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CHEMICAL TOXICITY OF ARSENIC IN DRINKING WATER AND ITS EFFECTS ON HUMAN HEALTH IN IRAQ WASIT (AL-HAY)

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Abstract:

Water and other environmental elements are necessary to all forms of life in addition to the future of the world. Poor sanitation and tainted water are linked to the spread of diseases like polio, cholera, dysentery, hepatitis A, typhoid, kidney disease, and diarrhea. People who have access to subpar, mismanaged, or nonexistent water and sanitation facilities run the risk of developing avoidable illnesses. Arsenic is one of the most toxic elements in nature, and its presence in the drinking water represents a dangerous environmental indicator because it affected many of the human body organs, such as cardiovascular, hematologic, hepatic, neurological, renal, and respiratory; it cannot be easily eliminated from the body. In this research, 7 locations have been studied to detect the arsenic level in water. The results of the study found that the concentrations of arsenic in water samples were (0-0.05) ppm for raw water, (0-0.05) ppm for tap water (0-0.27) ppm, and for RO water (0-0.18) ppm, while the value of WHO is (0.01) ppm.

Keywords: Water pollution, chemical toxicity, arsenic, health impacts.

Introduction

1- Introduction

Since water is the second most vital element for human life, drinking it is very crucial. We are aware that life cannot exist without water. However, it is quite difficult to find pure water for human utilize, which is why it is a major issue now in the entire world. For approximately half of the world's population, freshwater contamination is thought to be a concern. According to a United Nations report, by 2025, 2.7 billion people will not have enough water [1]. Arsenic is a very hazardous substance that possesses no known vital physiological function in humans. Arsenic can be found in nature in a variety of inorganic and organic forms, as well as in various oxidation states. In the environment, arsenic is transformed into both inorganic and organic forms [2]. One of the most dangerous metals found in the natural world is arsenic. Rather than coming from mine, smelting, or agricultural sources (fertilizers or pesticides), drinking water pollution from natural geological sources is the main cause of arsenic toxicity in humans. Drinking water in many industrialized and developing nations is tainted by arsenic [3]. Numerous organ systems, including the cardiovascular, hematologic, hepatic, neurological, renal, and respiratory systems are affected by arsenic's toxicity. Additionally, other cancer types have been linked to it, including skin, lung, liver, and bladder cancer [4]. Worldwide, a large number of individuals are exposed to inorganic arsenic by industrial emissions or drinking water. A strong human carcinogen, inorganic arsenic is linked to an increased risk of skin, lung, kidney, and urinary bladder cancer in addition to hyperkeratosis, pigmentation abnormalities, and effects on the neurological and circulatory systems . AsIII is the primary form of arsenic that interacts with tissue sulfhydryl groups after exposure to inorganic arsenic, which inhibits numerous functional groups, including enzymes [5]. The World Health Organization (WHO) and the US Environmental Protection Agency (EPA) established the MCL, or maximum permissible level, for drinking water, which is 10 µg/l (EPA, 2001). The WHO in addition recommends a guideline value of 10 µg/l for the concentration of arsenic in drinking water. Consuming water that possesses an MCL of 10 µg/l or less does not pose a risk to public health [6].

2- Chemical toxicity

Furthermore, the examinations take longer and cost more money because of the wide variety and quantity of hazardous compounds that could be found in waters. Practically speaking, it results in fewer analyses being conducted. Determining the possible adverse impact on aquatic habitats is another drawback. A vast quantity of chemical data exists, frequently presenting many chemicals at varying amounts. The majority of chemicals are very harmless, and little is known about how they interact with the environment [7]. Using the formula, the lifetime average daily dose (LADD) of the chemical toxicity risk associated with consuming arsenic through drinking water was calculated.

$$\mathbf{LADD}\left(\frac{\mathbf{mg}}{\mathbf{kg.d}}\right)=\frac{\mathbf{MC}\times\mathbf{IR}\times\mathbf{EF}\times\mathbf{LE}}{\mathbf{AT}\times\mathbf{BW}}\dots\dots\dots\dots\dots\dots.(\mathbf{1})$$

Where MC represents the mass concentration of uranium (µgL−1), IR stands for ingestion rate of drinking water (Ld−1), EF denotes exposure frequency (days per year), LE denotes life expectancy (years), AT stands for average time (days) means life expectancy (years) × 365, and BW denotes the average body weight of an Indian individual (kg)[8].

3- Materials and methods

In the Wasit administration, 23 samples labeled as tap, RO, and raw water are taken from Al-Hay. At position seven, a steady area is where this sample was taken. Samples are collected using plastic two-liter containers. Following collection, store the samples at 25 degrees Celsius in a secure area before taking them to a facility for analysis.by using icpoes the samples analyzed then collect the results and set it in table 1.

4- Tools and instruments

4-1: ICPOES

ICP/OES, or inductively coupled plasma/optical emission spectroscopy, is a potent technique for identifying the metals in a wide range of sample matrixes [9]. ICP-OES: An Advance Instrument measures and determines the elements present by analyzing the emission spectra of sample molecules. The device consists of an optical emission spectrometer and an inductively couple plasma. The primary parts of the ICP-OES apparatus consist of the following: a definite arrangement of the sampler, pump, nebulizer, spray chamber, ICP torch, and monochromator's/polychromatic, and detector [10]. One of the most effective and widely used analytical technologies for determining trace elements in a variety of sample types is ICP OES. Although it possesses been used, the phrase inductively coupled plasma atomic emission spectrometry (ICP OES) should not be confused with Auger electron spectroscopy (OES). The method relies on the photons that spontaneously exited stimulated atoms and ions during an RF discharge [11]. With this method, a number of nebulizers or sample introduction techniques are used to deliver liquid samples into an argon plasma created by radiofrequency (RF). Through collisional excitation at a high temperature, the sample mist that reaches the plasma is rapidly dried, evaporated, and energized. A wavelength selection device's entrance slit is photographed with the atomic emission that is emitted from the plasma after it possesses been observed, captured using a lens or mirror [9]. It is possible to inject liquid and gas samples straight into the device, but solid samples typically need to be extracted or acid-digested in order for the analyses to be present in a solution. The sample solution is transformed into an aerosol and fed into the plasma's central channel. Because the inductively coupled plasma (ICP) maintains a core temperature of about 10,000 K, the aerosol evaporates very fast. The analytic elements are released in the gaseous form as free atoms [12].

5- Results

5-1 Concentration of Arsenic in water

Arsenic content in water samples can be measured using the ICPOES technique. Following analysis, the concentration was found to be (0-0.05) ppm in raw water, (0-0.27) ppm in tap water, and (0-0.18) ppm in RO water samples.

Table 1. concentration of Arsenic (As) in water samples

S code	Raw water	Tap1 water	Tap2 water	RO water	E	N
WHO	0.01	0.01	0.01	0.01	-	-
R1	0.04	0	0.08	0.04	**46° 2'35.14" E**	**32° 9'1.05" N**
R2	0.04	0.04	0.27	0.04	**46° 2'2.70" E**	**32° 7'6.29" N**
R3	0.05	0.07	-	-	**45°59'55.14" E**	**32° 4'11.90" N**
R4	0.05	0.08	-	0.18	**45°59'32.81" E**	**32° 3'31.90" N**
R5	0.05	0.08	-	0	**45°58'51.33" E**	**32° 0'3.85" N**
R6	0	0.11	0.1	0.03	**46° 1'14.93" E**	**32°11'1.15" N**
R7	0	0.19	-	0.09	**46° 1'32.56" E**	**32°10'39.87" N**

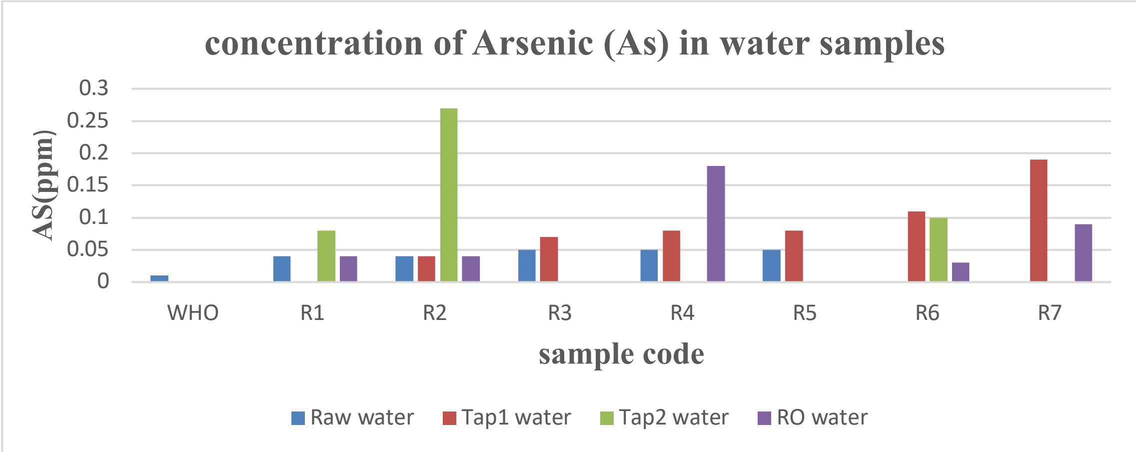

Figure 1: The concentration of .As (ppm) in water samples

5-2 Chemical Toxicity of water samples by (As) and its impact on human

Arsenic's chemical toxicity in water Right now, it's one of the most significant issues. Humans that drink arsenic-contaminated water suffer from numerous health consequences from arsenic toxicity. Numerous adverse health effects, including cancer (mostly of the skin, lungs, liver, kidney, and bladder), as well as neurological and cardiovascular problems, are caused by this type. One can determine the chemical toxicity of arsenic by utilizing equation (1), table (1), and the outcomes displayed in table 2.

Table 2. chemical toxicty of arsenic in water

S- code	1year	5 years	15 years	Adults 70 years
WHO	0.000907	0.000667	0.00036	0.000286
R1-Raw	0.003627	0.002667	0.00144	0.001143
R1-tap1	0	0	0	0
R1-tap2	0.007253	0.005333	0.00288	0.002286
R1-RO	0.003627	0.002667	0.00144	0.001143
R2-raw	0.003627	0.002667	0.00144	0.001143
R2-tap1	0.003627	0.002667	0.00144	0.001143
R2-tap2	0.02448	0.018	0.00972	0.007714
R2-RO	0.003627	0.002667	0.00144	0.001143
R3-raw	0.004533	0.003333	0.0018	0.001429
R3-tap	0.006347	0.004667	0.00252	0.002
R4-raw	0.004533	0.003333	0.0018	0.001429
R4-tap	0.007253	0.005333	0.00288	0.002286
R4-RO	0.01632	0.012	0.00648	0.005143
R5-raw	0.004533	0.003333	0.0018	0.001429
R5-tap	0.007253	0.005333	0.00288	0.002286
R5-RO	0	0	0	0
R6-raw	0	0	0	0
R6-tap1	0.009973	0.007333	0.00396	0.003143
R6-tap2	0.009067	0.006667	0.0036	0.002857
R6-RO	0.00272	0.002	0.00108	0.000857
R7-raw	0	0	0	0

R7-tap	0.017227	0.012667	0.00684	0.005429
R7-RO	0.00816	0.006	0.00324	0.002571

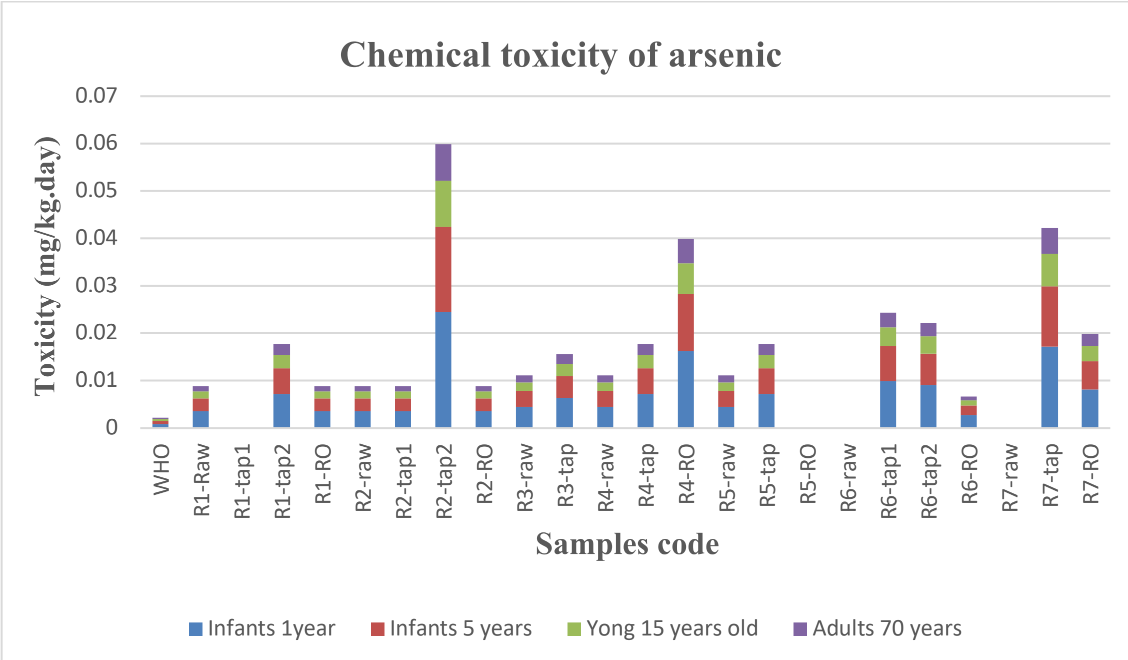

Figure 2. chemical toxicity of arsenic in water

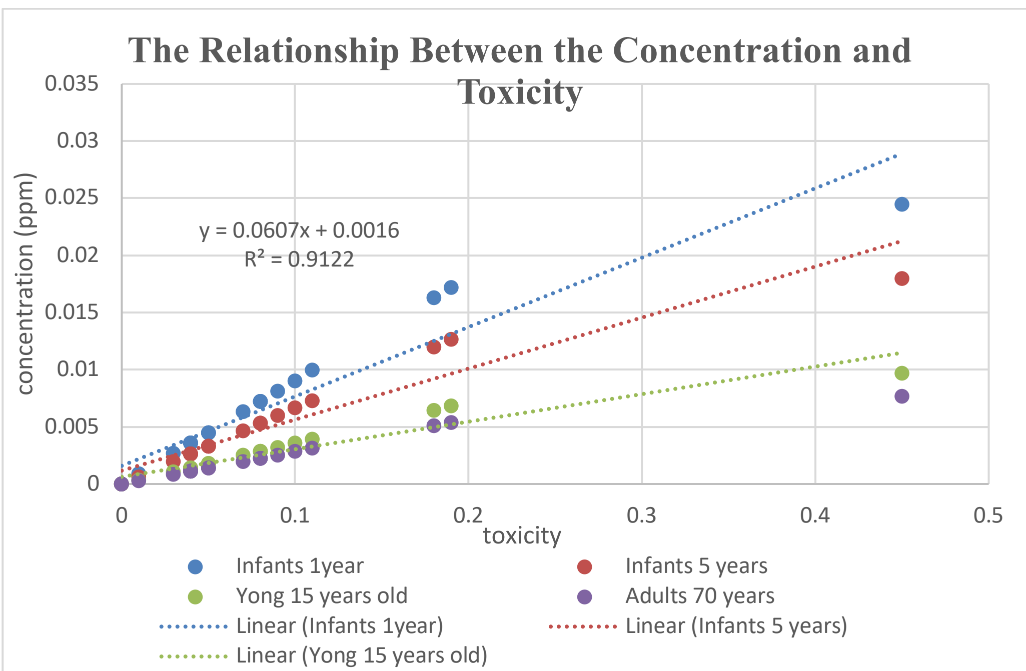

Figure 3. The linear relationship between the toxicity on Different age groups

6- Discussion

Arsenic contamination in drinking water remains a pressing environmental and public health concern, particularly in regions such as Al-Hay, Wasit, Iraq. The current study revealed significant variability in arsenic concentrations across different water sources, including raw, tap, and reverse osmosis (RO) water. This variability can be attributed to multiple environmental and infrastructural factors.

The results indicate that tap water often contains higher arsenic concentrations than raw water in most sampling locations. This unexpected trend suggests secondary contamination, likely from distribution pipelines that have accumulated sediment containing arsenic. Such pipes may release dissolved arsenic into the water, especially in areas where pipeline corrosion or inadequate maintenance prevails. These findings align with similar observations in previous studies, where aged infrastructure contributed to elevated metal concentrations in household tap water.

In contrast, RO water demonstrated inconsistent results. While in some regions (e.g., R1 and R2), RO water exhibited arsenic concentrations similar to or lower than raw water, in others (e.g., R4 and R6), RO-treated samples still showed elevated levels. This may reflect irregularities in system maintenance, filter lifespan, or efficiency of the local RO units. According to WHO guidelines, the maximum acceptable arsenic concentration in drinking water is 0.01 ppm. In the current study, some tap and RO samples surpassed this threshold, indicating a potential chronic health risk for local residents.

Moreover, the lack of strict monitoring and maintenance by relevant governmental bodies, such as the Ministry of Health and Environment, exacerbates the issue. Many of the public filtration systems suffer from infrequent inspections and limited infrastructure upgrades, especially in rural or underserved areas.

This disparity in water safety emphasizes the urgent need for:

1. Improved surveillance of water treatment and delivery systems.

2. Regular maintenance of public filtration and RO units.

3. Community education on safe water usage and awareness of potential sources of contamination.

4. Policy reinforcement to enforce WHO water quality standards.

In summary, while arsenic contamination appears to be localized and variable, its health implications are severe, particularly over long-term exposure. Future studies should explore the geochemical properties of the aquifers and distribution systems, as well as assess the effectiveness of remediation strategies tailored for arsenic removal.

7- Conclusions

- ✓ The concentration of arsenic in water samples higher than the permissible limit of WHO value.
- ✓ The chemical toxicity of arsenic in water affected the infants faster and more than adults.
- ✓ The relation between the concentration and chemical toxicity of arsenic is a linear.
- ✓ The concentration of arsenic in Tap water higher than raw water in many of region study.

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