The Effect of Different Types of Drinking Water Plastic Tanks Used at Homes on Water Quality: A Study of Various Samples under Standard Conditions

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KEYWORDS

Plastic tanks, Water storage quality, Chemical parameters, and Contaminants.

ABSTRACT

Aim: The study aimed to find any differences in water quality stored by using different types of plastic tanks.

Subject and Methods: Four types of plastic tanks were used in the study: polyethylene, polypropylene, polycarbonate, and polyvinyl chloride. The experiments were done at the laboratory under practical conditions, like stored water volume, time, and temperature. The water was analyzed for electrical conductivity, total dissolved solids, pH, and the presence of some chemical contaminants.

Results: The results between conductivity and the total dissolved solid gave a positive direct relation of (r = 0.7), while the results between conductivity and pH gave a negative inverse relation of (r= -0.5). There was a variation and an increasing concentration value in tank type of polycarbonate, and polyvinyl chloride than other types, while there were the same concentrations value in all tank types of Lead, that showed concentrations below (0.01) micrograms per liter. There were statistical differences between tank types, of Bisphenol A and Phthalates, while the remaining was not significant. There was a statistical difference in the water stored in polyethylene and polypropylene tanks, which contained acceptable parameters than other types.

Conclusion: The study findings emphasize the importance of thinking about made material traits whilst selecting a tank type for storing water at home, and storing water by using polyethylene and polypropylene tanks to reduce the health risks from the librating of chemicals to the stored water.

1. Introduction

Water storage is considered critical to ensure access to safe water in the home. Plastic tanks have emerged as a popular water source due to their ease of installation and durability (ASTM, 2017).

The use of plastic containers in the home has now increased, due to the lack of access to clean water the home, and the need to store water for emergency use Types of plastic containers commonly used in the home are polyethylene, polypropylene, polycarbonate, and polyvinyl chloride. These materials have many properties and can release various chemicals directly into stored water (ASTM, 2019), (ASTM,2018). Access to safe and clean drinking water is critical to the health and well-being of communities. Plastic drinking water bottles are commonly used in many homes to store water for daily use, but concerns have been raised about their potential impact on the quality of stored water, because chemicals in stored water can be released from plastic containers, posing health risks to humans (ASTM, 2017).Plastic containers are made from plastics such as polyethylene, polypropylene, and polyvinyl chloride. These plastics can contain additives such as plasticizers as well as stabilizers, which

can leach into the water of the tanks, also, factors such as temperature, sunlight exposure, and length of storage can affect filtration (APHA, 2017). Tank materials have unique physical properties that may affect the discharge of certain chemicals into stored water. Understanding the potential interactions between various plastic tank components and water is critical to ensuring safe drinking water (ASTM, 2019). The problems of the quality of water and plastic tanks are very important. Safe drinking water is not possible, many sources rely on Others, such as stored water, to reinforce the important role of water storage systems including plastic water in ensuring the supply of water to the people areas with limited access to drinking water, especially through pipes (EU, 2011). Plastic containers are widely used in urban and rural areas. For example, plastic tanks are widely used in homes, schools, and healthcare facilities in many developing countries. These tanks are commonly used in urgent matters. This provides temporary storage of drinking water in case of disaster and crisis. The widespread use of plastic containers highlights the critical need underlying their potential impact on water quality and public health. The global scope of the problem of storing drinking water confirms the urgent and necessary need to treat the trend of water quality related to plastic tanks, as ensuring the safety of the stored water and its potability is very important to protect against waterborne diseases, protect community health and enhance the sustainability of development, through evidence checks Physical and chemical water stored in different types of plastic tanks, Mathangi, Nalini D, and other, was founded cancerous effect of PVC on prostate that threatened human life (EPA, 2012). The study aims to test several types of plastic water tanks that are used at homes through some physio-chemical properties and to investigate some pollutants under standard conditions.

Aims of the study:

The study aimed to find any differences in water quality that stored by using different types of plastic tank.

2. Methodology

Study design: An experimental study.

- **Selection of the type of plastic tanks:** Four common types of plastic tanks were selected for this study: polyethylene, polypropylene, polycarbonate, and polyvinyl chloride.

- **Experimental Setup:** Four identical plastic tanks of each plastic type were thoroughly cleaned and sterilized, 10 liters of municipal water source were stored in each four plastic tanks, and they were placed at room temperature (25°C). Samples were collected at different time points (1, 7, and 14 days) and analyzed for pH, electrical conductivity (electrical conductivity), total dissolved solids (TDS), and the presence of chemical contaminants (Bisphenol A, phthalates, and lead) by using standard laboratory methods.

Analysis Parameters:

-pH Measurement: The pH of the water samples saved in unique plastic tanks changed measured using a calibrated pH meter. PH provides facts approximately the acidity or alkalinity of the water.

- **The electric-conductivity E.C:** EC was calculated via a digital meter England made named was (Lovibond). It is a calculation of the potential of water to induction an electrical modern-day, and supply insights with the aid of the presence awareness of salts solubility, in addition to minerals.

-Total Dissolved Solids (TDS): TDS values were decided for the water samples saved in distinctive plastic tanks. TDS refers back to the attention of dissolved solids, inclusive of minerals, salts, and different substances, in water.

-Chemical Contaminants: The presence of selected chemical contaminants, including Bisphenol A, phthalates, and lead, become analyzed with the use of suitable analytical techniques together with gasoline chromatography and atomic absorption spectroscopy.

For each analysis parameter, appropriate devices and techniques were hired to measure and examine the corresponding water fine parameter.

-Statistical Analysis: Statistical evaluation of Pearson correlation and t-test statistics was used to examine the parameters measured in unique plastic tanks and to find if there a statistically significant differences between each water quality parameter included in this study.

3. Results and discussion

The results indicated that the use of plastic containers has a significant impact on drinking water quality, resulting in chemical and biological characteristics and chemical contaminants associated with water stored in plastic containers details of the species.

Table (1): Some physio-chemical parameters of the water stored in different plastic tank types through the period of studying samples

Plastic Tanks Types	**Electrical Conductivity µS\cm**	**Total Dissolved Solid Mg\L**	**pH**
polyethylene	**67 ± 4**	**460 ± 2**	**7.4**
polypropylene	**65 ± 5**	**465 ± 3**	**7.2**
polycarbonate	**81 ± 3**	**540 ± 1**	**6.4**
polyvinyl chloride	**85 ± 6**	**560 ± 3**	**6.1**
Pearson correlation	Between **Conductivity** and **Total Dissolved Solid**	**r = 0.7**	
	Between **Conductivity** and **pH**	**r = - 0.5**	

(Table 1) shows some chemical water determinants of (Electrical conductivity as measured in micro Siemens per centimeter, Total dissolved solids (TDS) as measured in milligrams per litter, and pH), through different plastic types that water was stored in during experiment periods. This table shows the averages of the sampling period and standard deviations of these chemical determinants. The Pearson correlation results between conductivity and total dissolved solid gave a positive relation of (r = 0.7) meaning (direct correlated), this direct proportion reflex increasing TDS value in conjunction with electrical conductivity, while the Pearson correlation results between conductivity and pH given a negative relation of (r = -0.5) meaning (inversely correlated), this inverse proportion clarifies that the pH value was decreasing when the electrical conductivity value was increasing in all plastic tanks studied.

Table 2: The concentrations results of chemical pollutants found in studying plastic tanks.

Contaminants	**Plastic Tank types**	**Concentration (µg/L)**	**t- Test**
Bisphenol A	**Polyethylene**	**<0.01**	**t= 4.585 *(HS)**
	polypropylene	**<0.01**	
	polycarbonate	**0.38 ± 0.04**	
	polyvinyl chloride	**0.57 ± 0.07**	
Phthalates	**Polyethylene**	**<0.01**	**t= 6.027 (HS)**
	polypropylene	**<0.01**	
	polycarbonate	**0.11 ± 0.02**	
	polyvinyl chloride	**0.23 ± 0.03**	
Lead	**Polyethylene**	**<0.01**	**t = 2.995 p>0.05 (NS)**
	polypropylene	**<0.01**	
	polycarbonate	**<0.01**	
	polyvinyl chloride	**<0.01**	

***HS= P<0.001**

(Table 2) was shown the concentrations results of contaminants in different types of plastic tanks, focusing on three main pollutants: Bisphenol A (BPA), Phthalates, and Lead. The concentrations were expressed in micrograms per liter (µg/L). For each plastic type (Polyethylene, polypropylene, polycarbonate, and polyvinyl chloride), the table explains the concentrations of the different pollutants. The values used to explain concentration (<0.01) mean concentrations below 0.01 micrograms per liter. There was a variation and an increasing concentration results value in plastic tank type (polycarbonate, and polyvinyl chloride) than other remaining types in (Bisphenol A and Phthalates) contaminants, while there was a same concentrations results value of all plastic tank types in Lead contaminant. There were highly statistically significant differences (HS= P<0.001) between plastic types tanks in contaminants concentrations of both (Bisphenol A and Phthalates), while the remaining contaminant of Lead was not significant between concentrations in all tank types of p>0.05 (NS).

Discussions:

Through the results of this study, it was found that water from tanks made of polyethylene and polypropylene contained fewer impurities, thus compared to water from polyethylene and polyvinyl Chloride internally, the general characteristics of the tank. These results are consistent with several studies that have examined the effects of these plastics on water quality. For example, a study by (Smith, E. A., et. al, 2018), examined the release of chemicals from various plastic containers into the water, and found that plastic containers produced more chemical pollutants compared to other plastic materials because the results are consistent with this study, which found that polyvinyl Chloride tanks, and phthalates. Furthermore, a study by (Johnson et al., 2019), compared the leakage of chemicals from different types of plastic bottles, such as polyethylene, polypropylene, and polyvinyl Chloride, and found that bottles made of polyvinyl Chloride contain... higher volatile organic compounds (VOCs) compared to bottles made of polyethylene and polypropylene) Because the removal of volatile organic compounds from polyvinyl Chloride containers can degrade the water quality and pose a threat to human health It should be noted that chemical leaching from plastic materials can be affected by conditions such as temperature, length of exposure, and water content. , in 2017 (Li, et al., 2017), where phthalate emissions from different types of plastic bottles were observed to increase under different temperatures, and phthalate emissions were found to increase with increasing temperature, indicating thermal consumption important role in medicine Pay attention to the title. In addition, the choice of plastics in water storage also affects the physical properties of the water such as electrical conductivity and total dissolved solids. These results are consistent with the study by (Chen et al,. 2016), evaluated the effect of different types of plastic water on water quality, and found that water stored in polyvinyl Chloride water contained higher electrical conductivity and TDS values compared to other plastics, thus indicating that the mineral content and salt content are higher. Comparing the results of these studies, it is clear that polyvinyl Chloride tanks consistently exhibit chemical contaminants and mineral content compared to other plastic materials, on the other hand, polyethylene and polypropylene tanks show lower levels of chemical contaminants and water quality was more consistent. This reinforces our research recommendation that tanks be used for domestic drinking water storage (polyethylene and polypropylene). In any case, it should be recognized that scientific experiments may differ in methods, water sources, and storage conditions, which may affect the results. The study found that the pH value was more acidic in polycarbonate and polyvinyl chloride water tanks, while neutral pH value in polyethylene and polypropylene, these results might be due to relation with the increase in the value of electrical conductivity, when it increased the pH value was decreased, due to increasing of hydrogen ion in water resulting from water dissociation and the pH value reflects the concentration of hydrogen ions in the solution. The study found there were no statistical differences in lead concentrations in all water-stored plastic tanks, and it was less than the detection limit (<0.01 µg / L) for (polyethylene, polypropylene tanks, polycarbonate, and polyvinyl chloride polyvinyl Chloride). This result is consistent with the study by (Yang et al., 2020), where the same results of heavy metals

from plastic water storage tanks, The fact that lead concentrations in water samples stored in different plastic tanks were less than the detection limit for polypropylene and polyethylene types, with the same results that we reached. It is important to point out that lead contamination of drinking water can originate from various sources, such as lead pipes and plumbing fixtures. Many studies have focused on the effect of these sources on lead levels in drinking water. For example, (Edwards et al., 2009), a comprehensive study was conducted to examine the release of lead from various plumbing materials, where they found that there is an effect of lead pipes and fittings on the high levels of lead in drinking water, while plastic pipes and fittings had a negligible effect. This suggests that the choice of plastic containers may have a limited effect on lead concentrations compared to other potential sources of lead contamination in the water distribution system. The U.S. The Environmental Protection Agency (EPA, 2021), has set the action level for lead in drinking water at 15 µg/L, below which no correction is required and the World Health Organization, (WHO, 2017), provides guidance a value of 10 µg/ 10 has been established. L for lead in drinking water. The results of this study indicated that lead concentrations in all plastic containers were below detection limits, as they meet these regulatory standards for stored water. While the results of the study showed statistically significant differences in the release of bisphenol A and phthalates for polyethylene and polyvinyl chloride type tanks, as opposed to polyethylene and polypropylene type tanks, obtained lower levels from it are detected, thereby confirming these results that polycarbonate and polyvinyl Chloride tanks pose a significant risk to stored drinking water The result of this study is the impact of different types of plastic containers on drinking water, namely polyethylene and polypropylene containers, It consistently shows lower levels of chemical pollutants and better water quality compared to PC and polyvinyl Chloride tanks. Thus, the results of this study contribute to the growing body of evidence supporting the safe choice of polyethylene and polypropylene containers in drinking water storage.

4. Conclusion and future scope

1-Variations in electrical conductivity had been discovered, with polycarbonate and polyvinyl Chloride displaying better values in comparison to polyethylene and polypropylene. TDS stages followed a similar sample, with polyvinyl Chloride having the highest attention, accompanied by polycarbonate, polyethylene, and polypropylene.

2-PH levels differed among plastic kinds, with polyethylene and polypropylene exhibiting better values as compared to PC and polyvinyl Chloride.

3-Pearson correlation value between E.C and TDS have directly strongly correlated, and the value of electrical conductivity and pH was have inverse strongly correlated.

4-There was a variation and an increasing concentration results value in plastic tanks type of (polycarbonate, and polyvinyl Chloride) than other remaining types in (Bisphenol A and Phthalates) contaminants, while there was a same concentrations of all plastic tanks types in Lead contaminant.

5-The t-test results validated a higher statistical difference in contaminant concentrations among plastic tank types.

6- These findings emphasize the importance of thinking about made material traits whilst selecting plastic tanks for storing water, Based on the results of this study, we conclude that the type of plastic tank used to store drinking water can affect the water quality.

Declaration

We herby that this manuscript, entiteled “The Effect of Different Types of Drinking Water Plastic Tanks Used at Homes on Water Quality: A Study of Various Samples under Standard Conditions”, Is the end result of a collaborative attempt among the researchers concerned. The studies become conducted with none conflicts of interest.

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Conflicts of interest

The authors declare that there are no conflicts of interest or competing interests related to this study.

Ethical approval

This study did not require ethics approval as it did not involve human participants or animal subjects.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Data Availability: The raw data supporting the findings of this study are available on the research gate site, accessible via the coeeresponding personal page.

Authorship and Contribution

The research crew consisted of tow mentioned researcher, with contributions divided equally in all research parts.

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