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Study the chemical properties of bottled and potable water in Baghdad city

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Abstract:

Potable water is water which is fit for consumption by humans and other animals. It is also called drinking water, in a reference to its intended use. Water may be naturally potable, as is the case with pristine springs, or it may need to be treated in order to be safe. In either instance, the safety of water is assessed with tests which look for potentially harmful contaminants.

Water which is not safe to drink can carry diseases and heavy metals. People who consume this water will become ill, and there is a risk of death. Unfortunately, even in areas where the water is known to be unsafe, people may drink it anyway, out of desperation. The lack of potable water is often accompanied by other lapses in sanitation, such as open sewers and limited garbage collection. Many of these public health issues impact the poor more than anyone else.

Six various brands of local bottled and imported drinking water from different retail shops in Baghdad area with different capacities are collected during January 2016 and Two sample of potable water from two different area of Baghdad . These samples of bottled drinking water were purchased and unrefrigerated.

All these brands were analyzed by measuring chemical and parameters to ascertain their compellability with the prescribed/recommended limits of the World Health Organization and Gulf Standards organization Standard.

Key words: chemical properties, bottled water, potable water, Baghdad city

INTRODUCTION:-

Water which is not safe to drink can carry diseases and heavy metals. People who consume this water will become ill, and there is a risk of death. Unfortunately, even in areas where the water is known to be unsafe, people may drink it anyway, out of desperation. The lack of potable water is often accompanied by other lapses in sanitation, such as open sewers and limited garbage collection. Many of these public health issues impact the poor more than anyone else.

It is needless to mention that water, a compound of Hydrogen and Oxygen is a precious natural gift which is very essential for survival of mankind including animals. The water used for potable purposes should be free from undesirable impurities. The water available from untreated sources such as Well, Boreholes and spring is generally not hygienic and safe for drinking. Thus it is desirable and necessary to purify the water and supply under hygienic conditions for human drinking purpose.

As the name implies, the mineral water is the purified water fortified with requisite amounts of minerals such as Barium, Iron, Manganese, etc. which can be absorbed by human body. It is either obtained from natural resources like spring and drilled wells or it is fortified artificially by blending and treating with mineral salts. The mineral water shall be manufactured and packed under hygienic conditions in properly washed and cleaned bottles in sterilized conditions.(1)

One of the primary goals of WHO and its member states is that "all people, whatever their stage of development and their social and economic conditions, have the right to have access to an adequate supply of safe drinking water." A major WHO function to achieve such goals is the responsibility "to propose regulations, and to make recommendations with respect to international health matters ....”

The first WHO document dealing specifically with public drinking-water quality was published in 1958 as International Standards for Drinking-Water.

Any potable water that is offered for sale in a sealed container is considered to be bottled water. Sources of bottled water may be natural mineral water from springs, wells, lakes, or glaciers, or from distilled municipal water, or any other potable water source. It may be carbonated, distilled, ozone treated or purified. Regardless of its source, potable bottled water undergoes a long production process that may include, but is not limited to, filtration, distillation, de-ionization, reversed osmosis, ozone.(2)

Worldwide, tap water is regularly controlled by certified authorities because it is used for drinking and cooking. In contrast, bottled water goes through less comprehensive testing, which also occurs less frequently. Additionally, most of the regulatory standards applied to tap water do not apply to bottled water. For this reason, the chemical composition of bottled water must be investigated so that potential risks from exposure to potentially dangerous contaminants can be minimized, which is of particular concern because of the increase in bottled water consumption.

BOTTIED WATER:-

Unfortunately sufficient safe potable water is not available everywhere in the country, either harmful chemical substance are found in the layers of earth which enter into water or it may be contaminated due to pathogenic micro-organisms. If such water is consumed, the body suffers from water born diseases. Due to this, it has become imperative to process and bottle safe potable water for the mankind in prevailing conditions. The demand for purified water becomes more during summer season.

Although few companies have already entered in the bottling of safe potable water and mineralized water, but still huge gap is there in between demand and supply at all metropolitan-cities and towns. The product is widely accepted in offices, restaurants, railway stations, airport, bus stands, and hospitals and to some extent even in rich house-holds.

So there is good scope for establishing the units for processing and bottling plain and mineralized drinking water in different parts of the country.(3)

WHO Document:-

The first WHO document dealing specifically with public drinking-water quality was published in 1958 as International Standards for Drinking-Water.

It was subsequently revised in 1963 and in 1971 under the same title. In 1984–1985, the first edition of the WHO Guidelines for drinking-water quality (GDWQ) was published.

The GDWQ are subject to a rolling revision process. Through this process, microbial, chemical and radiological aspects of drinking-water are subject to periodic review, and documentation related to aspects of protection and control of public drinking-water quality is accordingly prepared /updated.

Since the first edition of the GDWQ, WHO has published information on health.

Criteria and other supporting information to the GDWQ, describing the approaches used in deriving guideline values and presenting critical reviews and evaluations of the effects on human health of the substances or contaminants examined in drinking-water.

For each chemical contaminant or substance considered, a lead institution prepared a health criteria document evaluating the risks for human health from exposure to the particular chemical in drinking-water. (2)

property	**restriction**
PH	6.5 - 8.5
TDS (mg/l)	100-600
Cl (mg/l)	200
SO_4 (mg/l)	250

Table 1:- The chemical properties limits according to WHO document

property	**restriction**
PH	6.5 - 8.5
TDS (mg/l)	100-500
Cl (mg/l)	150
SO_4 (mg/l)	150

Table 2:- The chemical properties limits according to Gulf Standard Document

CHEMICAL PROPERTIES OF WATER:-

Water has many unique characteristics that make it ideal for nurturing life. Learn about them with this tutorial.

1- Hydrogen Bonds:-

Water – a polar molecule – tends to be slightly positive on the hydrogen side and slight negative on the oxygen side. The electrostatic bond between the positive hydrogen side of this molecule and other negative ions or polar molecules is called a hydrogen bond.

Molecules and ions with which water forms hydrogen bonds (such as sodium chloride) are hydrophilic. On the other hand, Ions and molecules that do not form hydrogen bonds with water are hydrophobic.

2- Liquidity at Room Temperature:-

At room temperature, most compounds with low molecular weights take gaseous form. With water, however, hydrogen bonding helps to keep it a liquid at room temperature. Kept relatively close together, the molecules at room temperature are unable to dissipate sufficiently to form a gas. Temperatures of 212°F (or 100°C) are required to break the hydrogen bonds and convert liquid water into water vapor.

3- Chemical Reactions:-

When ionic compounds such as sodium chloride are added to water, hydrogen bonding will tend to pull those ionic compounds apart. This makes water a natural solvent.

Once ionic compounds dissolve, their anions and cations circulate through the water allowing further reactions to occur. Thus, water also sponsors and facilitates chemical reactions.

4- Stable Temperatures:-

Water takes more heat to raise its temperature than other common compounds, since much of that heat is required to first break the hydrogen bonds. Water also retains heat, so its temperature falls slowly. This means that larger systems of water (such as the ocean or a body) tend to maintain more or less constant temperatures, which in turn helps the earth (and us) to maintain relatively constant temperatures.

5- Freezing Point:-

At 32°F (or 0°C) and below, water molecules form hydrogen bonds in a crystalline lattice structure. This bonding spaces the molecules a bit farther apart than usual, causing water to expand when it freezes. This results in **ice being less dense** than liquid water, which is why ice floats.

Floating ice is critical to life on Earth. Bodies of water freeze from the top down, providing an insulating layer of ice that keeps the water below from freezing. For the organisms living below the surface, this property helps them to survive the cold weather.(4)

6- TDS :-

Total dissolved solids (TDS) are the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions.

No recent data on health effects associated with the ingestion of TDS in drinking-water appear to exist; however, associations between various health effects and hardness, rather than TDS content, have been investigated in many studies (see Hardness).

In early studies, inverse relationships were reported between TDS concentrations in drinking water and the incidence of cancer, coronary heart disease, and arteriosclerotic heart disease, and cardiovascular disease.

Total mortality rates were reported to be inversely correlated with TDS levels in drinking-water. It was reported in a summary of a study in Australia that mortality from all categories of ischemic heart disease and acute myocardial infarction was increased in a community with high levels of soluble solids, calcium, magnesium, sulfate, chloride, fluoride, alkalinity, total hardness, and pH when compared with one in which levels were lower. No attempts were made to relate mortality from cardiovascular disease to other potential confounding factors.

The results of a limited epidemiological study in the former Soviet Union indicated that the average number of "cases" of inflammation of the gallbladder and gallstones over a 5-year period increased with the mean level of dry residue in the groundwater. It should be noted, however, that the number of "cases" varied greatly from year to year in one district, as did the concentration of dry residue in each district, and no attempt was made to take possible confounding factors into account.

Certain components of TDS, such as chlorides, sulfates, magnesium, calcium, and carbonates, affect corrosion or encrustation in water-distribution systems. High TDS levels (>500 mg/liter) result in excessive scaling in water pipes, water heaters, boilers, and household appliances such as kettles and steam irons. Such scaling can shorten the service life of these appliances. (5)

7- Sulfates:-

Sulfates occur naturally in numerous minerals, including barite ($BaSO_4$), epsomite ($MgSO_4 \cdot 7H_2O$) and gypsum ($CaSO_4 \cdot 2H_2O$). These dissolved minerals contribute to the mineral content of many drinking-waters.

Sulfates and sulfuric acid products are used in the production of fertilizers, chemicals, dyes, glass, paper, soaps, textiles, fungicides, insecticides, astringents and emetics.

They are also used in the mining, wood pulp, metal and plating industries, in sewage.

Treatment and in leather processing. Aluminium sulfate (alum) is used as a sedimentation agent in the treatment of drinking-water.

Copper sulfate has been used for the control of algae in raw and public water supplies.

Ingestion of 8 g of sodium sulfate and 7 g of magnesium sulfate caused catharsis in adult males . Cathartic effects are commonly reported to be experienced by people consuming drinking-water containing sulfate in concentrations exceeding 600 mg/liter, although it is also reported that humans can adapt to higher concentrations with time (US EPA, 1985). Dehydration has also been reported as a common side-effect following the ingestion of large amounts of magnesium or sodium sulfate.

There are subpopulations that may be more sensitive to the cathartic effects of exposure to high concentrations of sulfate. Children, transients and the elderly are such populations because of the potentially high risk of dehydration from diarrhea that may be caused by high levels of sulfate in drinking-water (US EPA, 1999).

There have been a number of studies conducted to determine the toxicity of sulfate in humans. To high sulfate levels and other factors may have played a role (e.g., consumption of infant formula with high osmolarity or the presence of microbial pathogens).

A survey in North Dakota, USA, observed a slight increase in the percentage of people who reported a laxative effect when the drinking-water contained 500–1000 mg of sulfate per liter compared with people who reported a laxative effect with water containing <500 mg of sulfate per liter (28% versus 21%). Sixty-eight per cent of people consuming water with levels of sulfate between 1000 and 1500 mg/liter reported laxative effects. Several different conclusions were drawn from this survey by different people examining the data. It was concluded that drinking-water containing ≥750 mg of sulfate per liter was associated with a self-reported laxative effect, whereas water containing <600 mg/liter was not. (6)

8- Chlorides:-

Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium (CaCl2).

Sodium chloride is widely used in the production of industrial chemicals such as caustic soda, chlorine, sodium chlorite, and sodium hypochlorite. Sodium chloride, calcium chloride, and magnesium chloride are extensively used in snow and ice control. Potassium chloride is used in the production of fertilizers.

A normal adult human body contains approximately 81.7 g chloride. On the basis of a total obligatory loss of chloride of approximately 530 mg/day, a dietary intake for adults of 9 mg of chloride per kg of body weight has been recommended (equivalent to slightly more than 1 g of table salt per person per day). For children up to 18 years of age, a daily dietary intake of 45 mg of chloride should be sufficient. A dose of 1 g of sodium chloride per kg of body weight was reported to have been lethal in a 9-week-old child.

Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure. Healthy individuals can tolerate the intake of large quantities of chloride provided that there is a concomitant intake of fresh water. Little is known about the effect of prolonged intake of large amounts of chloride in the diet. As in experimental animals, hypertension associated with sodium chloride intake appears to be related to the sodium rather than the chloride ion. (7)

9- PH :-

The pH of a solution is the negative common logarithm of the hydrogen ion activity:

$$PH = -\log (H+)$$

In dilute solutions, the hydrogen ion activity is approximately equal to the hydrogen ion concentration.

The pH of water is a measure of the acid–base equilibrium and, in most natural waters, is controlled by the carbon dioxide–bicarbonate–carbonate equilibrium system. An increased carbon dioxide concentration will therefore lower pH, whereas a decrease will cause it to rise.

Temperature will also affect the equilibrium and the pH. In pure water, a decrease in pH of about 0.45 occurs as the temperature is raised by 25 °C. In water with a buffering capacity imparted by bicarbonate, carbonate, and hydroxyl ions, this temperature effect is modified. The pH of most raw water lies within the range 6.5–8.5.

Exposure to extreme pH values results in irritation to the eyes, skin, and mucous membranes. Eye irritation and exacerbation of skin disorders have been associated with pH values greater than 11. In addition, solutions of pH 10–12.5 have been reported to cause hair fibers to swell.

In sensitive individuals, gastrointestinal irritation may also occur. Exposure to low pH values can also result in similar effects. Below pH 4, redness and irritation of the eyes have been reported, the severity of which increases with decreasing pH. Below pH 2.5, damage to the epithelium is irreversible and extensive. In addition, because pH can affect the degree of corrosion of metals as well as disinfection efficiency, it may have an indirect effect on health.

The measurement that determines whether a liquid acid or base, or neutral. Considered to be of pH less than 7 fluids and acids are of the pH of the fluid above 7 alkaline a solution or rules. The pH 7 degrees they are considered neutral is equal to pure at a temperature of 25 Celsius acidity of the water. Measuring pH There are several ways the most important device ph-meter it is one of the most important operational water-quality parameters. Careful attention to pH control is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection. (8)

RESULTS AND DISSCUSION

Six various brands of local bottled and imported drinking water from different retail shops in Baghdad area with different capacities are collected during January 2016 and Two sample of potable water from two different area of Baghdad. These samples of bottled drinking water were purchased and unrefrigerated.

All these brands were analyzed by measuring chemical and parameters to ascertain their compellability with the prescribed/recommended limits of the World Health Organization and Gulf Standards organization Standard.

The results from the chemical analysis of the bottled and tap water were compared with standards recommended by the, WHO, Gulf document, as well as the reported values listed by the manufacturers on the product label in the case of bottled water.

Bottled water analysis:-

1- Chemical Parameters:-

Table 3 shows the individual chemical analyses of six locally produced and imported bottled water samples. And two sample of potable water.

The pH values ranged between 5.91 and 7.94 for the domestic bottled water brands and potable sample, with an average pH value of 6.85, whereas it varied between 6.43 and 7.94 for the bottled water brand, and varied between 5.91 and 6.46 for the potable water samples.

The pH values for the drinking water were within the acceptable range (of 6.5–8.5) as determined by the WHO, except for potable water the region1 (pH = 5.91) and region2 (pH = 6.46) the pH values are shown in figure 1.

The measured TDS in the bottled water samples ranged between (11.5 mg/l) and (118 mg/l), with an average value of (55.88 mg/l). In the potable water sample, the TDS ranged between (484 mg/l) for region 2 and (494 mg/l) for region 2, with an average value of (489 mg/l). We note that the TDS of both the bottled water brands and potable water samples were below the gulf limit of 500 mg/l and the WHO acceptability standard of 600 mg/l .The TDS measured values are shown in figure 2.

2 - Major anions:-

The results of the major anions for the local and imported bottled water samples and the potable water samples are shown in Tables 3.

The concentrations of chloride (Cl) in bottled water samples ranged between (0.06 mg/l) and (0.094 mg/l), compared with (0.216 mg/l) and (0.19 mg/l) in the potable water samples at region 1 and region 2, respectively.

Concerning Cl, its concentration in all the local and imported bottled water brands and potable water samples were below the acceptability standard limit of 200 mg/l suggested by WHO and 150 mg/l suggested by Gulf standard limit . There has been no health guidelines established by the WHO for Cl because it occurs at concentrations that do not appear to pose a risk to human health. The Cl measured values are shown in figure 3.

The concentrations of sulfate (SO_4) in bottled water samples ranged between (0.08 mg/l) and (0.16 mg/l), compared with (0.25 mg/l) and (1.98 mg/l) in the potable water samples at region 1 and region 2, respectively.

Concerning SO_4, its concentration in all the local and imported bottled water brands and potable water samples were below the acceptability standard limit of 250 mg/l suggested by WHO and 150 mg/l suggested by Gulf standard limit . There has been no health guidelines established by the WHO for SO_4 because it occurs at concentrations that do not appear to pose a risk to human health. The SO_4 measured values are shown in figure 4.

Samples	PH	TDS (mg/l)	Cl (mg/l)	SO_4 (mg/l)
Rodatian	6.43	19.8	0.084	0.08
Mazi	7.16	109	0.094	0.08
Ovian	6.96	14.8	0.08	0.16
Alloloa	7.94	11.5	0.0762	0.16
Alwaha	6.96	118	0.084	0.08
Alreem	7.02	62.2	0.06	0.08
Reg1	5.91	494	0.216	0.25
Reg2	6.46	484	0.19	1.98

Table 3:- The results of chemical properties of samples

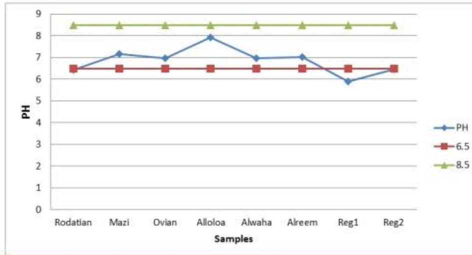

Figure 1:- PH Results for bottled water and potable water

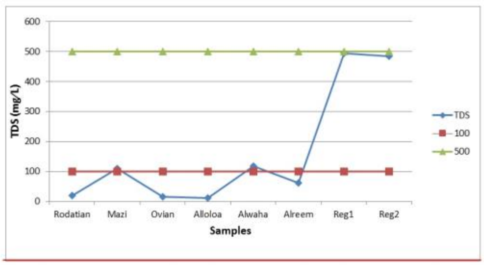

Figure 2:- TDS Results for bottled water and potable water

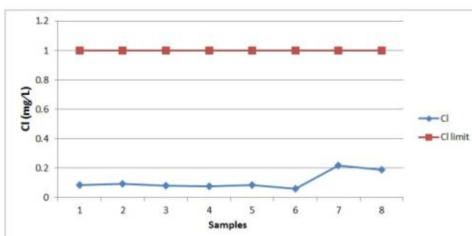

Figure 3:- Chloride Results for bottled water and potable water

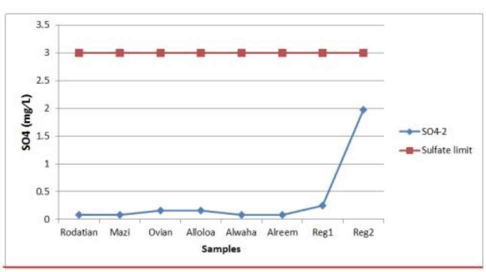

Figure 4:- Sulfate Results for bottled water and potable water

CONCLUSIONS:-

1- Chemical Parameters:-

The pH values for the drinking water were within the acceptable range (of 6.5–8.5) as determined by the WHO, except for potable water the region1 (pH = 5.91) and region2 (pH = 6.46) the pH values.

The TDS of both the bottled water brands and potable water samples were below the gulf limit of 500 mg/l and the WHO acceptability standard of 600 mg/l .

2-Major anions:-

There has been no health guidelines established by the WHO for Cl because it occurs at concentrations that do not appear to pose a risk to human health.

There has been no health guidelines established by the WHO for SO_4 because it occurs at concentrations that do not appear to pose a risk to human health.

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