CHEMICAL ANALYSIS OF DIFFERENT BRANDS OF BOTTLED WATER WITH WORLD HEALTH ORGANIZATION (WHO) STANDARDS

Adeela Mustafa, Hasnain Azam, Sarmad Ayaz Khan, Hoor ul Ain, Faryal Gul, Muhammad Awais, Inayatullah
1Department of Community Medicine, Khyber Medical College, Peshawar - Pakistan

ABSTRACT

Objective: To assess the quality and compare different brands of bottled drinking water with WHO standards.

Methods: This is a cross-sectional descriptive study conducted in Peshawar, Pakistan in 2022. 14 brands of bottled water were selected randomly by convenient sampling. Brands included were Aqua Divine, Aqua drink, Aqua Green, Aquafina, Nestle mineral water, Aqwah natural, Dasani, Hydrosip, Max 10 water, Muqattar, Truly, Tyrant Aqua, Dua, and Wah water. Two samples of each brand were taken and analyzed for physiochemical parameters, which included color, turbidity, taste, odor, and minerals such as calcium, total solids, nitrates, chloride, and sulphates. Comparison with WHO standards was done using one sample T-test using a one-sample t-test.

Results: According to our results, the pH values obtained were within the WHO range of 6.5-8.5. Chemical parameters such as calcium ranged between 10 mgs/L to 65 mgs/L (WHO level up to 300 mg/L, and Chloride concentration ranged from 20 to 156 mgs/L (WHO standard is 200 mg/L). Total solids were 500mg/L (WHO standard is up to 100mg/L), sulphates were 200 mg/L (WHO standard is up to 500mg/L and nitrates were not detected in any of the samples. Whereas physical properties such as color, odor, and turbidity were normal.

Conclusion: Our study concluded that the bottled drinking water of different brands available in Peshawar city is physiochemically fit for consumption as all the parameters tested were within the permissible limits of WHO.

Keywords: Bottled water, Drinking water, WHO water quality standards, Physiochemical parameters


INTRODUCTION

In Nature, all living things depend on water for routine activities. In the microbial world, no microorganism can survive without water. 1 Humans must have access to adequate, safe, and accessible supplies. Increasing access to clean water for drinking can have very positive effects on health. 2 Social development is associated with water through its impacts on health. Lack of safe drinking water is the main cause of ill health in underdeveloped countries. Positive community health and well-being depends on safe water supply. 3

As per statistics from World Health Organization (WHO 2002), inadequate sanitation and unsafe water contribute to an estimated 1.7 million deaths globally and about 54.2 million disability-adjusted life years (DALYs) annually, with about 80% of children mortality being brought on by diarrhea brought on by consuming tainted water. 4

With a fast-growing population and increasing urbanization in Pakistan, the need for fresh drinking water is increasing daily. There is no quality monitoring of Bottled water quality in developing nations (e.g., Ethiopia, Pakistan, etc.) for human consumption. In several parts of the country, bottled water plants have been established, indicating a rise in demand. 5 In Pakistan, increased public awareness of clean drinking water has encouraged the usage of bottled water, particularly in metropolitan areas. 6 Pakistan is ranked 80th among 122 countries in terms of drinking water quality. Only 20% of Pakistan’s population is said to have availability of clean water to drink. However, the quality and safety of bottled water are in doubt, as many mineral water brands have been found to fall short of WHO and PSQCA criteria in microbiological and chemical tests. 7 The contents of bottled water are not strictly regulated, and the concentration listed on the labels may not be true. According to research conducted in Pakistan, around 52 percent of bottled water was unfit for human consumption. 8 Globally People drink about 13x1010 liters of bottled water during a year. In Pakistan, the use of bottled water increased from 5.9% to 9.5% in recent years. 9

Due to increased demand, there is also increasing concern regarding the quality of bottled mineral water. 10, 11

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WHO had set up a specific concentration range for different chemical ingredients of bottled water, so every brand of bottled water should keep that range in mind to reach the standard and to be in the safe zone in light of health standards.\textsuperscript{12, 13} Essential chemicals i.e., Na, Ca, Nitrate, K, etc. are to be at a specific range for better health of human beings. Any concentration of the ingredients greater or less can cause adverse effects on health.\textsuperscript{14, 15} We focused on the comparison of the chemical ingredients concentration range of the most popular brands of bottled water according to WHO standards. Our study provided a new set of important information on different brands of bottled water in Peshawar city for health benefits. Our studies will provide people the important information about popular brands of bottled water consumed by them, and to choose those brands of water which are according to WHO standards.

MATERIALS AND METHODS

A cross-sectional descriptive design was set for the study. The study was approved by the Ethical review board of Khyber Medical College. The bottled water sample was collected from different shops across the city of Peshawar. Chemical analysis was done in the laboratory of the Community Medicine department, at Khyber Medical College. The sample size was calculated using the WHO formula, \( N=\frac{Z^2 \times P \times (1-P)}{d^2} \). According to this formula, the sample size has to be 245. However, given the lack of many bottled water brands in Peshawar, such a huge sample size was not feasible. Our study included 14 brands, including multinational and local brands, 2 samples for each brand were collected making a total of 28 samples. Non-probability convenient sampling technique was used for the collection of samples. Common brands which are commonly used by people were included in the study and unsealed water bottles were excluded. Each sample was 500ml in volume. Special care was taken to pick out samples that were of a fresh batch. Data was analyzed using SPSS software.

RESULTS

Physical Characteristics: The physical characteristics of the water including color, odor, taste, and turbidity were in the normal range according to the WHO standards. Chemical Properties of different brands' bottled Water: The chemical properties which were analyzed included Chloride, Nitrate, Total solids, Calcium, and sulfate, and their concentration is shown in Table 1 below: According to PSQCA and WHO standards normal Ranges are:

1. PH.6.5
2. Chloride. 200mgs/L
3. T. Solid. 1000 mgs/L
4. Calcium. 300mg/l
5. Sulphate. 200mgs/L
6. Nitrates. 0.1mgs/L.

Table 1: Physical Properties of Mineral Water

<table>
<thead>
<tr>
<th>Colour</th>
<th>Physical Parameter</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>Abnormal</td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Turbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td></td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>Present</td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Taste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>Bad</td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td></td>
<td>28</td>
<td>100%</td>
</tr>
<tr>
<td>Present</td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 2: Chemical properties of different brands of drinking water

<table>
<thead>
<tr>
<th>Brands of bottled water</th>
<th>Chloride concentration mg/L</th>
<th>T. SOLIDS Mg/L</th>
<th>Nitrates mg/L</th>
<th>Calcium Mg/L</th>
<th>Sulphate Mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqua divine</td>
<td>140.00</td>
<td>250.00</td>
<td>Nil</td>
<td>50.00</td>
<td>54.00</td>
</tr>
<tr>
<td>Aqua drink</td>
<td>40.00</td>
<td>230.00</td>
<td>Nil</td>
<td>40.00</td>
<td>55.00</td>
</tr>
<tr>
<td>Aqua green</td>
<td>85.00</td>
<td>330.00</td>
<td>Nil</td>
<td>55.00</td>
<td>48.00</td>
</tr>
<tr>
<td>Aquafina</td>
<td>96.00</td>
<td>190.00</td>
<td>Nil</td>
<td>96.00</td>
<td>64.00</td>
</tr>
<tr>
<td>Aqwah natural</td>
<td>156.00</td>
<td>436.00</td>
<td>Nil</td>
<td>14.00</td>
<td>46.00</td>
</tr>
<tr>
<td>Dasani</td>
<td>20.00</td>
<td>190.00</td>
<td>Nil</td>
<td>140.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Dua</td>
<td>126.00</td>
<td>275.00</td>
<td>Nil</td>
<td>15.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Hydrosip</td>
<td>134.00</td>
<td>290.00</td>
<td>Nil</td>
<td>55.00</td>
<td>64.00</td>
</tr>
<tr>
<td>Max 10 water</td>
<td>136.00</td>
<td>440.00</td>
<td>Nil</td>
<td>18.00</td>
<td>58.00</td>
</tr>
<tr>
<td>Muqattar</td>
<td>140.00</td>
<td>426.00</td>
<td>Nil</td>
<td>50.00</td>
<td>65.00</td>
</tr>
<tr>
<td>Nestle pure life</td>
<td>90.00</td>
<td>205.00</td>
<td>Nil</td>
<td>25.00</td>
<td>45.00</td>
</tr>
<tr>
<td>Truly</td>
<td>148.00</td>
<td>316.00</td>
<td>Nil</td>
<td>46.00</td>
<td>42.00</td>
</tr>
<tr>
<td>Tynant aqua</td>
<td>132.00</td>
<td>320.00</td>
<td>Nil</td>
<td>50.00</td>
<td>63.00</td>
</tr>
<tr>
<td>Wah water</td>
<td>105.00</td>
<td>320.00</td>
<td>Nil</td>
<td>15.00</td>
<td>48.00</td>
</tr>
</tbody>
</table>
The chemical properties of our sample were according to PSQCA &WHO standards. Nitrate was not detected in any of the samples. Chloride concentration ranged from 20 to 156 (mgs/L) which is lower than 200 mgs/L (WHO standard). It is clear from the result that all the water samples have chloride concentrations within the permissible limit of WHO.

The value of calcium ranged between 10 mgs/L to 65 mgs/L. The calcium concentration is less than WHO standard value for calcium (300 mgs/L). Sulphate concentration ranged between 10 mgs/L and 140 mgs/L. Sulphate concentration is also within the normal limit according to WHO standard value for Sulphate (200 mgs/L).

**DISCUSSION**

The physiochemical characteristics of bottled water were found to be according to WHO standards in our study. A study was conducted in Saudi Arabia in which 21 different brands of locally produced bottled water were collected from a market in Riyadh. The concentrations of Ca, Total solids, and pH value were noted from the labels and then samples were analyzed for concentrations of these minerals in the laboratory. The mean level of Ca and pH was found to be higher than that mentioned on the label whereas the TDS was found to be lower than the mean mentioned on the label. While in our study concentrations mentioned on the label were the same as analyzed in the lab and were within the WHO range. 16

A study was carried out in Wadi Al-Shati, Libya. Turbidity results ranged from 0.84 to 1.04 NTU, pH values ranged from 5.63 to 7.45, TDS values ranged from 28 to 303 mg/L, calcium values ranged from 0.4-6 mg/L, while chloride concentrations were 1.3 to 45 mg/L, nitrate was only 37 mg/L and sulfate concentrations were 0 to 73 mg/L. All these parameters’ values were within the recommended WHO standards except pH. While in our study all the parameters complied with WHO standards. 17

A study was carried out in Sudan, where the results when matched to drinking water standards set by WHO, the United States Environmental Protection Agency (EPA), the International Bottled Water Association (IBWA), and the Food and Drug Administration (FDA, all results were discovered to be within the appropriate ranges for acceptance as ours. 18

A study looked into the physical and chemical properties of packed water available in Bangladesh’s capital Dhaka. The investigated parameter values were discovered to be in the following ranges: pH (6.11-6.83), EC (38.3-492.1 S/cm), TDS (24.0-296.80 mg/L), DO (5.88-8.76 mg/L), TH (1.5-228.0 mg/L), Cl- (0.23-2.70 mg/L), NO3 - (0.11-2.98 mg/L), SO4 2- (0.04-111 mg/L), Fe2+ (2.25- The results showed that all other parameter values were quite low and appeared to be within the WHO and Bangladesh Drinking Water Quality Standard (BDWQS) limit. This study’s results were within alignment with our study’s results. 19

A study conducted in Lahore, Pakistan, compared various bottled water available in Lahore for commercial use. The results revealed a significant difference in quality. Data analysis revealed pH ranges of 7.35-7.95, turbidity 2.14-2.48 NTU, TDS 84-183 mg/L, calcium 16-40 mg/L, chloride 35-95 mg/L, sulphates 22–120 mg/L, nitrates 0.9–3.8 mg/L. Matching our study all the values were in the recommended WHO ranges 20

An important limitation of this study is the small sample size but a large sample size is needed so that all available brands are analyzed.

**CONCLUSION**

Our study concluded that the bottled drinking water of different brands available in Peshawar city is physiochemically fit for consumption as all the parameters tested were within the permissible limits of WHO.
REFERENCES


CONFLICT OF INTEREST: Authors declare no conflict of interest

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AUTHOR’S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under

Mustafa A: Main Idea, Research proposal
Azam H: Data Collection and writing
Khan SA: Review and proofreading
Ain HU: Data Collection
Gul F: Review and proofreading
Awais M: Data Collection

Inayatullah: Data Collection

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.