate method also known as the standard plate count is simple to perform and also is commonly to determine heterotrophic bacteria density .Nutrient agar media a general medium is used for total microbial count in drinking water. Nutrient Agar medium is prepared and sterilized in auto-clave at 121˚C for 15 minutes. Melted the sterile solid agar medium by placing a tube of plate count agar in a beaker of boiling water (each tube contains enough medium for two plates.). Kept the melted medium in a water bath, between 44 and 46 °C, until used. Pipetted diluted sample 0.1 ml into the sterile petri dish. Prepared at least two plates for each different volume of undiluted and diluted sample used .Poured 10ml of liquefied medium (1/2 of the contents of plate count agar tube) into the dish by gently lifting the cover just high enough to pour Mixed the melted medium thoroughly with the sample in the petri dish by rotating the dish in opposite directions or by rotating and tilting .Placed the plates on a level surface and allowed them to solidify dried and placed them in a sealed plastic bag kept in an incubator pre warmed to 35 °C. Incubated the plates for 48 ± 3 hours at 35 ± 0.5 °C. Counted all colonies on the plates promptly after incubation , after 24 hrs and 48 hours.

3 Results:

Present Study was undertaken to evaluate physical, chemical & microbiological characteristics of brands of packaged drinking water (A-E) along with Dehradun supply water (F). Results are shown in the tables.1,2,3 and discussed at appropriate places.

Table1: Physical Characteristics

S.no	BRANDS NAMES	TASTE	ODOUR	TEMP (^{0}c)	pH	CONDUCTIVITY (Ω cm^2)
1	A	Tasteless	Odourless	20.8	6.8	300
2	B	Tasteless	Odourless	21.2	6.5	300
3	C	Tasteless	Odourless	20.5	6.9	300
4	D	Tasteless	Odourless	21.2	6.5	300
5	E	Tasteless	Odourless	21	6.7	300
6	F	Pungy taste	Pungy odour	23	8	370
7	Standard	Tasteless	Odourless	18-27.5	6.5-8.5	250-350

Table 2: Chemical Characteristics

BRANDS NAMES	TOTAL HARDNESS (ppm)	Mg^{+2} (ppm)	Ca^{+2} (ppm)	TOTAL ALKALINITY (ppm)	TOTAL DISSOLVED SOLIDS (mg/l)	COD (mg/l)	BOD (mg/l)
A	215	30	75	220	136.3	15	8
B	200	30	75	235	145.4	18	6
C	210	30	80	225	151.2	12	8
D	207	32	78	245	156	16	7
E	209	32	76	234	153	18	7
F	250	39	209	450	175	10	32
Standard	200-600	30-100	75-200	200-600	130-160	10-40	5-30

Table No3: Microbiological Analysis

BRANDS NAMES	TOTAL COLONY COUNT (o hrs)	TOTAL COLONY COUNT (24 hrs)	TOTAL COLONY COUNT (48hrs)
A	0	0	0
B	2	3	3
C	1	2	3
D	0	0	1
E	1	1	2
F	3	3	4
Standard	0	0	1-2

4. Discussion:

To evaluate quality of water physical, chemical and microbiological characteristics needs to be studied in detail.

Odour and Taste: Odour and taste produced by the water are usually cased by the organic and inorganic compound that are dissolved or suspended in the water. Organic compounds such as petroleum or organic matters on one hand produces both odour and taste to water which affects the aesthetic value as well as health problems to users while inorganic compounds such as minerals and salts usually produces taste to the water. All brands were observed to be tasteless and odourless as compared to Dehradun supply water which was found to be pungent indicating presence of dissolved or suspended impurities in the water and hence not safe for drinking purpose.

Temperature: Temperature is a very important parameter as it affects chemical reaction rate, gas solubility, viscosity and density. In general the rate of chemical reaction increases with increase in water temperature. It was found to be within the limits in all brands except brand F.

pH: pH is the most important parameter to determine the corrosive nature of water . Higher value of pH value indicates corrosive nature of water and has positively correlation with electrical conductance and total alkalinity. All brands exhibited pH range within the permissible limits except brand F which was having alkaline pH thus must be corrosive in nature.

Conductivity: Ground water quality is measured by the method of electrical conductivity. As the salt is more conducive of electricity and if there is more amount of salt in a fixed volume of water the electrical conductivity of the water will be more in comparison to less saline water. The ability of a solution to conduct an electrical current is governed by the migration of solutions and is dependent on the nature and numbers of the ionic species in that solution. This property is called electrical conductivity. It is a useful tool

to assess the purity of water. All brands exhibited conductivity range within the permissible limits except brand Fshowing high value indicative of presence of high salt content in water.

Turbidity: Turbidity is presence of suspended solid and colloidal particles such as clay, finally divided organic and inorganic matters. Turbidity expresses the optical property that causes light to scatter and absorb instead of transmitting it in a straight line. Clarity of water is very important to ensure an acceptable product for human consumption. All brands were clear except brand F where suspended impurities were observed.

Total hardness: Hardness is a measure of metallic cations that are presented in water, like Ca^{+}_{2} and Mg^{+}_{2} as well as Fe^{+}_{2} and Mn^{+}_{2}. This is property of water which prevents the lather formation and leads to excessive usage of soap. It is not health hazardous but definitely economical disadvantages.All brands were within the limits. However brand F was found to be little harder so economically disadvantage.

Alkalinity: Alkalinity in water is due to the presence of bicarbonates, carbonates and hydroxides ions. It can be defined as the quantity of ions in water to neutralize acid or a measure of water strength to neutralize acid. Alkalinity is mainly contributed by the minerals dissolved in water. All brands are little close to standard values except brand F where it was towards higher side of the prescribed limits.

Total solids (TS) & total dissolved solids (TDS): Dissolved solids refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water.

In general, the total dissolved solids concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water. Therefore, the total dissolved solids test provides a qualitative measure of the amount of dissolved ions but does not tell us the nature or ion relationships. An elevated total dissolved solids (TDS) concentration is not a health hazard Therefore; the total dissolved solids test is used as an indicator test to determine the general quality of the water. Brand F again was found to be high in the content thus making it bitter and corrosive as compared to all other brands which are within the limits assigned to normal safe drinking water.

Chemical oxygen demand & biochemical oxygen demand: This is standard method for indirect measurement of the amount of pollution in a sample of water. The chemical oxygen demand test procedure is based on the chemical decomposition of organic and inorganic contaminants, dissolved or suspended in water. Brand F showed low value of COD and higher value of BOD suggesting industrial discharge in the supply while all other brands are within the standard values.

Microbiological analysis:

This is very important parameter to be studied and needs special attention as 80% of the diseases in India are water-borne and caused by the presence of bacteria, viruses and other unicellular organisms. Therefore all brands were analyzed for presence of colonies of bacteria in the sample and also for growth of the same after 24 and 48 hrs so that their shelf life could be seen. It was observed that all brands showed negligible colony count initially and also after 24 hrs but growth increased after 48 hrs of the usage. However brand F was found to be contaminated and is not safe for drinking purpose.

5 Conclusion:

In the present study we used different brands of bottled packaging water to check the quality which brand is better to use & results revealed that all five brands fulfilled all requirements and comply all standard values. So we conclude that all brands are good to use and have almost equal quality justifying their price in the market however water supply of Dehradun is found to be totally unsafe for drinking purpose.

Acknowledgement

The authors gratefully acknowledge to Director and Management of SBSPGI, Balawala, Dehradun, India and Jal Sansthan Dehradun for providing the necessary facilities during this experimental study.

Conflict of interests

The authors declare that there is no conflict of interest..

References

1. Aini M, Fakhru'l-Razi A, Suan K, "Water Crisis Management: Satisfaction Level, Effect and Coping of the Consumers", Water Resour Manag, , 2001;15 ;31–39.
2. ALGhuraiza, Y. and Enshassib, A. "Customers' Satisfaction with Water Supply Service in the Gaza Strip", Build Environment, 2006;41;1243–1250.
3. Ashish S, Hansa K, Basavaraj P, Shilpi S, Khushboo , and Jain S ,Physico-Chemical and Bacterial Evaluation of Packaged Drinking Water Marketed in Delhi - Potential Public Health Implications J. Clin. Diagn. Res, 2014 ; 8(3);246–250.
4. Iftikhar A, "Factors Determining Public Demand for Safe Drinking Water", International Journal of Environmental Research and Public Health, 2010;5 (3); 265-272.
5. AnetteV, "An Analysis of a Bottled Water's Design, Source and Brand and its Influence on Perceived Quality and Purchase Intention", World Journal of Social Sciences, 2007; 2(6); 200 – 217.
6. Standard Methods for the Examination of Water and Wastewater 1999 by American Public Health Association, American Water Works Association, Water Environment Federation
7. Inhorn, S.L., ed.. Quality Assurance Practices for Health Laboratories. American Public Health Assoc., Washington, D.C. 1978.
8. Stanley I,Verner SS,. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. EPA-600/4-83-004, U.S. Environmental Protection Agency, Washington, D.C. 1983.
9. U.S. Environmental Protection Agency. Manual for the Certification of Laboratories Analyzing Drinking Water. EPA-815-B-97-001, U.S. Environmental Protection Agency, Washington, D.C. 1997.
10. International Organization for Standardization. General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC Guide 25. International Org. for Standardization, Geneva, Switzerland. 1990.
11. U.S. Environmental Protection Agency. National Environmental Laboratory Accreditation Conference (NELAC) Notice of Conference and Availability of Standards. Federal Register 59, No. 231. 1994.
12. U.S Environmental Protection Agency. 1995. Good Automated Laboratory Practices. U.S. Environmental Protection Agency, Research Triangle Park, N.C.