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Improvement of Drinking Water (Surface and Ground) Quality Beneficial to Human Use

Raafat A Mandour*
Toxicology Unit, Emergency Hospital, Mansoura University, Egypt

Abstract

Water quality guidelines can be used to identify constituents of concern in water, to determine the levels to which the constituents of water must be treated for drinking purposes. Membrane technology for the water cycle is playing an important role in the provision of safe water supply and treatment. The aim of this paper is to improve the water quality, to be valid for domestic purposes, through minimizing the health risks associated with either direct or indirect use of water. The need for standards and guidelines in water quality stems from the need to protect human health. The results revealed that there were several areas polluted chemically by some heavy metals (Ni, Cd, Pb, Mn and Fe), and microbiologically by *Entamoeba histolytica*, Amoeba, Egg of Nematodes and Total count of Bacteria. We conclude and recommend that water must be treated with better membranes, with both higher permeability and tighter cutoff. Removal of chemical constituents must be done, and sewage system projects should be implemented in all towns and villages.

Keywords: Water quality; Guidelines; Membranes

Introduction

Water supply is a worldwide issue that is becoming increasingly evident in many countries. From a socio-economic standpoint, increasing water resources by reuse can strengthen the infrastructure of a country, and improve the lives of its people. We have been facing increasing problems due to the pollution of the surface and ground waters. Major water bodies receive increasing loads due to the inadequate and insufficient treatment facilities. Due to the geography and climate variations around the world, approximately 70% of the renewable water resources are unavailable for human use [1,2]. Lack of a sufficient quantity of water suitable for irrigation and drinking can lead to food shortages and health concerns for millions. In addition, water scarcity can stifle a nation's economy, fuel conflicts, and negatively impact the environment [3]. The global water supply is being stressed further, as human population continues to grow exponentially [4]. Consequently, there is an urgent need to increase water. The standard Reverse Osmosis (RO) membrane is a Thin Film Composite (TFC), and its introduction in the late 1970s was a major advance in membrane preparation, resulting in greatly improved permeability and retention. Recently, there have been new developments involving thin film nano-composite (TFN) RO membranes [5].

The aim of drinking water quality management is to minimize the health risks associated with either direct or indirect use of water. The need for standards and guidelines in water quality stems from the need to protect human health.

Materials and Methods

All samples were manually collected in two liter polyethylene bottles for chemical analysis and in one sterile liter glass bottle for microbiological analysis, using the procedure described in the standard methods for the examination of water and wastewater [6]. Forty three samples representing different types of drinking water (surface and wells), were selected, according to the specific objectives of the study.

Heavy metals were measured by Atomic Absorption Spectrophotometer (AAS) Buck Scientific Company, USA. The primary concern of the study on domestic pollution is assessing microbiological contamination.

Microbiological analysis

From the public health point of view, the coliform bacilli with some of pathogenic bacteria are the most important to investigate. This is done as follows:-

Total count of bacteria: Bacteria are single-called micro-organisms that cause disease, termed as pathogens. The total count of bacteria for each water sample is done by pour plate method. This must not exceed 50 cell/ml at 37°C for 24 hours, or 22°C for 48 hours.

Total coliform: The term total coliform refers to rod shaped, non-spore-forming bacteria. The coliform group bacteria are capable of producing acid and gas from lactose in a suitable culture medium, using MacConkey Broth at 35 to 37°C. It is customary to report results as Most Probable Number (MPN). The MPN is not an exact enumeration, but a high probability estimate of a coliform count per 100 ml of water. These counts are reported as MPN/100 ml. The water sample must not exceed than 3 cell/100 ml, according to Egyptian Ministry of Health (EMH) [7].

Biological analysis: Microscopic examination for living microorganisms (protozoa, bluish green algae) is made without any treatment. Few drops of water samples are put on a glass slide and examined by light Microscope, using high power.

Results

Table 1 represents the chemical results of polluted drinking water samples by some heavy metals, which exceed than the permissible

***Corresponding author:** Raafat A Mandour, Toxicology Unit, Emergency Hospital, Mansoura University, Egypt, Tel: 00201225260108; E-mail: mandourraafat@yahoo.com

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limits of WHO [8] and EMH [7]. Table 2 shows the microbiological contamination in most of the studied drinking water samples.

Water treatment

Powdered limestone is effective in removing Pb^{2+} ions from aqueous solutions, tap water and natural water samples. It is an inorganic sorbent which is abundant in nature, low in cost, and have minimal environmental impact for restoration or remediation of natural resources. The experimental results revealed that this simple sportive-flotation procedure, using limestone as a sorbent and oleic acid as a surfactant, succeeded in removing nearly 99% of Pb^{2+} ions from aqueous solutions at pH 7, after shaking for 5 min and at room temperature (~ 25°C). The sorption of lead ions onto limestone may proceed *via* cation exchange, precipitation of lead hydroxide, and/or lead carbonate [9]. Moreover, the recommended procedure was successfully applied to some natural water samples, and was nearly free from interferences of some selected foreign ions [10]. Iron and Manganese is removed by passing air through nozzle and drawing water from production well. via centrifugal pumps, due to oxidation of iron and manganese ions by aeration compressor. Potassium permanganate and sodium hydroxide are added to adjust the pH, before reaching the cemented aeration tank. Thirty minutes time is required to collect the water in cemented aeration tank. Pressure sand filters were used for retention of the resulted sediments in sedimentation tank, and then the pure water was chlorinated before reaching to the network. Apart from the places (samples 17, 18) mentioned in table 1, treatment units must be made prevalent throughout the Fe and Mn polluted areas, as suggested before. It is noted that the water treatment of both well No 17 and 18 at Mit-Ghamr district has improved the quality of drinking water by decreasing the Fe and Mn values distinctly from 0. 49 and 0. 45 ppm to 0.001 and 0.003 ppm, respectively.

Discussion

Table 1 shows the values of detected heavy metals, such as Cd, Ni, Pb, Mn and Fe in some of the studied samples, higher than the permissible limits of WHO [8] and EMH [7]. This might be due to discharged domestic wastewater of many villages, which lies on the two sides of the two branches of Nile. Also, these two branches receive through distributaries canals, the agricultural wastes such as pesticides, fertilizers and other residues. Table 2 shows that the polluted drinking water samples by micro-organisms (bacteria, coliform, bluish green algae and protozoa) exceed than the permissible limits of EMH [7]. The risks from chemical pollution of water are on a small scale compared with the hazards from microbial contamination of drinking water. Among 20 to 30 different infective diseases may be affected by change in water supply. Many of these water related diseases depend on facial access to domestic water sources. The chain transmission may be broken by safe disposal of faeces, as well as by protection of the water supplies. It is important to mention that bacteria may survive for more than six months in proper subsurface environment [11]. Most of the study area is devoid of sewage system. Many people use septic tanks without any cautions, for preventing the water from contamination.

NO	**District / sample name**	Cd	Ni	Pb	Mn	Fe
Permissible limit of WHO		0.003	0.07	0.01	0.4	0.3
Permis0073ible limit of EMH		0.003.	0.02	0.01	0.4	0.3
I	**El-Mansoura district**					
	1-Network of Shoha station	0.0	**0.022**	0.006	0.010	0.023
II	**Talkha district**					
	2-Network of Mit-antar	0.001	0.013	**0.022**	0.011	0.001
	3-Demera	0.002	0.007	**0.019**	0.004	0.002
III	**Nabaru district**					
	4-Nabaru	0.001	0.006	**0.021**	0.012	0.001
IV	**Sherbin district**					
	5-Network of Sherbin station	0.004	0.006	0.0	0.001	0.002
V	**Bilqas district**					
	6-Network of Bilqas station	0.002	**0.029**	0.0	0.001	0.003
	7-El-satamony	**0.004**	0.010	0.003	0.0	0.001
VI	**Minyet el-nasr district**					
	8- Mit-asim	0.003	0.018	0.003	0.001	0.011
VII	**El-Gamalia district**					
	9-Network of El-Gamalia station	**0.004**	**0.021**	0.002	0.001	0.001
0.001	**Aga district**					
	10-Ikhtab well	0.003	0.013	0.003	0.0	0.002
	11-Mit EL-Amil well	**0.004**	0.005	0.001	0.0	0.001
	12-Network of Aga el-gadida	0.002	**0.024**	0.001	0.004	0.005
IX	**Mit-ghamr district**					
	13-Atmeda well	**0.004**	0.007	0.0	0.014	0.038
	14-Damas well	0.001	0.015	0.027	0.009	0.001
	15-Mit-el ezz well	0.0	**0.023**	0.001	0.0	0.008
	16-Dandit well	**0.005**	0.013	0.0	0.0	0.001
	17-Mit-Mohsen well before treatment	0.0	0.0	0.004	**0. 45**	**0.49**
	18-Mit-Mohsen well after treatment	0.001	0.006	0.002	**0.003**	**0.001**
	19-Mitelfaramawy well	0.025	0.460	0.140	0. 43	0.36
	20- Sahragt el-kobra	0.027	0.007	**0.031**	0.005	0.002

Table 1: Chemical results of polluted drinking water samples by some heavy metals (mg/l).

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Also, disposal sites and open drains, in which the wastes usually are disposed, are present extensively in the area. According to WHO [8] and EMH [7] standard limits for drinking, the drinking water must not contain any bacteria. The differentiation of the microbial load might be attributed to the volume, the type and the source of pollution of the water sources. Thus, the drinking water must be treated, made free of microbiological pollution, before distributing it to consumers. Also, it is very important to prevent different sources of microorganisms to reach drinking water. Sewage system projects are implemented in all towns and villages. Potential pretreatment strategies include inactivation by advanced oxidation, such as UV, with the addition of bio-film signaling agents that either disperse or interfere with quorum sensing [12]. In water treatment, the contaminants are typically pathogens, colloids, non organic materials, and in some cases, trace organic compounds (natural and synthetic). Low pressure membranes are playing a major role in water treatment.

For some membranes, there is a need to improve retention at the same or higher water permeability, and this has been achieved by 'stretched pore' membranes [13], where the elongated pores achieve higher permeability, along with lower molecular weight cutoff. Water reclamation by RO could be assisted by improved bio-fouling control strategies under development. Guidelines are set of values of specific parameters deduced from the studies and field observations that typically represent the upper limit of safe usage. No single set of water quality guidelines is universally applicable. Many factors, including the level of technology, economic status, relative associated risk and field conditions, influence the variability of guidelines among nations [3,14,15]. The common standards are adapted to make water safe to drink. RO is now the predominant method of desalting. Membrane distillation (MD) is a thermally driven membrane process, which has the benefit of ambient pressure and the ability to operate at very high

Permissible limit of EMH		≤ 50 cells/1 cm^3 at 37°C for 24 hrs	≤ 2 cells/100 cm^3	Total count of algae ≤ 1×10^4/L	protozoa
I	**El-Mansoura district**				
	1-Network of new main station			0.01×10^{4}`	Amoeba 20/L Egg of Nematodes 5/L
	2-Old main station	20		0.04×10^{4}`	Egg of Nematodes 5/l
	3-Network			0.01×10^{4}`	Egg of Nematodes 5/L
	4-Shoha Station	60		2.28×10^{4}	Amoeba 150/L
	5-Network of Shoha Station				Amoeba 20/L
II	**Talkha district**				
	6-Main station	7		0.09×10^{4}`	Egg of Nematodes 80/L
	7-Network			0.07×10^{4}`	Egg of Nematodes 40/L
	8-Network of Mit-antar			0.21×10^{4}`	*Entamoeba histolytica* cyst 40/L
III	Dekernis district				
	9-Main station	3		0.14×10^{4}	Amoeba 80/L
	10-Network			0.13×10^{4}	Amoeba 80/L
IV	**Sherbin district**				
	11-Sherbin Main station	0		0.13×10^{4}`	*Entamoeba histolytica* cyst 40/L
	12-Network of Sherbin station			0.11×10^{4}`	*Entamoeba histolytica* cyst 40/L
	13-Main station of Bosat	3		0.04×10^{4}`	Amoeba 80/L
	14-El-hag Sherbini			0.05×10^{4}`	Amoeba 80/L
	15-Ras el-khalig				*Entamoeba histolytica* cyst 40/L
V	**Bilqas district**				
	16-Network of Bilqas station	1		0.11×10^{4}`	Amoeba 1600/L
	17-Basindela	0		0.09×10^{4}`	Amoeba 40/L
VI	El-Gamalia district				
	18-Network of El-Gamalia station	1		0.02×10^{4}`	Amoeba 20/L
	19-Network			0.01×10^{4}`	Amoeba 20/L
VII	**El-Sinbillawin district**				
	20-Mit-ghorab	98		0.02×10^{4}`	
VIII	El-Manzala district				
	21-Main station	1		0.81×10^{4}	*Entamoeba histolytica* cyst 20/L
	22-Network			0.8×10^{4}	*Entamoeba histolytica* cyst 20/L
IX	Temy el-amdid district				
	23- Temy el-amdid			0.2×10^{4}	*Entamoeba histolytica* cyst 40/L
X	**Aga district**				
	24-Miyet Sammanoud well before Cl2	200			Egg of Nematodes 40/L
	25-Network of Miyet Sammanoud				Egg of Nematodes 5/L
	26-Aga el-gadida well after Cl2				Amoeba 80/L
	27-Network of Aga el-gadida				Amoeba 80/L
	28-Mit-meaned				
XI	**Mit-ghamr district**				
	29-El-Rahmania well	150	0		
	30-Mit-el ezz well	500	0		

Table 2: Microbiological results of polluted drinking water samples by microorganisms.

salinity [16], so that overall recoveries >80% may be feasible, possibly involving MD crystallization [17].

Conclusion

One of the main reasons responsible for the deviation of the previous recorded parameters from the standard WHO [8] and EMH [7] values is due to percolation of the drainage liquid wastes to the groundwater. Water treatment uses better membranes, with both higher permeability and tighter cutoff.

Recommendations

On the light of the results obtained through the study made on the different types of water through Dakahlyia Governorate, it is recommended that:

1. Reverse osmosis and distillation units are effective means for treating water from cold water tap for drinking and cooking.
2. Using household filter (with replaceable cartridges), which contain granular activated carbon as an adsorbent, where the adsorption is a major step in making drinking water more pleasant by reducing objectionable tastes, odors, colors and sediments.
3. Removal of chemical constituents by adding chlorine and chlorinated organics, where they have been either implied or explicit in current advertising claims.
4. Chemical and microbiological analyses must be carried-out periodically for the surface and groundwater, to ensure the water suitability for drinking purposes.
5. Excess of Mn and Fe could be treated through oxidation process, through addition of air, chlorine, potassium permanganate or ozone, followed by filtration.
6. Post-alkalization and chlorination are intended to protect the distribution pipe work, and to prevent the growth of bacteria, respectively.
7. The well location should be located at safe distance from all possible sources of contamination.

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