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COMPARISON OF DRINKING WATER BOTTLES OF DIFFERENT COUNTRIES ALONG WITH ZAMZAM WATER

Sajid Mahmood[1*], Syed Tahseen Kazmi[2], Syed Shahzaib Ali[3]

[1] Laboratory Assistance Pakistan Environmental Agency Islamabad,
[2] House Officer (DHQ or Allied) Hospital Faisalabad,
[3] Department of Structures & Environmental Engineering, Faculty of Agricultural Engineering & Technology, University of Agriculture, Faisalabad, Pakistan.

***Corresponding Author Email: searchline2001@yahoo.com**

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ABSTRACT

Bottled water is perceived by many people of Pakistan and other countries as well a safer alternative to other sources of water such as tap water. This may be attributed to consumers disliking the taste of tap water or it's organoleptic. Bottled water usage has increased even in countries where clean tap water is present such as in Germany, Kuwait and Saudi Arabia etc. The objective of present study was to compare the drinkable bottled water quality between different countries along with ZamZam water. Eleven different brands of bottled water including one un- bottled water (zamzam) collected from Pakistan, U.A.E, Kuwait, Germany and Saudi Arabia. They were analyzed for physio-chemical and microbiological parameters for estimation of quality of water. For physio-chemical analysis, the pH meter, EC meter, Flame photometer and UV-Spectrophotometer were used respectively. For bacteriological parameters like Total Coliforms, Fecal Coliform and E. coli, filtration technique is adopted. In this study, comparison of mineral contents with labeled values mentioned on different brands of the countries like Rawdatain(Kuwait), Al-Ain(UAE), and Masafi (UAE) which have difference in actual measured values and labelled but all within WHO and IBWA standards. Bottle water companies claim, the water from different sources such as spring, deep ground and natural water but no doubt it may be taken from different natural sources and they are saying it a mineral water when it was not pass through any treatment processes. These bottles water are actually processed/treated water which does not contain sufficient amount of minerals necessary for the health.

KEYWORDS

Bottled Water, Brands, Tap Water, ZamZam Water, Physiochemical Analysis, Bacteriological analysis, WHO, IBWA, PSQCA, Mineral Content, Purified/Processed water.

1. INTRODUCTION

The basic brick of life on this planet is water. Every living thing depends on water for its existence. Water covers almost 70% of earth surface, making it the most widespread substance on the planet. Out of all the water present on the planet 97.41% is saline and the remaining 2.59% is fresh water. Humans only use less than 1% of this water [1]. Water is essential for the survival of all living things. Water makes up more than two thirds of the weight of the human body. The human brain is made up of 95% water, whereas blood and lungs contain 82% and 90% water respectively (fine waters, 2006) it indirectly helps in, oxygenating, food absorption, temperature controlling, balance coordination and waste removal in our body. Apart from these functions humans need water for domestic use (bathing, washing cooking) and industrial use (cooling, washing, chemical solvent, etc.) [2]. Water is a scarce commodity, and its shortage often results in crises [3,4]. Water is often misused and wasted. It can easily be polluted, and its chemical properties thus alter. According to figures published by the United Nations subsidiary organizations and other international agencies, about 1.1 billion people are without sufficient access to water. And the other 2.4 billion people have to live without adequate sanitation. access to safe drinking water supply is not only a basic need and prerequisite for a healthy life; it is also a fundamental right. The environmental policies about water issues such as the national water policy, national environmental policy etc. and regulatory framework like the environmental protection act 1997 exists in Pakistan. But no strategy has been developed so far to implement this regulatory framework. Government of Pakistan in the early nineteen introduced national environmental quality standards (NEQs) through legislative notification of various counseling committees. The implementation of these NEQs is, however, proceeding at a very slow rate of knots. The world health organization is a part of United Nations (UN) and it focuses on international public health. The WHO documents the guidelines for drinking water quality to help ensure that people are drinking safe water around the world [5]. The WHO guidelines cover microbiological, chemical and physical qualities. However, it is stressed that microbiological quality is the most important since this is the biggest cause of illness and death around the world through pathogens. Although there are several contaminants in water that may be harmful to humans, the first priority is to ensure that drinking water is free of pathogens that cause diseases [5]. According to an estimate given in a report of the leadership for environment and development, by the year 2025 about 52 nations comprising half the world's population will have a severe shortage of potable water. Most of the impacts are related to either water quality or water quantity. The composition of water which is contaminated by disease causing agents (or pathogens) or toxic chemicals can lead to health problems. The usefulness of the maximum available water supply is determined in large part by its quality. There are a number of problems that can affect the quality of the drinking water. Polluted water is unfit for drinking purpose. Some major contaminants of water pollutions are following:

a.) Microbial Contaminants - microorganisms are a part of natural environment. Most have little or no effect on human health. Some microorganisms are beneficial and even essential to human health. Unfortunately, a few microorganisms cause disease when they are present in drinking water. Contaminated water is the major contributor to health hazards. Diseases closely associated with water are classified according to their mode of transmission and the form of infection the four different categories are:

Water-borne diseases: These spread when a pathogen is transmitted by ingestion of contaminated water. Diarrheas, dysentery (Shigella), Cholera (Vibrio Cholera), Typhoid (Salmonella), Hepatitis are water born disease, which affects a large number of peoples.

Water -related diseases: These are caused by pathogens carried by insects that act as mechanical vectors and water provides habitat for insect vectors. Diseases spread by flies, mosquito are also included in this category such as, Loa, Malaria, Filariasis etc.

Water washed Diseases: These include orally spread diseases or diseases spread from one person to another facilitated by a lack of an adequate supply of water for washing. Skin, eyes and Intestinal tract infections are included in this category.

Water-based diseases: These diseases are caused by pathogenic organisms which spend part of their life cycle in aquatic organism. These diseases are caused by parasitic worms. Two common water-based diseases are "Schistosomiasis" (Penetrating, Skin), and "Dracunculiasis" (Swallowed), which is eradicated from Pakistan during 1993. Thus, it is important to note that not all water-related diseases are related to drinking water quality. Safe drinking water or drinking water means that the "level of risk is so small that a reasonable, well-informed individual need not be concerned about it, nor find any rational basis to change his/her behavior to avoid a negligible but non-zero risk." Safe drinking water is one of the most fundamental resources for the protection of public health. Drinking water should be clear, colorless and have no unpleasant taste or Odor. It comes from municipal water systems, wells or springs. It is often treated to remove bacteria and other pathogens and pesticides. In general, water for drinking should be free of harmful bacteriological and chemical components.

b.) Filtered water - filtering describes the physical removal of particles (chlorine, some Suspended substances) through the use of a Fine membrane. It is not possible to filter out bacteria or viruses, due to their size of about 0.001 microns.

c.) Tap water - public water systems disinfected with Chlorine usually provides residual disinfection throughout a public-water distribution system. Chlorination is the most common and effective method for purifying Water. Even under poor sanitary and hygienic conditions, in which people collect whatever water that is available from community tanks, wells, pumps and taps for use in their homes, if water is chlorinated, a dramatic decline in the incidence of water-borne diseases. The efforts of governments and international organizations such as UNICEF and the World Health Organization (WHO) have provided over one billion people access to clean water which they otherwise would not have had, however, there still remains over one billion people who do not have access to safe water supply [6].

d.) Bottled water - any water other than natural mineral water filled hermetically sealed containers for direct consumption, generally disinfected by ozone treatment because of its strong oxidant nature. This process of ozoning does not add any taste. Ozone provides a residual disinfection for a limited time usually up to one year [1]. Bottled water is normally divided into different categories depending on its origin and treatment. The regulation with respect to bottling and microbiological and chemical quality differs between the different categories.

In the European Union (EU), the following 3 categories are used**:**

Natural mineral water: It is defined as microbiologically safe water originating from an underground water reservoir and tapped from one or more springs or extraction wells. The regulation for mineral water is less strict compared to the regulations for tap water. Bottled water sold as natural mineral water can be treated, but only to reduce the contents of Fe, Mg, S, and as. In addition, filtration, decantation, oxidation, and treatment with ozone-enriched air are allowed if they do not alter the elemental composition of the water. Natural mineral water is regulated under the E.U mineral water directive.

Bottled spring water*:* Spring water, namely, groundwater in a natural state but bottled at the source. The bottled spring water must conform to the standards of the EU Drinking Water Directive. Further, it is subjected to many of the requirements of the Natural Mineral Water Directive such as restrictions on treatment and addition of minerals.

Bottled tap water*:* Bottled tap water sourced from filtration plant or municipality supplied taps. Fit for human consumption. Process includes Reverse osmosis and ozoning, bottled tap water is regulated under the same directive as tap water, namely the EU drinking water directive. It must therefore conform to all standards in this directive, which comprises 48 quality parameters, including limit values for anions and cations, conductivity, flavor, color, and microbial quality. Water is an essential food and the human body consists of about 70% water. The general recommendation is for an adult person to consume approximately 2 L of water per day, Bottled water is defined as all types of waters for human consumption marketed in bottles. Sales and consumption of bottled water have hugely increased in recent years. From 1988 to 2002, the global sales of bottled water have more than quadrupled to over 131 million m3 annually. Bottled water was perceived to taste better and be purer, clearer, and safer than tap water. These perceptions of the qualities of water seemed to affect water-drinking preferences and consumption patterns [1,7]. Safe drinking water should be and is among the highest priorities for every nation on earth. Today contaminated water kills and effects more people than cancer, AIDS, wars or accidents all put together.

It is vitally important that the water which humans drink should be free of disease-causing germs and toxic chemicals that pose a threat to human health. Water is an integral part of life, facing quality problem and cause serious health impacts to human beings. The purpose of this study is to compare the accuracy of the physicochemical (pH, turbidity, hardness and (TDS) and bacteriological (T.C and F.C) parameters of the various brands of bottled drinking water in Kuwait, Germany, U.A.E (Sharjah) and Pakistan with that of unbottled water of Saudi Arabia such as Zamzam water. The mineral quantities of different bottle water are judge with the help of Zamzam water and also compare with the tested different quantities of parameters mentioned on the labels of each brands as well as the national and international standards. Some following objectives are to analyze quantities of dissolved minerals and compare them with bottle labels on it. To evaluate the increasing trend in consumer preference of bottled water over tap water. To check the credibility of bottle water manufacturers who sale it as mineral water, natural water, deep water etc. with respect to the definition of mineral water. To compare water Quality analysis of Sharjah, Kuwait, Pakistan and Saudi Arabia (Zamzam) with their national and international standards. To suggest remedial measures for improving the quality of bottled water.

2. METHODOLOGY

This section outlines all the procedures and methods that were used to conduct the current project work on assessment of existing practices and concepts of bottled water. The study will also cover public perceptions, public awareness, increasing consumption and composition of different types of bottled water. The methods chosen specifically to relate to the aims and objectives of the research study. To conduct this study bottled water samples of different brands were collected from three different countries namely Kuwait, Saudi Arabia, United Arab Emirates, (UAE), Germany and Pakistan. So, step on was sampling strategy: The samples were collected in the month of Oct, 2013. Each sample bottle was assigned label included date, time and location. Bottled water is transported to the laboratory of Pakistan Council of Research in Water Resources (PCRWR) for the analysis within the recommended time period. Then step two was experimental study Detailed physiochemical tests were performed on different bottled water samples to determine the pH. conductivity(EC), turbidity, alkalinity, bicarbonates(HC03), magnesium(Mg), calcium(Ca), carbonates(CO_3), chloride(Cl), hardness, nitrates(NO_3), potassium(K), sodium(Na), sulfate(SO4), total dissolved solids (TDS), total coliforms, total E.coli. Some consideration in sampling operations **I.** Physical testing **ii**. Chemical testing **iii.** Bacteriological testing.

2.1 Analysis

The water samples were analyzed for physical, chemical and bacteriological parameters by using standard methods. The details of the parameters and methods used for their analysis are given in Table 1.

Table 1: Water Quality Parameters and methods used for analysis

S. no	Parameters	Analysis Method
1	Alkalinity (m.mol/l as $CaCo_3$)	2320, Standard method (1992)
2	Bicarbonate	2320, Standard Method (1992)
3	Calcium (mg/l)	3500-Ca-D, Standard Method (1992)
4	Carbonate (mg/l)	2320, Standard method (1992)
5	Chloride (mgl)	Titration (Silver Nitrate), Standard Mehod (1992)
6	Color (TCU)	Sensory Test
7	Conductivity (µS/cm)	E.C meter, Hach-44600-00, USA
8	Hardness (mg/l)	EDTA Titration, Standard method (1992)
9	Magnesium (mg/l)	2340-C, Standard Method (1992)
10	Nitrate (mg/l)	Cd. Reduction (Hach-8171) by Spectrophotometer
11	Odor	Sensory Test
12	pH	pH Meter, Hanna Instrument, Model 8519, Italy
13	Potassium (mg/l)	Flame Photometer PFP7, UK
14	Sodium (mg/l)	Flame photometer PFP7, UK
15	Sulfate (mg/l)	Sulfa Ver4 (Hac-8051) by Spectrophotometer
16	TDS (mg/l)	2540C, Standard Method (1992)
17	Turbidity (_NTU)	Turbidity Meter, Lamotte, Model 2008, USA
18	Total Coliform (MPN/100ml)	922-B, Multiple tube Fermentation technique, Standard Methods for the examination of water and waste water
19	E.Coli (MPN/100ml)	922-E, Multiple tube Fermentation technique, standard methods for the examination of water and waste water

2.2 Physical parameters

2.2.1 PH

For most practical purposes the pH of an aqueous solution can be taken as the negative logarithm of the solutions hydrogen ion concentration. The practical pH scale extends from 0 to 14. The pH meter was standardized according to the manufacturer's instructions. Before measuring the pH of the test samples, the electrode was washed thoroughly first with distilled water and then with the sample water. The electrode was then dipped into the sample and the system was allowed to stabilize before making the final reading. Determination was made in unstirred solutions in order to avoid the loss of carbon dioxide or other volatile components.

2.2.2 Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, and valence and on the temperature of measurement. The apparatus used for this analysis was the EC meter, HACH-44600, USA, Jenway, 4320. The samples were shaken thoroughly before taking any measurements and then allowed to stabilize until the removal of any attained air bubble(s). EC meter was standardized with the help of a standard solution of potassium chloride, 0.01 M at a constant temperature of 25°C. The conductivity cell was then thoroughly rinsed with distilled water as well as a small amount of the sample. The beaker was filled with some of the sample. The EC of the samples was noted from the screen of EC meter. Temperature affects conductivity in such that it varies by about 2% per 1°C. The temperature of 25 ºC is taken as standard.

2.2.3 Turbidity

The turbidity is of interest for two main reasons. First, turbidity is an important parameter for characterizing the water quality. Secondly, knowledge of the turbidity allows an estimate to be made of the concentration of un-dissolved substances. The method used for this analysis was the Nephelometric method. The apparatus consisted of a Turbidity meter, Hanna HI 93703. The turbidity method was based on a comparison of the intensity of light scattered by the sample under defined conditions, with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of light means higher the turbidity. "True color" (water color) due to dissolved substances may absorb light and cause low turbidity values. This effect usually is, however not significant in the case of treated water. First press on/off switch wash cuvette properly with deionize water calibrate turbidity with standard of known turbidity 10 NTU fill cuvette up to mark with sample Place the cuvette into the cell the mark on cuvette cap should point the LCD press the read key and LCS will display the reading note the reading and wash the cuvette with deionized water

2.3 Chemical parameters

2.3.1 Alkalinity

Alkalinity of water is its acid-neutralizing capacity. The method used for this analysis is standard method. Take 10 ml sample was mixed with 2 or 3 drops of mixed indicator in a conical flask. The alkalinity of the sample was determined by titrating with a standard acid (HCL 0.02 M) until the color changed from blue to pink.

Total alkalinity as cac03 (mg/lit) = 10001000×B×1000×A×N/V
A= ml of standard acid solution to reach the end point
N= normality of acid used and
V= ml of sample, Analyze method blank before analysis the sample.

2.3.2 Bicarbonate (HCO_3)

Bicarbonates are the dominant anions in most surface and ground waters. No guideline values are recommended by the WHO. The method used for this analysis was the Standard Method
The reagents used for this analysis include:

i) Mixed indicator (bromocresol green + methyl red) and
ii) Standard acid (HCL) 0.02 N
10 ml of the sample was taken in a flask and to it was added one drop of a mixed indicator. It was then titrated against the standard acid until the color changed from bluish green to pink, and the volume of acid used was recorded.

2.3.3 Magnesium (Mg)

Magnesium ranks eighth among the elements in order of abundance and is a common constituent of natural water. Magnesium by a similar action to calcium, imparts the property of hardness to water. The method used for analyzing magnesium concentration was Standard Method. Magnesium was estimated as the difference between hardness and calcium as $CaCO_3$.

Concentration of Mg (mg/l) = [total hardness (as $CaCO_3$ mg/l)-Calcium hardness (as mg
CaC03/l) x 0.243].

2.3.4 Hardness

Total hardness is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligram per liter. The method used for this analysis was the EDTA Titration Standard Method. EDTA forms soluble chelates of calcium and magnesium ions. When a small amount of Eriochrome Black T indicator was added to solution containing calcium and magnesium ions at pH 10.0± 0.1, the solution became wine-red in color. If the solution is titrated with EDTA the calcium and magnesium Ions are complexed and at the end point the color of the solution changes from wine-red to blue. Take 10 ml of the sample and to that add 20 ml of deionized water. One ml of buffer solution and 1-2 drop of Eriochrome Black T indicator was also added. Then, the standard EDTA titrant was added slowly with continuous stirring, until the last red tinge of color disappeared from the solution. The end point of the solution was, normally, blue. The duration of the titration was not extended beyond 5 minutes measured from the time of the addition of the buffer.

Hardness as CaC03 (mg/l) = ((A) xCxlOOO)/V
Where,

A= ml of EDT A for titration of sample;

C can be calculated from the standardization of the EDTA titrant and equivalent to ml of standard calcium solution/ ml of EDT A titrant
V= ml of sample.

2.3.5 Chloride (Cl)

The chloride (Cl) ion is one of the major inorganic anions present in water. In potable water, the salty taste produced by chloride concentrations is variable and dependent on the chemical composition of water. The method used for this analysis was the titration (silver nitrate) standards method. A 20 ml sample was taken in a conical flask. A few drops of K2CrO indicator, solution was added and titrated against a standard solution of AgN0з (titrant), up to a pinkish yellow end point 100 ppm NaCl standard was used to confirm the accuracy.

Concentration of Cl (mg/l) = ((A-B) xNx35.45xl000)/V where,
A and B are the volumes of silver nitrate solution required by the sample and blank respectively;
N = Normality of AgN03 used and V = Volume of sample (ml).

2.3.6 Sodium (Na) & Potassium (K)

Sodium ranks sixth among the elements in order of abundance and is present in most natural waters. The level of Na may vary from less than 1 mg/l to more than 500 mg 11, Potassium ranks seventh among the elements in order of abundance. The method used for the analysis of sodium and potassium was the same emission photometric method (Model: PFP-7, JENW AY, and UK). The principle of the Flame photometer operation is that compounds are thermally dissociated and are further excited to high energy levels and when these atoms return to their ground state they emit radiation which lies mainly in the specific visible region of the spectrum. Light emitted is proportional to the sample concentration. Detection limits of the instrument for sodium and potassium is <0.2 mg/I. After ignition, the filters select control is set at a proper position. The suction rate of the distilled water should be 2-6ml/minute. Blank and standard solutions of various concentrations were aspirated, and fine control was adjusted to have stable positive readings. After blank and standards, samples were aspirated, and the results were noted.

2.3.7 Sulfate (SO4)

Sulfate is an abundant ion in the earth's crust. The method used for analysis of sulfate was the Turbiditimetric Method. The sulfate ion in the sample reacts with barium chloride crystals and forms insoluble barium sulfate turbidity. The amount of turbidity formed is proportional to the Sulfate concentration. UV -VIS Spectrophotometer (Analytic Jena) was used for the analysis. 10 ml of deionized water was taken in a properly washed beaker and 2 ml of Sulphate Buffer solution was added to it followed by an addition of one pinch of Barium chloride crystals. The stirred solution was vigorously for about 1 minute and the absorbance reading was then taken after 5 minutes of reaction time at a wavelength of 420 nm, performed with actual water samples. The concentration was determined from the following equation:

Conc. of sample= Abs. of sample x Conc. of standard/ Abs. of standard

2.3.8 Nitrate (N03)

Nitrogen is commonly present in natural water due to the end product of the aerobic decomposition of organic nitrogenous matter. The method used for the, analysis of Nitrate was the UV Spectrophotometer Method. UV-VIS Spectrophotometer (Analytic Jena) was used for the analysis. 10ml of deionized water was taken in a 25 ml cuvette and to it was added 0.2 ml of IN HCL. It was applied special correction or blank correction, followed by 10ml standard or sample in cuvette, and HCl was then added to it. The absorbance reading was taken at 220nm to measure the nitrate concentration in the sample and at 275nm to determine the organic interference. Subtracted two times the absorbance reading at 275nm from the reading at 220 nm in order to obtain the corrected reading. To determine the concentration, the following equation is used;

Conc. of sample= Abs. of sample x Conc. of standard/ Abs. of standard.

2.3.9 Total Dissolved Solids (TDS)

Measurement for total dissolved solids is a procedure to check the correctness of the analyses. This check does not require additional laboratory analyses. TDS of the water samples was measured in the following way:

Total dissolve solids (TDS) = 0.6 (alkalinity) + Na + K + Ca + Mg + Cl +S04 + N03 + F

If the ratio of the calculated TDS to conductivity falls below 0.55, the lower ion sum is suspect and needs to be reanalyzed. If the ratio is above 0.7, the higher ion sum is also suspect and needs to be reassessed. The acceptable criterion is as follows.

Calculated TDS/Conductivity = 0.55 - 0.70
It the ratio of TDS to EC is outside these limits the measured TDS or measured conductivity is suspect and needs to be reassessed.

2.4 Bacteriological Parameters

The membrane filter technique (MF) is the second method used for the enumeration of fecal coli forms. The membrane filter technique involves passing a portion of sample through a membrane filter. The filter process is designed in such a way as to retain coli form bacteria present in the sample. Prepare M.Endo agar for total coliforms and MFC agar for fecal coliforms, for analysis, the whole assembly of membrane filtration method is washed and sterilized in autoclave at 121 ºC for 15 min. The deionized water for use in this method is also sterilized before use.

2.4.6 Method

Wash the assembly with 90% ethanol and then sterilized with deionized water. Place the filter paper of 0.45 micron at the base of the cup. Then pour sample in the calibrated cup and turn on the motor. It will create the vacuum inside and the sample will be filtered by the filter paper. Turn off the motor and transfer the filter paper with sterilized forceps on the media plates. Repeat this process for another plate. The whole process is carried out in the sterilized area of fume hood. The entire filter with the retained bacteria is placed on a specially prepared media contained in a Petri dish. The Petri dish and its content are next incubated for 24 hours at 44.5°C. At the end of the incubation period, the filter is examined with a 10 - 15X stereoscopic or some other optical device. All blue colored colonies on the filter are counted. Each blue colored colony is assumed to be the result of one fecal coli form originally in the sample. From the colony counting procedure and knowing the sample volume filtered, it is possible to calculate the number of fecal coli form/ 100 ml present in the original sample. The MF technique results in an exact count. The techniques used in the MF procedure are considered more easily mastered than those used in the MPN.

3. RESULTS AND DISCUSSION

Following results have been obtained from and analyzed at Pakistan Council of Research of Water Resources (PCRWR) during the study conducted on the investigation of different parameters of bottled water collected samples from different countries. Water is the most widespread substance on earth. The consumption of water which is contaminated by disease causing agents (or pathogens) or toxic chemicals can lead to health problems [8]. Today contaminated water, kills and effects more people than cancer, AIDS, wars or accidents all put together. It is vitally important that the water which humans drink should be free of disease-causing germs and toxic chemicals that pose a threat to human health. Of all types of contaminants, microbiological contamination poses the greatest risk to public health due to their ability to cause diseases with small infectious doses and can become widespread rather quickly. Also, some microbiological contaminants are extremely persistent. Chemical contaminants are both naturally occurring and the result of anthropogenic activities such as agriculture, water treatment, and industry. Physical contamination occurs when the esthetic quality (e.g., taste, color, and odor) of drinking water is affected. Preventing contamination and implementing sustainable treatment technologies are ways to increase access to safe drinking water [9]. Safe drinking water should be and is among the highest priorities for every nation on earth. Worldwide consumption of bottled water has been steadily increasing with the common perception that bottled water is both healthier and safer to drink than tap water [10]. The World Health Organization (WHO) has provided guidelines for drinking water, which are advisory in nature, and are based on scientific research and epidemiological findings [5]. The values of various water quality parameters recommended by the WHO are the general guidelines as shown in (Table 2). That is why different countries have established their own water quality standards include Pakistan Council of Research and Water Resources (PSQCA), International Bottled Water Association (IBWA), Germany Bottled Water Association (GBWA) Saudi Arabia Standard Organization(SASO) in table 1,3,4 and 5 in order to meet their national priorities, taking into account their economic, technical, social, cultural, and political require merits. During the present study eleven different brands of bottled water included one un-bottled water (zamzam) collected from Pakistan, U.A.E, Kuwait, Germany and Saudi Arabia [11]. They were analyzed for physio-chemical and microbiological parameters for estimation of quality of water [12-14]. The eleven different brands of drinking water as used the proceeding sections are given in table 2.

Table 2: Brands name of samples

Rawdatain Origin	Kuwait natural mineral water. Underground source seeped through desert sand and rock bed.
Masafi Origin	UAE natural mineral water Underground springs in Masafi Mountains (UAE).
Al Ain	U.A.E mineral water. Bottled after RO process.
Apollinarism	Germany natural mineral water.
Zamzam Origin	Saudi Arabia natural mineral water. Underground source in mountains of Makkah with religious significance and known for its unique natural characteristics and taste.

Nestle, Sparkle, Kinley, Aquafina, Springle, and Verbena these all brands of bottled mineral water collected from Pakistan.

In the following tables the value of samples has been compared with their labels and national standards for bottled drinking water. These are the standards given or regulated by the government

Table 3: Compared values of different brands of Pakistan with their labels and PSQCA standards.

Physical parameter

Sr. No	Parameters	PSQCA	Label	Sparkle	Kinley	Aquafina	Nestle	Springle	Verbena
1	PH	6.5	6.5-8.5	7.39	7.6	7.6	7.26	7.65	7.18
2	Electrical conductivity (µS/cm)	-	-	538	655	193	358	510	412
3	Turbidity(NTU)	-	-	BDL	BDL	BDL	BDL	BDL	BDL

Chemical parameters

Sr.No	Parameters	PSQCA standards	Label	Sparkle	Kinley	Aquafina	Nestle	Springle	Verbena
1	Alkalinity(mg/l)	-	-	-	-	-	-	-	-
2	Bicarbonates(mg/l)	-		105	115	15	25	245	40
3	Calcium(mg/l)	100	40-70	32	40	BDL	52	56	44
4	Carbonates(mg/l)	-		BDL	BDL	BDL	BDL	BDL	BDL
5	Chloride (mg/l)	250	70-150	46	169	24	86	11	83
6	Hardness(mg/l)	-		120	160	50	150	250	170
7	Magnesium (mg/l)	50	4-15	12	15	12	5	27	15
8	Potassium((mg/l)	10	0.02-5	2.2	2.4	1	0.2	1.2	BDL
9	Sodium (mg/l)	50	7-30	75	58	18	11	21	9
10	Sulphate (mg/l)	250	12-50	39	32	48	44	16	BDL
11	Nitrates(mg/l)	10		1	BDL	BDL	BDL	3	BDL
12	Total dissolved solids (mg/l)	500	160-350	296	360	106	196	281	227

Biological parameters

Sr. No	Parameters	PSQCA standards	Sparkle	Kinley	Aquafina	Nestle	Springle	Verbena
1	Total coliform	0/100ml	Nil	Nil	Nil	Nil	Nil	Nil
2	Fecal coliform	0/100ml	Nil	Nil	Nil	Nil	Nil	Nil
3	E.coli	0/100ml	Nil	Nil	Nil	Nil	Nil	4

Table 4: Compared value of Kuwait's bottled water with its label and WHO standard

Physical parameters

Sr.No	Parameters	WHO standards	Label of Rawdatain	Rawdatain
1	PH	6.5-8.5	7.5	7.31
2	Electrical conductivity (µS/cm)	-	-	294
3	Turbidity(NTU)	-	-	BDL

Chemical parameters

Sr.No	Parameters	WHO standards	Label of Rawdatain	Rawdatain
1	Alkalinity(mg/l)	-	-	49
2	Bicarbonates(mg/l)	125-350	58	49

3	Calcium(mg/l)	100	36	29
4	Carbonates(mg/l)	-	-	BDL
5	Chloride (mg/l)	250	17.8	54
6	Hardness(mg/l)	500		112
7	Magnesium (mg/l)	50	4.9	10
8	Potassium((mg/l)	12	2	2.1
9	Sodium (mg/l)	200	9.9	11
10	Sulphate (mg/l)	250	56	9
11	Nitrates(mg/l)	50	6.8	0.06
12	Total dissolved solids (mg/l)	1000	-	162

Biological parameters

Sr.No	Parameters	WHO standards	Rawdatain
1	Total coliform	0/100ml	Nil
2	Fecal coliform	0/100ml	Nil
3	E.coli	0/100ml	Nil

Table 5: Compared values of U.A. E's bottled water with their labels and IBWA standards.

Physical parameters

Sr.No	Parameters	IBWA standards	Label of Alain	Alain	Label of Masafi	Masafi
1	PH	6.5-8.5	7.3	7.29	7.8	7.87
2	Electrical conductivity (µS/cm)	-	-	228	-	260
3	Turbidity (NTU)	-	-	BDL	-	BDL

Chemical parameters

Sr.No	Parameters	IBWA standards	Label of AlAin	Alain	Label of Masafi	Masafi
1	Alkalinity(mg/l)	-	-	41		41
2	Bicarbonates(mg/l)	-	50	41	27	41
3	Calcium(mg/l)	-	8	31	3.4	2
4	Carbonates(mg/l)	-	-	BDL	-	BDL
5	Chloride (mg/l)	250	40	48	47	60
6	Hardness(mg/l)	-	75	107	-	127
7	Magnesium (mg/l)	-	1.1	7	19	30
8	Potassium((mg/l)	-	2	5.4	0.2	0.6
9	Sodium (mg/l)	-	8	5	10	14
10	Sulphate (mg/l)	250	5	4	19	5
11	Nitrates(mg/l)	44	0.10	0.1	0.4	BDL
12	Total dissolved solids (mg/l)	500	110	125	143	120-180

Biological parameters

Sr.No	Parameters	IBWA standards	Alain	Masafi
1	Total coliform	0/100ml	Nil	Nil
2	Fecal coliform	0/100ml	Nil	Nil
3	E. coli	0/100ml	Nil	Nil

Table 6: Compared value of Germany's bottled water with its label and GBWA standards

Physical parameters

Sr.No	Parameters	GBWA standards	Label of Apollinaris	Apollinaris
1	PH	6.5-9.5	-	6.9
2	Electricalconductivity (µS/cm)	-	-	262
3	Turbidity (NTU)	-	-	BDL

Chemical parameters

Sr.No	Parameters	GBWA standards	Label of Apollinaris	Apollinaris
1	Alkalinity(mg/l)	-	-	-

2	Bicarbonates(mg/l)	-	-	25
3	Calcium(mg/l)	400	100	24
4	Carbonates(mg/l)	-	-	BDL
5	Chloride (mg/l)	50	100	41
6	Hardness(mg/l)	-	-	130
7	Magnesium (mg/l)	50	130	17
8	Potassium((mg/l)	12	20	2.1
9	Sodium (mg/l)	150	410	11
10	Sulphate (mg/l)	240	80	70
11	Nitrates(mg/l)	50	1.6	0.8
12	Total dissolved solids (mg/l)	-	2767	183

Biological parameters

Sr.No	Parameters	GBWA standards	Apollinaris
1	Total coliform	0/100ml	Nil
2	Fecal coliform	0/100ml	Nil
3	E.coli	0/100ml	Nil

Physical parameters

Sr.No	Parameters	SASO standards	Zamzam
1	PH	6.5-8.5	7.56
2	Electrical conductivity (µS/cm)	-	1012
3	Turbidity (NTU)	-	BDL

Table 7: Compared the values of Zamzam water with SASO standards

Chemical parameters

Sr.No	Parameters	SASO standards	Zamzam
1	Alkalinity(mg/l)	-	
2	Bicarbonates(mg/l)	-	240
3	Calcium(mg/l)	200	112
4	Carbonates(mg/l)	-	BDL
5	Chloride (mg/l)	150	112
6	Hardness(mg/l)	200	320
7	Magnesium (mg/l)	150	10
8	Potassium((mg/l)	-	44
9	Sodium (mg/l)	100	110
10	Sulphate (mg/l)	150	124
11	Nitrates(mg/l)	50	8
12	Total dissolved solids (mg/l)	100-500	627

Biological parameters

Sr.No	Parameters	SASO standards	Zamzam
1	Total coliform	0/100ml	Nil
2	Fecal coliform	0/100ml	Nil
3	E.coli	0/100ml	Nil

The following graph show relative comparison of mineral contents among different countries bottle water brand along with unbottled natural water of Saudi Arabia. the brands like Rawdatain, Alain, Masafi, Apollinaris, Springle, Kinley, Sparkle, Aquafina, Nestle, Verbena and Zamzam having pH values more than the 7.00 (neutral value) except the brand of Germany which is 6.9 less than neutral value. According to these tested values we can say that, all the brands are slightly alkaline except the Apollinaris brand of Germany which is slightly acidic. Among other parameters like, bicarbonate, carbonate, calcium magnesium, sodium, potassium, chloride, sulphate, nitrate and TDS we found unusual higher concentrations in one of the tested brand of Pakistan, Kinley having chloride, and TDS concentration are 169 and 360 respectively. the microbial level of different bottle water and one un bottled water (Zamzam) show not any type of bacteria (Total coliform, E.coli etc.) except in one Pakistani Brand (Verbena).The nitrate level of this brand is below the detection limit which not conform with it bottle labeled value. The primary health concern regarding NO_3 is the formation of methemoglobinemia, a so-called 'blue-baby syndrome'. NO_3 can change to NO2 in the stomach of infants, which can then oxidize hemoglobin to methemoglobin, making it difficult to transport oxygen around the body. In Italy, a limit of 10 mg/L NO3 has been recommended for the water destined to infants. Concentrations of Na varied from 5 to 75 mg/L. None of the values exceeded the maximum limit of different standards. Most of the water brands contain lower amounts of Na except Zamzam water which is 110 mg/L. An excess of Na>200 mg/L in drinking water may cause a salty taste or odor, as well. (STACKCLOUM)

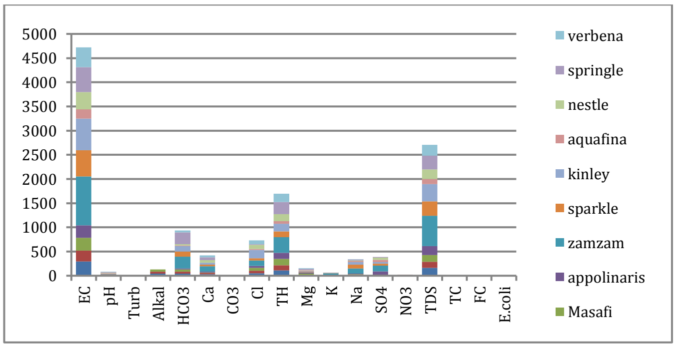


Figure 1: Overall graphical representation of different parameters in bottle water of different countries

The below graph between tested value of Kuwait's brand and its labeled values like pH, HCO3, calcium, sulphate, nitrate are lower than the tested values except the concentrations of chloride, magnesium are higher than its labeled values. Only few tested parameters like sodium, potassium nearly equal to the values mentioned on the bottle labeled.

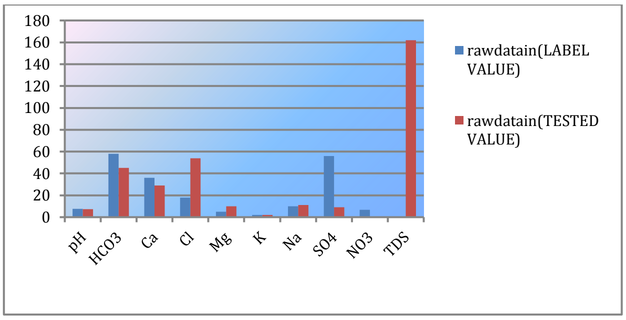


Figure 2: Comparison of mineral contents in tested and labeled bottle water (Kuwait)

The graph of Kuwait bottled water brand show all the values within the WHO standards values.

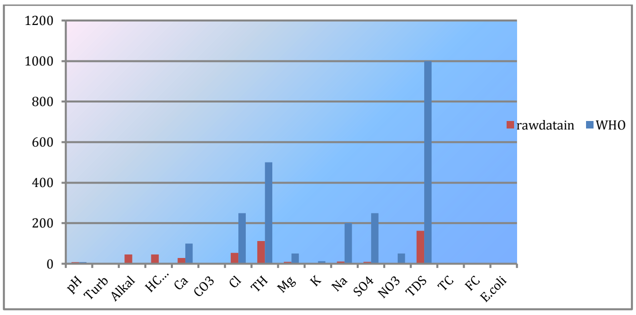


Figure 3: Comparison of mineral contents in tested with who standard values (Kuwait)

The following graph show the brand like Al-Ain having tested values of magnesium, sodium, sulphate, nitrate and TDS are lower except the values of calcium and chloride which is higher than -the values mentioned on the label. While the concentrations of parameters like pH, bicarbonate, and somewhat TDS are almost equal to the values on the label.

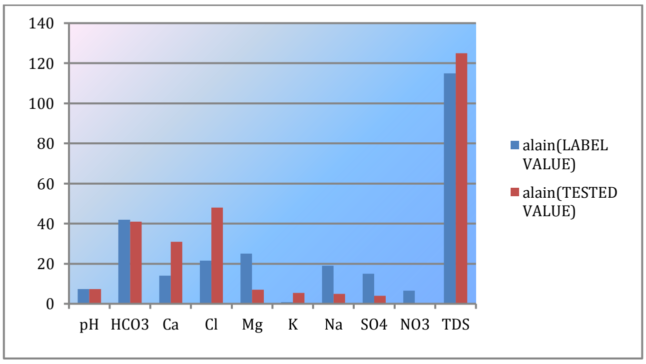


Figure 4: Comparison of mineral contents in tested and labeled bottle water (U.A.E)

The following graph show the brand Masafi having tested values of sulphate, nitrate and TDS are lower, except the values of bicarbonate, sodium and chloride which are higher than the values mentioned on the label. While the concentrations of parameters like pH and calcium are equal to the values on the label.

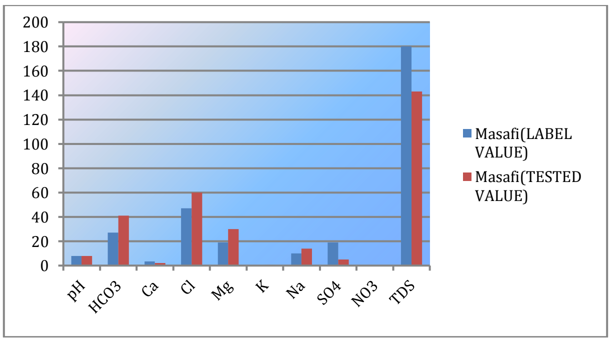


Figure 5: Comparison of mineral contents in tested and labeled bottle water (UAE)

All the tested values in this graph of two brands of UAE are within International Bottled Water Association standards value except the electrical conductivity which is not set under these standards.

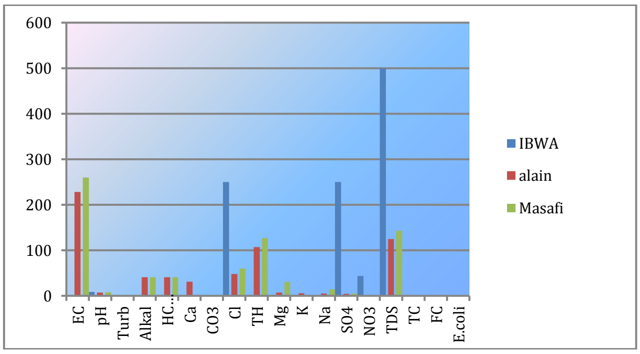


Figure 6: Comparison of mineral contents in tested with IBWA standard values (UAE)

The tested values of parameters shown in the graph are almost lower than the labeled values except the values of chloride and sulphate which are nearly equal to the labeled values on the bottle. From the values of pH (6.9) and TDS (183) we can say that this water has acidic properties due to reverse osmosis treatment of natural water. According to new scientific output the water with pH higher than the 8 is good for health while the water with pH lower than 7 is almost not fit for health causes different blood diseases.

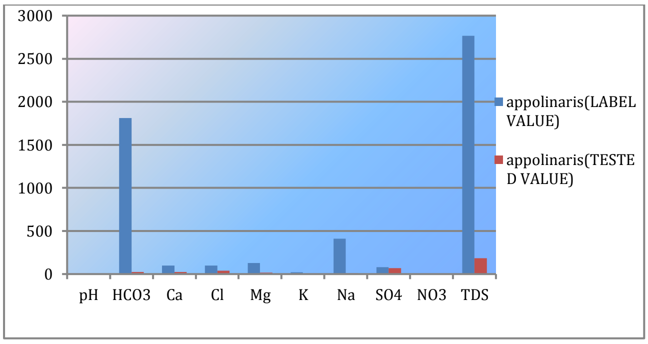


Figure 7: Comparison of mineral contents in tested and labeled bottle water (Germany)

According to this graph all the values are within the German Bottle water standards value, which are mentioned on the bottle label and set in the guidelines.

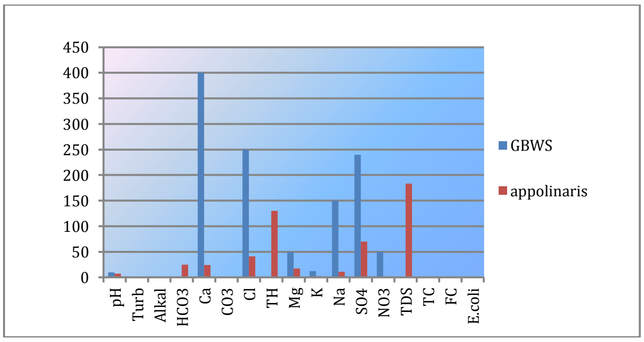


Figure 8: Comparison of mineral contents in tested with GBWS standard values (Germany)

The different parameters six brands of Pakistan shown in the following graph are overall within the labeled values except the one brand like kinley, chloride and TDS concentrations found higher than the maximum range mentioned on the label. Contents of TDS in water vary significantly in different geological horizons due to the difference in solubility of minerals. By the way, an elevated TDS concentration is not considered as a health hazard. The highest HCO_3 concentration (245 mg/L) is found in springle brand, while the lowest (15 mg/L) is recorded in Aquafina brand. High HCO_3 contents in the water are described to chemical weathering of limestone and dolomite.

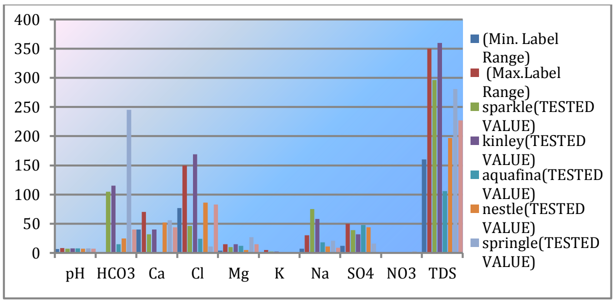


Figure 9: Comparison of mineral contents in tested and labeled bottle water (Pakistan)

All the parameters values tested in the different Pakistani brand are within PSQCA limit values except the sparkle and Kinley brand having sodium contents greater than the standard values. The microbiological limit in one brand named verbena is higher than the recommended limit of 0/100ml.

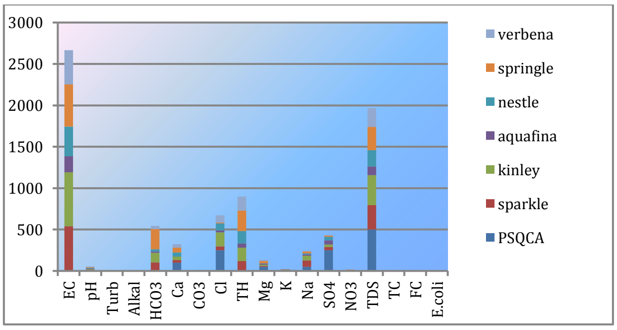


Figure 10: Comparison of mineral contents in tested brands with PSQCA standard values (Pakistan)

This graph shows different parameters of zamzam water (unbottled) with the Standard values prescribed for Saudi Arabia drinking water. All the parameters value exceeds the standard limit, which are set for bottled water except the pH, calcium, sulphate and nitrate.

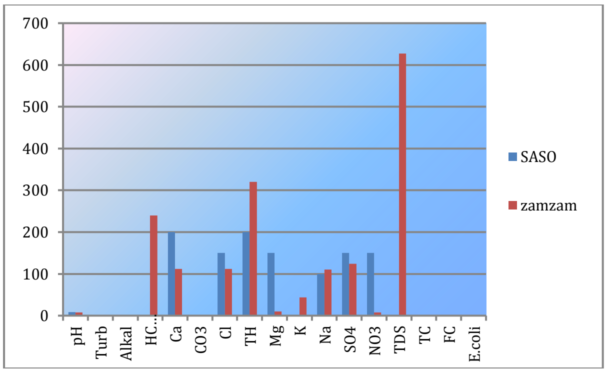
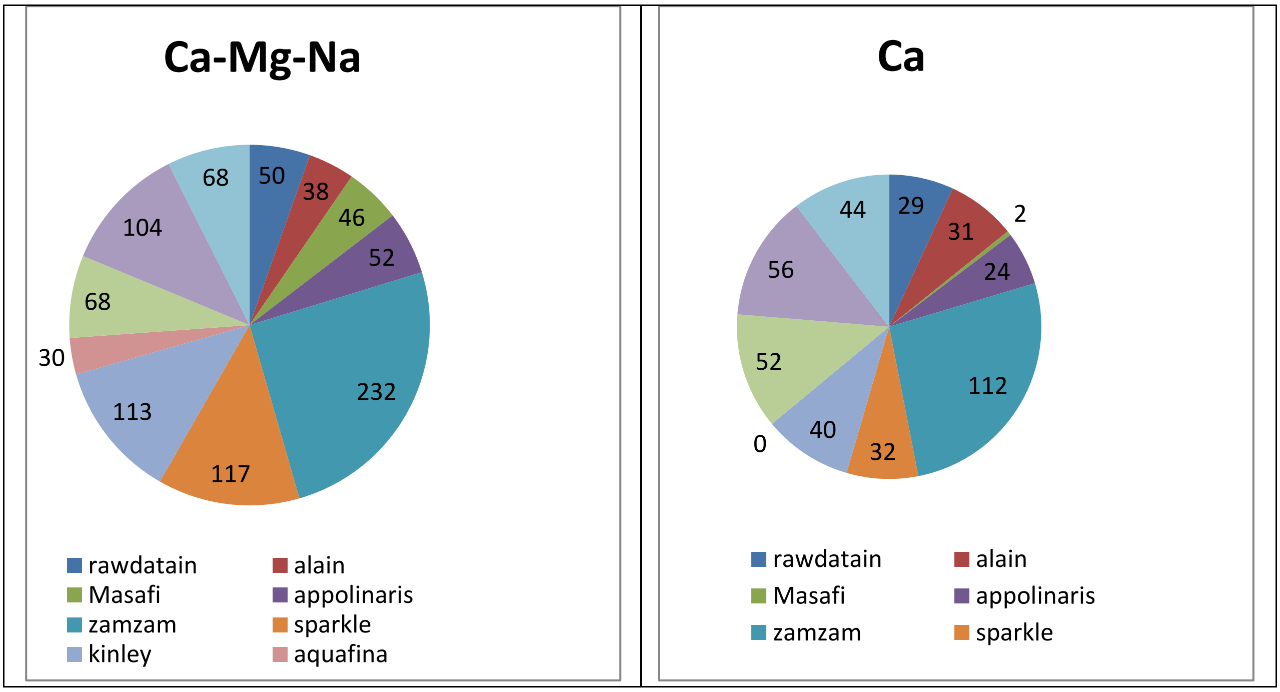


Figure 11: Comparison of mineral contents in tested with SASO standard value (SAUDI ARABIA)

The following graph shows the relative concentration of Calcium and product of calcium-magnesium-sodium contents. It is suggested that consumers should choose to drink bottled water brands with an optimal mineral content, i.e., high levels of Ca and Mg and relatively low Na (below 20 mg/L) to prevent adverse health effects. In this study, the water type is classified by low, moderate and high mineral water on the sum of ionic level that is Ca-Mg-Na. The most frequently observed water type is Na-Ca-HCO3-Cl. All the studied water brands are dominated by either Ca or Na except two brands (Masafi and Al-Ain).



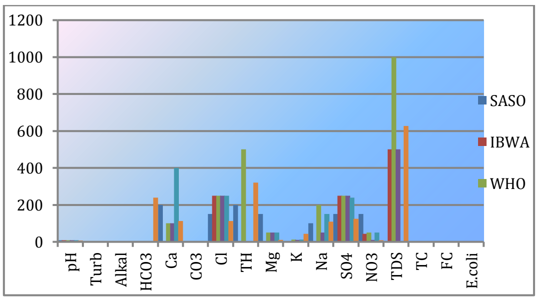


Figure 12: Comparison of different standards with Zamzam water

4. CONCLUSION

It is found that the overall water quality of different brands within their local and international standards. Secondly labeled concentration value on different bottle water is not matched with the values got after testing in the laboratory. Bottle water companies claim, the water from different sources such as spring, deep ground and natural water but no doubt it may be taken from different natural sources and they can be say it mineral water when it was not pass through any treatment processes. These bottles water are actually processed/treated water which does not contain sufficient amount of minerals necessary for the health. So, the bottled water we purchase from market is purified/processed water with few mineral contents. The Zamzam only the natural water which contain sufficient amount of minerals, thus fulfill all the criteria of mineral water.

5. RECOMMENDATION

1. All-natural mineral water which is filled into hermetically sealed containers/bottles of various compositions forms, and capacities that must be safe and suitable for direct consumption.

2. Standards are fixed by law and adopted in countries to their national priorities taking in account their economic, technical, social, cultural and political situation. At any time, they can be changed or modified whenever new scientific evidence becomes available.

3. Preventive measures must be taken at all levels (packaging to distribution) to prevent water contamination.

4. It is ensured by the monitoring agencies of each country that, the total dissolved mineral contents of the water mentioned on the bottle label are matching and also compliance with their national and international standards what they are using.

5. New Standards especially for mineral water are to be established, requested and enforced by competent national authorities by adopting a risk benefit approach keeping in view of mineral contents in one of sacred natural mineral water (Zamzam).

6. The countries like Pakistan and in other countries general public use quality criteria for bottle water as mineral water and unbolted water as non-minerals water which must be changed through public awareness and mass media.

7. Separate research-based standards and guidelines for purified and mineral water quality should be available to bottle water manufacturers and monitoring agencies.

8. The agencies responsible for monitoring of water quality perform periodic checks and make ensure that it must be mentioned on the bottle water label, type of water sources with treatment process applied on it.

9. Before development of standards/guidelines for bottle water, keeping in view the macro and micro nutrients must be according to medical recommended quantity per day.

10. All personnel responsible for testing the quality of water in bottle water quality laboratory should be educated and provided in-service training on a regular basis.

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