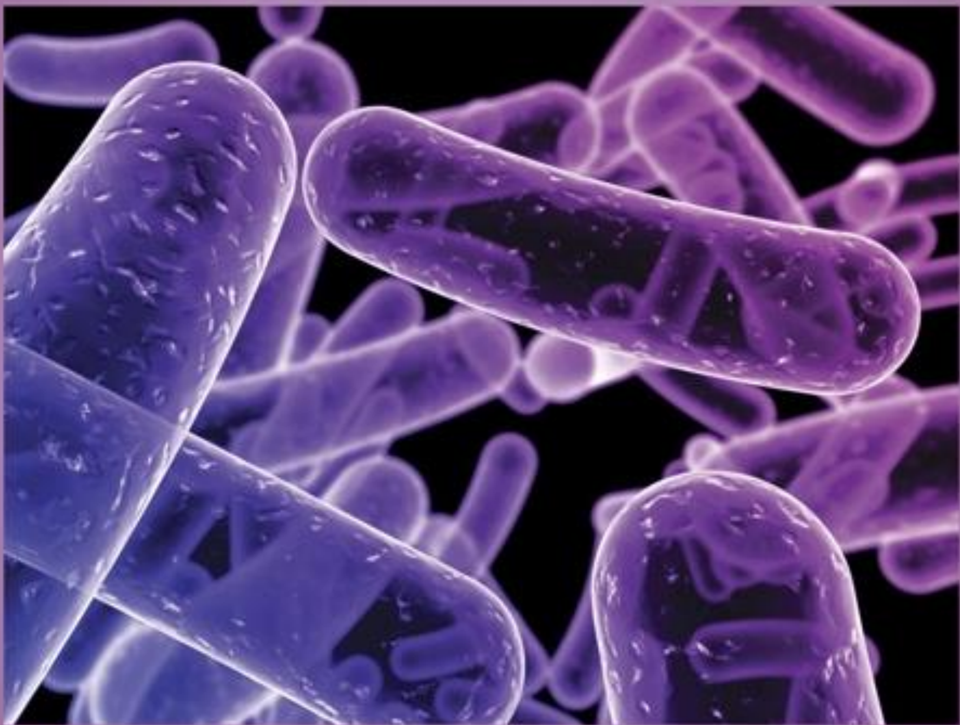
EGYPTIAN ACADEMIC JOURNAL OF
BIOLOGICAL SCIENCES
MICROBIOLOGY

G



ISSN
2090-0872

WWW.EAJBS.EG.NET

Vol. 16 No. 2 (2024)

Citation: *Egypt. Acad. J. Biolog. Sci. (G. Microbiolog) Vol.16 (2) pp.81- 93 (2024)*
DOI: 10.21608/EAJBSG.2024.372134

Egypt. Acad. J. Biolog. Sci., 16(2):81-93 (2024)

Egyptian Academic Journal of Biological Sciences
G. Microbiology

ISSN: 2090-0872
https://eajbsg.journals.ekb.eg/

Assessment of Biological and Chemical Contaminations in Household Taps and Filters Water in Giza Governorate, Egypt

Mohamed A. Kelany[1]; Mahmoud M. Ghuniem[1]; Manal F. Abd-Elaziz[1]; Mahmoud I. Al-Arnos[1]; Wesam S. Ghaly[2] and Mona M. Moghazee[3*]

[1]Ministry of Agriculture and Land Reclamation, Agricultural Research Center, Central Laboratory of Residue Analysis of Pesticides and Heavy Metals in Foods (QCAP Egypt) Giza, 12311, Egypt.
[2]Faculty of Biotechnology, October University for Modern Sciences and Arts (MSA).
[3]Genetics Department, Faculty of Agriculture, Ain Shams University. P.O. Box 68, Hadayek Shoubra 11241, Qaliubiya, Egypt.
*E. Mail: m_moghazee@agr.asu.edu.eg

ARTICLE INFO
Article History
Received:2/7/2024
Accepted:5/8//2024
Available:9/8/2024

***Keywords*:**
Tap and filter water, Heavy metals, Microbial analysis, Nitrate, and nitrite.

ABSTRACT

Water pollution is a fundamental problem that must be addressed. The consequences of drinking water quality on human health have prompted research efforts to focus on its physical, chemical, and biological safety. Therefore, the basis of this study was the implementation to evaluate the chemical and biological characteristics of drinking water at the level of filtered and unfiltered water. The comparison revealed that there were no significant differences in the pH readings and electrical conductivity of household filtered water with tap water, where taps had an average pH of 6.81, but samples from filters had an average pH of 6.7 and mean of conductivity for tab samples was 350.7 EC and it was in filtered sample 365.7 EC. In addition, there was a slight increase in the percentage of nitrates between the filtered and unfiltered samples. As a result of the microbiological count, significant differences appeared between the tab and filtered samples, whereas the mean of the microbial count at 22°C, 37°C and fungi were 49.03, 58.3, and 2.23, respectively, for the tab sample while for filtered samples the median of the microbial count was 207.7, 177.53, and 18.9, respectively. For tap water, the mean concentrations of Al and Mn, were 61.95 mg/kg and 50.43 mg/kg, respectively, which are within the permissible limits set by both Egyptian and European standards for drinking water. For filtered water, the mean concentrations of Al and Zn were 112.46 mg/kg and 51.94 mg/kg, respectively, both of which are within the safe limits as per Egyptian and European standards for drinking water.

INTRODUCTION

Water is vital for all biological activities and is necessary for life on Earth. It is found in the vast oceans that are home to aquatic life and the human body, which is composed mostly of water around 60%. Water acts as a universal solvent, carrying nutrients and waste products between cells (Dargaville & Hutmacher, 2022).

Citation: *Egypt. Acad. J. Biolog. Sci. (G. Microbiolog) Vol.16 (2) pp.81- 93 (2024)*
DOI: 10.21608/EAJBSG.2024.372134

Recently, the lack of water in many Middle Eastern and North African nations become a significant issue. Egypt has turned out to be a dry nation due to the elevation of its population and unsuitable irrigation process. Nearly 97% of Egypt's natural water source is from the Nile River, with roughly 55.5 billion m^3 of freshwater annually. On the other hand, over 2.4 billion m^3 of wastewater is produced annually, making recycling difficult (Badr, 2009; Osman et al. 2021).

The growing demand for water in urban and industrial regions along dry and semiarid coastal zones has prompted the quest for alternate nonconventional water supplies. Desalination facilities are the most practical solution to the massive water demand in dry regions, particularly in Egypt, which has limited Nile River water resources and is likely to cause drought due to climate change and upstream dam development. Desalination technologies, including thermal and membrane, are commonly used to improve the properties of drinking water. Thermal desalination techniques include vapour compression desalination, multistage flash desalination, and multi-effect desalination. Electrodialysis, forward osmosis, and RO are methods used in membrane desalination.

So, water chemical and biological pollution are a serious threat to human health and ecosystems. Chemical pollution refers to pollutants such as heavy metals, industrial waste, and agricultural runoff. In 2002, a study by the World Health Organization underscored the dangers of heavy metals in drinking water, which can cause health problems ranging from developmental disorders in children to organ damage in adults (World Health Organization, 2002). Biological pollution: describes the presence of dangerous microorganisms such as bacteria, viruses, and parasites in water. According to the Centers for Disease Control and Prevention (CDC), contaminated water is the leading cause of diarrheal infections, affecting millions of people worldwide each year (Centers for Disease Control and Prevention CDC, 2021).

One of the expected chemical pollutants is the nitrification process, which is a two-step cycle through which nitrite-oxidizing bacteria oxidize ammonia to nitrite, and nitrite is then oxidized to nitrate by nitrite-oxidizing bacteria. In addition to bacterial nitrification, synthetic nitrogen sources, such as organic matter in soil, manure, and fertilizers dependent on urea, can be converted by mineralization and hydrolysis into nitrate (World Health Organization, 2017; Moloantoa *et al.*, 2022). High nitrate in drinking water can cause a condition called methemoglobinemia, a blood disorder that primarily affects infants below the age of six months.

Humans are more likely to be exposed to heavy metals when drinking fluids, thus bioaccumulating harmful metals occurs in the human body. This causes severe risks to human health and can lead to cancer and other risks (Jamshed *et al.*, 2018). Increased urbanization and industrialization are responsible for increasing concentrations of trace metals in water, especially heavy metals. Chronic diseases of drinking water samples are linked to heavy metals. Many researchers have studied the levels of heavy metals in drinking water and reported their negative effects on human health (Lubal, 2024).

Recently, obtaining and providing clean water and reducing sources of contaminated water has become extremely important, so UV-disinfection systems, membrane filters, and activated carbon filters are the core components of the Point-of-Use (PoU)system. PoUs, or home water treatment systems, have become extremely popular in recent years. These devices are generally used for drinking and cooking and are made to treat a limited amount of contaminated water. They are suitable for short-term responses due to their affordability and ability to accommodate the needs of small groups (Gade *et al.*, 2024).

This study compares the chemical and biological processes of treated water from household filters with tap water. In addition to giving householders advice on how to protect their health by using the filter more successfully, the work's results are anticipated to be beneficial to Egyptians who are interested in utilizing water filters to acquire clean water after recycling it for drinking.

MATERIALS AND METHODS

Materials:

Water Sampling:

Sixty-four tap and filtered water samples (thirty-two of each kind) were collected by trained personnel using pre-sterilized 1 L glass bottles through different regions of the Giza Governorate. The water faucet was disinfected by a wipe that was immersed in 70% alcohol, and water flow was left for a few minutes before the water collection. Tap and filtered water samples were frequently obtained from the Al-Haram district throughout the winter months of 2023/2024.

Media and Chemicals Reagent:

Plate Count Agar (PCA) and Dichloran-Glycerol (DG-18) culture media from Hi-Media™ (India) were used. pH buffer solutions (Merch Millipore™) pH 4.0, 7.0 and 10.0 were utilized for pH verification. In addition, the conductivity buffer solution (HANNA™) 1480µS/cm was used for the conductivity meter verification. In the laboratory, water was deionized (DW) using a Millipore Milli-Q (USA) water purification system. *N-Octylamine* from MERC-Schuchardt, potassium nitrate from ACROS company, sodium nitrate from Organic company, phosphoric acid from ProL ABO company, and ethanol from El-Nasr company. Concentrated nitric acid (69%) purchased from Merck, certified reference metal stock standard solutions (1000 mg/L) of lead (Pb), cadmium (Cd), selenium (Se), copper (Cu), zinc (Zn), iron (Fe), aluminum (Al), chromium (Cr), tin (Sn), cobalt (Co), manganese (Mn) and nickel (Ni) prepared in 2–3% HNO_3 which purchased from Merck –Germany. A stock solution of nitrate and nitrite was prepared from certified reference materials Sigma-Aldrich Trace CERT® with concentrations of 1000 ± 4 mg/l. For a duration of six months, the working solution was prepared using deionized water and nitrate and nitrite ion concentrations of 100 mg/l.

Point-of-use (PoU) System:

PoU filters, which are the type taken into consideration in our study, consist of a fabric pre-filter and a low porosity activated carbon (ACB) block. Express Water Whole House Heavy Duty Mineral Water Filter Kit - 3 Stage Water Filter Replacement Kit - Sediment, Carbon Block, KDF High-Capacity Cartridge Filters - 5 Micron Water Filter 4.5" x 20" Tap-mounted.

Methods:

Several tests were performed on water samples obtained from taps and home filters, such as Chemical analysis assays: pH, Electrical Conductivity (EC) evaluations, Nitrate & Nitrite measurements, and Heavy metals measurements. Furthermore, Microbiological analysis assay (total viable count and total number of fungi).

Chemical Analysis Assays:

1) **pH Measurement Procedure:**

The electrode of the pH meter was rinsed with distilled water and dried, with a clean paper towel or tissue and avoided finger touching, the electrode was rinsed again and dried, and the verification was performed according to the manufacturer manual. A 100 ml beaker was used and rinsed three times with sample water, and 50 ml of sample water (tap or filter) was placed into the beakers. the reading was obtained according to Clark, (2015).

2) **Electrolytic Conductivity (EC):** was measured by following the primary standards based on molality for electrical conductivity (IUPAC Technical Report) according to Pratt *et*

al., 2001. The value was then recorded according to Hou *et al.*, (2019).

3) Measurement of Nitrate and Nitrite:

All reagents used in this procedure were analytically and HPLC graded, 10 ml of phosphoric acid was diluted with deionized water in a 100 ml measuring flask. This solution should be prepared when the volume reaches one-third of its initial volume (Wong *et al.*, 2014).

HPLC Conditions:

HPLC–pump: mobile phase flow rate 0.8 ml/min, analytical column: C8 150× 4.6 mm × 5um, (e.g., ZORBAX Eclipse XDB-C8), injection volume: 10 µl the data analyzed by Software: Chem Station for LC 3D, Rev.

Procedure:

The test methods used to measure the samples were validated in a laboratory, as previously reported (Cheng and Tsang, 1998), and it was also verified to check its performance. Ten grams of sample were weighed in a 250 ml plastic tube, and 100 ml of deionized water was added to be shaken gently in a water bath for 30 minutes at 70^{o} C. Then the solution was allowed to cool down at room temperature, and finally, an aliquot was filtered by a 0.45 µM membrane filter and subjected to HPLC analysis.

4) Heavy Metals Measurements:

Both filtered and unfiltered water had measurements of twelve heavy metals: Al, Zn, Se, Cr, Fe, Mn, Ni, Sn, Co, Cu, Cd and Pb metals by the direct aspiration to Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Preparation of working standard solutions in accordance with the standard preparation procedure according to (Ghuniem *et al.*, 2019; 2022). These solutions covered a range of 100 µg/ml for Pb, Cd, Cu, Sb, Zn, Fe, Sn, Mn, As, Co, Cr, Ni, Se, and Al; a range of 10 µg/ml for Pb, Cd, Cu, Sb, Zn, Fe, Sn, Mn, As, Co, Cr, Ni, Se, and Al; and a range of 1 µg/ml for Pb, Cd, Cu, Sb, Zn, Fe, Sn, Mn, As, Co, Cr, Ni, Se, and Al.

ICP OES Conditions:

ICP OES is a multi-element analysis technique that employs an inductively coupled plasma source to dissociate the sample into its constituent atoms or ions and excite them to the point where they emit light with a specific wavelength. A detector evaluates the intensity of the emitted light and estimates the concentration of that specific element in the sample. The instrument started with plasma view at axial, plasma flow at 12 l/min, auxiliary flow at 0.2 l/min, nebulizer flow at 0.35 l/min ICP radio frequency at1400 Watt, Pump flow rate at 2.5 l/min, View distance at 15 cm, ultrasonic nebulizer heater at 140°C, and ultrasonic nebulizer cooler at 3°C.

5) Microbiological Analysis Assay:

Plate Count Agar (PCA) and Dichloran-Glycerol (DG-18) medium were prepared by dissolving components, adjusting pH according to the manufacturer's instructions, sterilizing, and cooling **(**Tihăuan et al., 2022**)**. Regarding enumeration of bacteria inoculation was done by transferring 1 ml of test sample to Petri plates, followed by adding PCA medium to the Petri plates. Then the inoculated plates were incubated at 37°C and 22°C according to ISO 6222, (1999). For the enumeration of yeast and moulds, inoculation was done by taking 1 ml of the test sample and transferring it to Petri dishes, then adding DG-18 medium to the Petri dishes. The inoculated plates were incubated at 30°C according to PN ISO 21527-1. (2008).

Statistical Analysis:

The analysis of all data was performed with an ANOVA test using SPSS (v19) software. The mean ± standard deviation was used to express the results. A mean difference was considered substantially different if the probability was less than 0.05, and this was defined as significance ($P<0.05$) (Everitt, 2001).

RESULTS

Chemical Analysis Assays:

pH and EC and NO^{3-} and NO^{2-} Measurements:

Samples collected from various household taps had an average pH of 6.81, but samples from household filters had an average pH of 6.7. There was a non-significant variation in pH between the filtered and unfiltered samples ($p > 0.05$), there were no discernible differences between them according to these values. Electrolytic conductivity also reflects a non-significant ($p > 0.05$) increase in conductivity after filtration samples when compared to before filtration (Table 1 & Fig. 1**).** The results showed that all tested samples were free from any detectable amounts of nitrite. On the other hand, the results of nitrate after filtration show a non-significant decrease ($p>0.05$) of nitrate before filtration samples ($p > 0.05$). The values of pH and EC and nitrite and nitrate are found to be within the maximum limits set by both Egyptian and European standards for drinking water (Egyptian Standard, ES No. 1-190, 2007; Egyptian Standard, ES No. 1588, 2005; European regulations, 2014). The mean of the nitrate data for the tab and filtered samples is shown in Table 1 & Figure 1.

Table 1: The Difference Between pH and Electrolytic Conductivity (EC) Before and After Filtration and Nitrogen measure (Before & After) Process.

Parameters	**Filtration**				**Nitrogen**	
	pH		**EC**		**Nitrate (NO^{3-})**	
	Before	**After**	**Before**	**After**	**Before**	**After**
Mean	6.81	6.78	350.7	365.7	0.227	0.22
min	6.10	5.8	202	173	0.00	0.00
max	7.7	7.4	440	480	0.94	0.76
SD	0.331	0.337	70.2	83.7	0.23	0.18
P	0.691		0.44		0.905	

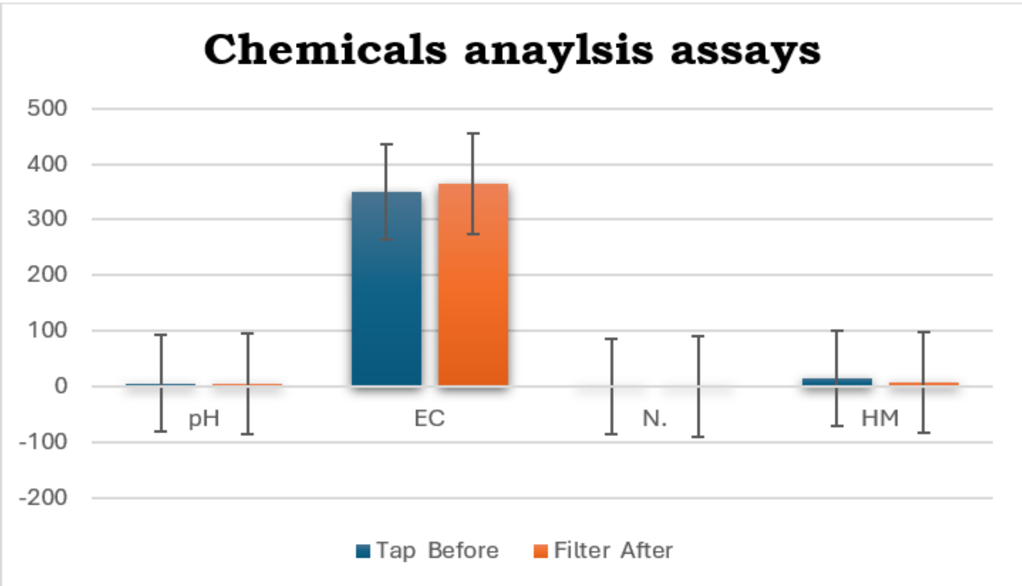


Fig. 1: An illustration of the chemical analysis assays performed on samples before filtration (tap samples "BF") and after filtration (filtration samples "AF"); pH, EC, Nitrogen (N.), Heavy metals (HM).

Heavy Metals Measurement:

The comprehensive analysis of tap and filtered water samples using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) has a valuable insight into the presence of various potentially toxic elements. The study's findings of tap water samples show that Al, Cr, Mn, and Zn were the most recursiveness detected metals, each found in all tested samples. Fe was also commonly detected, appearing in twenty-one samples, while Sn was found in seventeen samples, Co in 14, and Cu in 9. Notably, Se, Ni, and Pb were not found in any of the tested samples, suggesting that the water is free from these contaminants. The mean concentrations of Al and Mn, at 61.95 mg/kg and 50.43 mg/kg respectively, are within the maximum permissible limits set by both Egyptian and European standards for drinking water (Egyptian Standard, ES No. 1-190, 2007; Egyptian Standard, ES No. 1588, 2005; European regulations, 2014), which is reassuring for public health considerations. Also, the detectable amounts of Cd, Cr, Co, Cu, Fe, Sn, and Zn were below the quantification limits further showing that these elements are present in extremely low concentrations, posing no significant health risk. Moreover, the absence of Se, Ni, and Pb is particularly noteworthy, given the health implications associated with these elements as in Table 2.

Table 2: Results of Heavy metals in tap water Samples.

Detected elements	Element's concentrations (µg/L)				Frequency		Free samples		Samples Less than LOQ		Samples Above LOQ		MPL (µg/L)	The violated elements		The violated samples	
	Minimum	Maximum	Mean	Median	No	%	No	%	No	%	No	%		No	%	No	%
Al	< 50	143.60	61.95	50.00	32	100.0%	0	0.0%	19	59.4%	13	40.6%	200	0	0.0%	0	0.0%
Cd	< 1	< 1	1.00	1.00	2	6.3%	30	93.8%	2	6.3%	0	0.0%	3	0	0.0%		
Co	< 50	< 50	50.00	50.00	14	43.8%	18	56.3%	14	43.8%	0	0.0%	-	0	0.0%		
Cr	< 50	< 50	50.00	50.00	32	100.0%	0	0.0%	32	100.0%	0	0.0%	50	0	0.0%		
Cu	< 50	< 50	50.00	50.00	9	28.1%	23	71.9%	9	28.1%	0	0.0%	2000	0	0.0%		
Fe	< 50	< 50	50.00	50.00	21	65.6%	11	34.4%	21	65.6%	0	0.0%	300	0	0.0%		
Se	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	10	0	0.0%		
Mn	< 50	63.82	50.43	50.00	32	100.0%	0	0.0%	31	96.9%	1	3.1%	400	0	0.0%		
Ni	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	20	0	0.0%		
Pb	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	10	0	0.0%		
Sn	< 50	< 50	50.00	50.00	17	53.1%	15	46.9%	17	53.1%	0	0.0%	-	0	0.0%		
Zn	< 50	< 50	50.00	50.00	32	100.0%	0	0.0%	32	100.0%	0	0.0%	3000	0	0.0%		

***N.D: Not Detected
***LOQ: Limit of quantification
MPL: Maximum permissible limits

On the other hand, the study's findings of filtered drinking water samples showed that Cr was the most recursiveness detected element, present in all samples. This was followed by Al, Mn, Sn, and Zn, and each was detected in 31 samples. Fe also commonly, appears in 30 samples. In contrast, Cu and Co were found to be far less recursiveness. It is reassuring to note that none of the water samples had detectable levels of Se, Ni, Cd, or Pb, which are often of concern in environmental health discussions. The mean concentrations of Al and Zn were 112.46 mg/kg and 51.94 mg/kg, respectively, both of which are within the safe limits as per Egyptian and European standards for drinking water. The detected amounts of Cr, Co, Cu, Fe, Mn, Sn, and Zn were below the quantification limits, suggesting that the water samples are safe concerning these elements. The adherence to permissible limits for Al and Mn further corroborates the water's compliance with safety standards, ensuring that the water quality is within acceptable health parameters. This comprehensive analysis underscores the importance of regular monitoring of drinking water to safeguard public health against the potential adverse effects of elemental contaminants, (Table 3).

Table 3: Results of Heavy metals in filtered water Samples.

Detected elements	Element's concentrations (µg/L)				Frequency		Free samples		Samples Less than LOQ		Samples Above LOQ		MPL (µg/L)	The violated elements		The violated samples	
	Minimum	Maximum	Mean	Median	No	%	No	%	No	%	No	%		No	%	No	%
Al	< 50	181.90	112.46	107.00	31	96.9%	1	3.1%	3	9.4%	28	87.5%	200	0	0.0%	0	0.0%
Cd	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	3	0	0.0%		
Co	< 50	< 50	50.00	50.00	2	6.3%	30	93.8%	2	6.3%	0	0.0%	-	0	0.0%		
Cr	< 50	< 50	50.00	50.00	32	100.0%	0	0.0%	-	0.0%	32	100.0%	50	0	0.0%		
Cu	< 50	< 50	50.00	50.00	4	12.5%	28	87.5%	4	12.5%	0	0.0%	2000	0	0.0%		
Fe	< 50	< 50	50.00	50.00	30	93.8%	2	6.3%	30	93.8%	0	0.0%	300	0	0.0%		
Se	N.D	N. D	N. D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	10	0	0.0%		
Mn	< 50	< 50	50.00	50.00	31	96.9%	1	3.1%	31	96.9%	0	0.0%	400	0	0.0%		
Ni	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	20	0	0.0%		
Pb	N.D	N.D	N.D	N.D	0	0.0%	32	100.0%	0	0.0%	0	0.0%	10	0	0.0%		
Sn	< 50	< 50	50.00	50.00	31	96.9%	1	3.1%	31	96.9%	0	0.0%	-	0	0.0%		
Zn	< 50	106.50	51.94	50.00	31	96.9%	1	3.1%	2	6.3%	29	90.6%	3000	0	0.0%		

***N.D: Not Detected
***LOQ: Limit of quantification
MPL: Maximum permissible limits

Microbiological Examination:

The total number of bacteria increased significantly in the filtered samples compared to the unfiltered tap samples at 37°C and 22°C, respectively. In contrast, the bacteria that were recovered from the PCA medium had the same outcome. The mean at 37°C before filtration was 58.3 and after filtration was 177.5 colonies, while at 22°C before filtration was 49 and after filtration was 207. Most results above are on the border of acceptable limits of the Egyptian standard for drinking water (Egyptian Standard, ES No. 1-190, 2007; Egyptian Standard, ES No. 1588, 2005), the total number of yeast and moulds grown on Dg-18 medium increased non-significantly in the filtered samples. The mean number of yeast and moulds before filtration was 2.23 and 18.9 After filtration. The mean total number of microorganisms differs noticeably between the tab and filtered samples, all these results are shown in Table 4 & Figure 2.

Table 4: Shows the difference between total bacteria count in PCA media at 37^{o}C and 22^{o}C, while yeast and molds count in PCA media at 30^{o}C.

Media	Tm	Before/ after	Median	Minim	Maxim	SD	P
PCA	37^{o}C	BF	58.3	0.00	301	114.8	0.001
		Af	177.53	0.00	301	145.4	
	22 ^{o}C	Bf	49.03	0.00	301	110.2	0.0001
		Af	207.7	0.00	301	140.5	
Dg-18	30°C	Bf	2.23	0.00	30	6.6	0.209
		Af	18.9	0.00	301	73.1	

DISCUSSION

The pH standard for drinking water is specified by the water quality rules to be between 6.5 and 9.5. The pH of the water that enters the treatment facilities would be between 7 and 9. As it moves through the system of reservoirs and water mains, this could be altered (World Health Organization, 2007). This may prove that the acids in drinking water cannot be neutralized by ordinary household filters, the National Research Council, division on Earth, Life Studies, water science, Technology Board, committee on Public Water Supply Distribution Systems and Reducing Risks (2005) stated that. Calcite or crushed calcite (calcium carbonate) is used by acid-neutralizing filters to regularly alter pH. This increases the alkalinity and durability of water that passes through the filters as it absorbs minerals (Nasr *et al.,* 2014)

The EC of the samples after filtration increased about 2.5 times that of the samples taken before filtration. This may be due to the increase in ions present in the home filtration system, which help in manufacturing filters, or they are added inside the filter for other purposes unrelated to electrical conductivity, such as the presence of some dissolved solids such as calcium, magnesium, and chloride (Assad, 2015). Therefore, the ions in the solution carry an electric current, and the electrical conductivity increases with the ion concentration, according to Laghari *et al.* (2018).

When measuring both nitrate and nitrite in filtered and unfiltered samples, the result showed the presence of only nitrate. However, the result was not significant for the tap samples, as the presence of nitrates in them ~~is~~ due to several reasons, including the presence of waste seeping into the water samples or the duration of storage in water tanks, and this is consistent with Woolverton, (2015). While the percentage of nitrates in the filtered samples was somewhat significant, this agreed with Daley (2017) who stated that selective ion exchange filters for nitrates work by absorbing nitrate ions from anion-circulating resins. This is also consistent with the increase in microbial load achieved by the experiment, which leads to an increase in nitrates, according to the World Health Organization, (2017).

Heavy metals like Co, Sn, Fe, Cr, and Al were found to be significantly decreased in the filtered samples when compared to the unfiltered tap sample, but the remaining metals did not significantly decrease in the filtered samples **(**Badr et al., 2011). This is because of a close relationship between the heavy metal content of water, the water supply and its source, the disposal technique used to remove the heavy metals from the water, and the total length of pipes and piping items used to supply water to homes. The findings of this study align with the previous research, showing that the mean concentrations of chromium, lead, cadmium, and iron are significantly lower in tap water compared to filtered water. This is an important consideration for public health, as these metals can have various adverse effects on human health. Regulatory agencies like the EPA have set maximum contaminant levels for these metals in drinking water to ensure safety and protect against potential health risks (Taylor *et al.,* 2005; Niu *et al.,* 2006; Radulescu *et al.*, 2014).

The microbial load was measured by counting the number of colonies for all 32 samples taken from household faucets and household filters and measuring on a count basis. This confirms that filters are sometimes a source of increased bacterial content or a fertile environment for microbial growth. This is consistent with Wu *et al.*, (2017) and Nriagu, *et al.*, (2018), and this may be due to many influencing factors such as a low percentage of residual disinfectant elevated temperature in the storage tanks and relatively long residence time in storage tanks.

Conclusion and Recommendations:

In conclusion, the results of this study provide the status of tap water and filtered water quality with respect to the elements tested, and study the use of home filters, which have become widely used at the present time in various countries and societies and may have a significant impact on obtaining clean water (if used correctly), as there are some instructions that obtained through the study stating that the home filter must be cleaned. By the company or technician every two months. The cartridge must also be replaced at least every 4 months according to the manufacturer's instructions. Choosing a home filter is also important because sometimes there is a distinct difference between the several types of filters. All these things are important for improving public health, as drinking water contributes to vital and physiological interactions within the human body. In this study, the results are found to be generally positive, but they serve as a reminder of the need for continued vigilance in water quality testing. Continuing to protect public health and ensuring the provision of clean and safe drinking water for all requires diligent efforts to evaluate water pipes and their quality.

Declarations:

Ethical Approval: Not applicable.

Conflicts of Interest: The authors declare that they have no competing interests.

Authors Contributions: Mohamed A. Kelany, Mahmoud M. Ghuniem and Manal F. Abd-Elaziz contributing conceptualization, Wesam S. M. Ghaly and Mahmoud I. Al-Sayed did manual scientific experiments. Wesam S. Ghaly and Mahmoud I. Al-Sayed collected, prepared, analysis, and drafted data. Mahmoud M. Ghuniem, Mona M. Moghazee and Mahmoud I. Al-Sayed contributed writing and approval of the contents. Mohamed A. Kelany and Mona M. Moghazee did the work of paraphrasing and measuring the plagiarism ratio. Wesam S. M. Ghaly collected the water samples. Mohamed. A Kelany, Mahmoud M. Ghuniem and Mona M. Moghazee generated the numbers and did the final revision. Mohamed A. Kelany and Mona M. Moghazee supervised all stages of manuscript preparation. Manal F. Abd-Elaziz, Mahmoud M. Ghuniem, Mohamed A. Kelany, and Mona M. Moghazee contributed to the publication. Mohamed A. Kelany and Mona M. Moghazee have read, reviewed, and approved the content of the last version of this review.

Consent to publication: Not applicable.

Funding: Not applicable.

Availability of Data and Materials: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgements: My thanks and gratitude to Professor Dr. Fatma Mohamed Ibrahim Badawy (may God have mercy on her), Professor of Microbial Genetics, Department of Molecular Genetics and Biotechnology, Faculty of Agriculture - Ain Shams University, Faculty of Agriculture, Ain Shams University, who taught me the basics of scientific life. friendship. Eman M. Fahmy, Professor of Immunological Genetics, Department of Genetics, for her assistance in proofreading and linguistic review.

REFERENCES

Assad, A. I. G. (2015). Quality of tap drinking water in Kuwait: physicochemical characteristics. In 2015 International Conference on Sustainable Mobility Applications, Renewables and Technology (SMART) (pp. 1-4). IEEE. https://doi.org/10.1109/ SMART.2015.7399256

Badr, E. A., Agrama, A. A., & Badr, S. A. (2011). Heavy metals in drinking water and human health, Egypt. *Nutrition & Food Science,* 41(3), 210-217. https:// doi.org/10. 1108/ 003466511111 32484

Badr, E. S. A. (2009). Evaluation of the environmental impact assessment system in Egypt. *Impact Assessment and Project Appraisal*, *27*(3), 193-203. https:// doi.org/10.3152/146155109X465 959

Centers for Disease Control and Prevention (CDC) (2021). Waterborne Diseases. https://www.cdc.gov/ healthy-water-data/about/ index. html

Cheng, C. F., & Tsang, C. W. (1998). Simultaneous determination of nitrite, nitrate, and ascorbic acid in canned vegetable juices by reverse-phase ion-interaction

HPLC. *Food Additives & Contaminants,* 15(7), 753-758. https://doi.org/10.1080/02652039809374706

Clark, I. (2015). Sampling and Analysis. Groundwater Geochemistry and Isotopes, 381–402. https://doi.org/10.1201/b18347-11

Daley, D. J. (2017). Nitrate in domestic water supplies: potential adverse health effects. *Clearwaters, 47* (Summer), 53. https://experts.esf.edu/ esploro/outputs/magazine article/nitrate-in-domestic-water-supplies-potential/99915879904826

Dargaville, B. L., & Hutmacher, D. W. (2022). Water is the often neglected medium at the interface between materials and biology.*Nature Communications, 13*(1), 4222. https://doi.org/10.1038/s41467-022-31889-x

Egyptian Organization for Standardization and Quality (2005). Guidelines for Potable Bottled Natural Mineral Water, ES No. 1588, ICS: 67.160.20, (Cairo, Egypt).

Egyptian Organization for Standardization and Quality (2007). Guidelines for Drinking Water, part (1) ES No. 1-190 (Cairo, Egypt).

Elsaie, Y., Ismail, S., Soussa, H., Gado, M., & Balah, A. (2023). Water desalination in Egypt; literature review and assessment. *Ain Shams Engineering Journal/Ain Shams Engineering Journal,* 14(7), 101998. https://doi.org/10.1016/j.asej.2022.101998

European Union (Drinking Water) Regulations (2014), S.I. No. 122, 21. http://www.irishstatutebook.ie/eli/2014/si/122/made/en/pdf

Everitt, B. S. (2001). Statistics for psychologists: An intermediate course. Psychology Press. https://doi.org/10.4324/9781410605542

Gad, M., Marouf, M. A., Abogabal, A., Hu, A., & Nabet, N. (2024). Commercial reverse osmosis point-of-use systems in Egypt failed to purify tap water. *Journal of Water and Health,*22 (5): 905–922. https://doi.org/10.2166/wh.2024.036

Ghuniem, M. M., Khorshed, M. A., & Souaya, E. R. (2019). Method validation for direct determination of some trace and toxic elements in soft drinks by inductively coupled plasma mass spectrometry. *International Journal of Environmental Analytical Chemistry,* 99(6), 515-540. https://doi.org/10.1080/03067319.2019.1599878

Ghuniem, M. M., Khorshed, M. A., El-Safty, S. M., Souaya, E. R., & Khalil, M. M. (2022). Potential human health risk assessment of potentially toxic elements intake via consumption of soft drinks purchased from different Egyptian markets. *International Journal of Environmental Analytical Chemistry,* 102(15), 3485-3507. https://doi.org/10.1080/03067319.2020.1770742

Hou, J. P., Li, R., Wang, Q., Yu, H. Y., Zhang, Z. J., Chen, Q. Y., ... & Zhang, Z. F. (2019). Three principles for preparing Al wire with high strength and high electrical conductivity. *Journal of Materials Science & Technology, 35*(5), 742-751. doi.org/10.1016/j.jmst.2018.11.013

International Organization for Standardization (ISO) (2008). Microbiology of food and animal feeding stuffs Horizontal method for the enumeration of yeasts and moulds Part 1: Colony count technique in products with water activity greater than 0, 95. ISO 21527-1: 2008.

ISO 6222 (1999). Water quality Enumeration of culturable micro-organisms Colony count by inoculation in a nutrient agar culture medium. International Organization for Standardization, Geneva, Switzerland.

Jamshaid, M., Khan, A. A., Ahmed, K., & Saleem, M. (2018). Heavy metal in drinking water and its effect on human health and its treatment techniques-a review. International Journal of Biosciences,12(4), 223-240. http://dx.doi.org/10.12692/ijb/12.4.223-240

Laghari, A. N., Walasai, G. D., Jatoi, A. R., Shaikh, F. A., & Siyal, Z. A. (2018). Performance analysis of water filtration units for reduction of pH, Turbidity, Solids and Electricity Conductivity. Engineering, *Technology & Applied Science Research,* 8(4), 3209-3212. https://doi.org/10.48084/etasr.2100

Lubal, M. J. (2024). Health effects of heavy metal contamination in drinking water. *Uttar Pradesh Journal of Zoology,* 45(10), 16-25. https://doi.org/10.56557/upjoz/2024/v45i104041

Moloantoa, K. M., Khetsha, Z. P., Van Heerden, E., Castillo, J. C., & Cason, E. D. (2022). Nitrate water contamination from industrial activities and complete denitrification as a remediation option. *Water*, 14(5), 799. https://doi.org/10.3390/w14050799

Nasr, A. B., Walha, K., Puel, F., Mangin, D., Amar, R. B., & Charcosset, C. (2014). Precipitation and adsorption during fluoride removal from water by calcite in the presence of acetic acid. *Desalination and Water Treatment*, 52(10-12), 2231-2240. https://doi.org/10.1080/19443994.2013.799441

National Research Council, Division on Earth, Life Studies, Water Science, Technology Board, Committee on Public Water Supply Distribution Systems, ... & Reducing Risks (2005). *Public water supply distribution systems: Assessing and reducing risks: First report*. National Academies Press. http://www.nap.edu/catalog/1172.html

Niu, Z.B., Wang, Y., Zhang, X.J., He, W.J., Han, H.D. & Yin, P.J. (2006), “Analysis of influence factors and control methods on iron release phenomenon in drinking water distribution system”, *Huanjing Kexue,* 27, 2, 310-14. PMID: 16686195.

Nriagu, J., Xi, C., Siddique, A., Vincent, A., & Shomar, B. (2018). Influence of household water filters on bacteria growth and trace metals in tap water of Doha, Qatar. *Scientific Reports,* 8(1). https://doi.org/10.1038/s41598-018-26529-8

Osman, H. E. M., Abdel-Hamed, E. M. W., Al-Juhani, W. S. M., Al-Maroai, Y. A. O., & El-Morsy, M. H. E. M. (2021). Bioaccumulation and human health risk assessment of heavy metals in food crops irrigated with freshwater and treated wastewater: A case study in southern Cairo, Egypt. *Environmental Science and Pollution Research,* 28(36), 50217-50229. https://doi.org/10.1007/s11356-021-14249-y.

Pratt, K. W., Koch, W. F., Wu, Y. C., & Berezansky, P. A. (2001). Molality-based primary standards of electrolytic conductivity (IUPAC Technical Report). *Pure and applied chemistry,* 73(11), 1783-1793. https://doi.org/10.1351/pac200173111783.

Radulescu, C., Dulama, I. D., Stihi, C., Ionita, I., Chilian, A., Necula, C., & Chelarescu, E. D. (2014). Determination of heavy metal levels in water and therapeutic mud by atomic absorption spectrometry. *Romanian Journal of Physics*, 59(9-10), 1057-1066.

Taylor, J., Dietz, J., Randall, A., & Hong, S. (2005). Impact of RO-desalted water on distribution water qualities. *Water Science and Technology*, 51(6-7), 285-291. doi.org/10.2166/wst.2005.0648

Tihăuan, B. M., Axinie, M., Marinaș, I. C., Avram, I., Nicoară, A. C., Grădișteanu-Pîrcălăbioru, G., & Pîrvu, L. (2022). Evaluation of the putative duplicity effect of novel nutraceuticals using physico-chemical and biological in vitro models. *Foods*, *11*(11), 1636. doi.org/10.3390/foods11111636.

Wong, Y. F., Makahleh, A., Saad, B., Ibrahim, M. N. M., Rahim, A. A., & Brosse, N. (2014). UPLC method for the determination of vitamin E homologues and derivatives in vegetable oils, margarines and supplement capsules using pentafluoro phenyl column. *Talanta*, *130*, 299-306. http://dx.doi.org/10.1016/j.talanta.2014.07.021

Woolverton, P. (2015). Fact sheet: Nitrate in drinking water. *State of Oregon Department of Environmental Quality*, (4), 19. doi.org/10.1016/S0002-8223(97)00353-2

World Health Organization (2002). Guidelines for drinking-water quality. World Health Organization.

World Health Organization (2017). Nitrate and Nitrite in Drinking Water, background Document for Development of WHO Guidelines for Drinking Water Quality. Background Document for Development of WHO Guidelines for Drinking Water Quality, 31. doi.org/10.1159/000225441

World Health Organization. (2008). Guidelines for drinking-water quality: second addendum. Vol. 1, Recommendations. World Health Organization.

Wu, C. C., Ghosh, S., Martin, K. J., Pinto, A. J., Denef, V. J., Olson, T. M., & Love, N. G. (2017). The microbial colonization of activated carbon block point-of-use (PoU) filters with and without chlorinated phenol disinfection by-products. Environmental Science: Water Research & Technology, 3(5), 830-843. https://doi.org/10.1039/C7EW00134G

ARABIC SUMMARY

تقييم التلوث البيولوجي والكيميائي في الصنابير ومرشحات المياه المنزلية في محافظة الجيزة، مصر

محمد عبد الحكيم كيلاني[1]؛ محمود مصطفى غنيم[1]؛ منال فوزي عبد العزيز[1]؛ محمود إبراهيم العرنوس[1]؛ وسام غالي[2]؛ منى محمد مغازي[3]*

1 مركز البحوث الزراعية، المعمل المركزي لتحليل متبقيات المبيدات والعناصر الثقيلة في الأغذية (**QCAP**)، وزارة الزراعة وإستصلاح الأراضي، الجيزة، 12311، مصر.
2 كلية التكنولوجيا الحيوية جامعة أكتوبر للعلوم الحديثة والآداب (**MSA**)
3 قسم الوراثة، كلية الزراعة، جامعة عين شمس. ص.ب 68، حدائق شبرا 11241الخيمة، القليوبية، مصر.

تلوث المياه مشكلة خطيرة يجب معالجتها. لقد دفعت عواقب جودة مياه الشرب على صحة الإنسان الجهود البحثية للتركيز على سلامتها الفيزيائية والكيميائية والبيولوجية على مدار العشرين عاماً الماضية. لذلك كان أساس دراستنا هو تقييم الخصائص الكيميائية والبيولوجية لمياه الشرب (على مستوى المياه المفلترة وغير المفلترة). وأظهرت المقارنة عدم وجود فروق معنوية في قراءات الرقم الهيدروجيني والتوصيل الكهربائي للمياه المنزلية المفلترة مع مياه الصنبور، بالإضافة إلى زيادة طفيفة في نسبة النترات في المياه بين العينات المفلترة وغير المفلترة أيضاً. تأكد وجود نسبة من المحتوى الميكروبيولوجي نتيجة لبعض العوامل مثل إنخفاض نسبة بقايا المطهرات وإرتفاع درجة الحرارة في الخزانات ومدة البقاء الطويلة نسبياً في الخزانات. وأخيراً ننصح الدولة بإعطاء الأولوية للإصلاح الدوري لشبكة توزيع أنابيب المياه ونوصي بإستخدام الفلاتر في السكن والتي يجب صيانتها بإستمرار. وذلك لضمان أن المياه المعالجة تلبي دائماً المتطلبات المحددة مسبقاً لخصائصها الكيميائية والفيزيائية.