International Journal of Dental Sciences and Research, 2020, Vol. 8, No. 2, 31-34
Available online at http://pubs.sciepub.com/ijdsr/8/2/1
Published by Science and Education Publishing
DOI:10.12691/ijdsr-8-2-1

Effect of Home Water Filtration Systems on Fluoride Content of Drinking Water in Riyadh, Saudi Arabia

Munther Alalowi[1,*], Mohammed Alsalem[2]

[1]Pediatric Dentistry Department, National Guard Hospital, Riyadh, Saudi Arabia
[2]Department of Developmental Dentistry, UT Health, San Antonio, USA
*Corresponding author: monther.333@hotmail.com

Received December 10, 2019; Revised January 22, 2020; Accepted February 09, 2020

Abstract **Background**: Reverse Osmosis (RO) is a method used by spiral-wound membranes to separate and extract dissolved solids, organics, and bacteria from water. Commercial stores in Riyadh are equipped with a variety of RO filters which differ in the type of membrane used and stages of filtration ranging from 1 stage and up to 7 stages. This study aimed to determine the extent to which different home RO water filtration systems remove fluoride from drinking water. **Materials and Methods**: Two types were most common in commercial stores in Riyadh: Puri OptimaR RO filters with cellulose-based or thin-film composite membranes. Both types have filtration capabilities ranging from 1 stage and up to 7 stages. Samples were coded from 1 to 7 based on the filter type. Samples were analysed using DR3900 Laboratory VIS Spectrophotometer with RFID. **Results:** Most of the water samples showed a reduction in fluoride content in the range of 0.1-0.8 ppm after passing through various RO filters. Mean difference in fluoride removal was found to be (0.4) and (0.45) ppm for RO filters with the cellulose-based or thin-film composite membrane, respectively. **Conclusions:** The results of the study showed that the use of reverse osmosis water filtration technologies has a substantial effect in reducing the level of fluoride in drinking water.

Keywords: *fluoride, dental caries, drinking water, purification*

Cite This Article: Munther Alalowi, and Mohammed Alsalem, "Effect of Home Water Filtration Systems on Fluoride Content of Drinking Water in Riyadh, Saudi Arabia." *International Journal of Dental Sciences and Research*, vol. 8, no. 2 (2020): 31-34. doi: 10.12691/ijdsr-8-2-1.

1. Introduction

The supply of fluoride containing water to the public is considered to be one of the most effective means in preventing dental caries. [1] While the benefits of fluoridated drinking water have been established, the optimum fluoride content is dependent on a number of variables such as climate temperature of the region, and the number of other fluoride intake sources. [2] Maintaining such optimal fluoride concentration is crucial to ensuring its safety and effectiveness. That has led a number of regulatory bodies to determine the optimal fluoride levels in drinking water to be (0.7–1.2 ppm). [3,4]

With the increased public concern of the potential harmful microbes and pesticides that may be found in tap water, tendencies toward acquiring home water filtration systems are on the rise. [5] The mechanism by which these filtration systems works is mostly by reverse osmosis (RO), where an organic membrane is used and the pollutants are eliminated by a number of carbon powder bed filters. [6] RO has been shown to be efficient in filtering out contaminants, including fluoride, especially in areas where water is highly contaminated. [7] This has raised some concern that the decrease in fluoride content could, in turn, reduce the caries prevention effect. [8]

Commercial stores in Riyadh are equipped with a variety of RO filters which differ in the type of membrane used (cellulose based or thin film composite membrane) and stages of filtration ranging from 1 stage and up to 7 stages. These variations may have an influence on the quality of filtration and subsequent fluoride elimination from drinking water. Hence, the aim of this study was to determine the extent to which different home RO water filtration systems remove fluoride from drinking water.

2. Methods

2.1. Collection of Water Samples

The study was conducted on water samples obtained from bottled commercial drinking water. Of water filters available in commercial stores in Riyadh, two types were most common; Puri Optima[R] RO filters with cellulose based or thin film composite membranes. Both types have filtration capabilities ranging from 1 stage and up to 7 stages. The samples were collected in plastic bottles (polyethylene) that had been previously rinsed twice with deionized water to remove any fluoride residue. All the collected water samples were transported immediately to the laboratory where they were subjected to fluoride

estimation analysis on the same day. All the samples were coded from 1 to 7 based on the filter type.

2.2. Analysis of Fluoride Content

All the samples were analysed at a water laboratory using DR3900 Laboratory VIS Spectrophotometer with RFID. Fluoride concentrations in all samples were analysed using a standard method given by the American Public Health Association using fluoride ion selective electrode. [9] It was standardized using fluoride solutions of 0.1–10 ppm. For fluoride analysis, equal amounts (20 ml) of each water sample and total ionic strength adjustment buffer solution were combined in a plastic beaker and agitated to remove air bubbles. For each sample, before recording the readings, the electrode was rinsed, blot dried and then placed into the test solution. The solution was stirred thoroughly with the electrode, and the steady readings on the meter were noted.

2.3. Statistical Analysis

The obtained values were analysed using the Statistical Package for the Social Sciences (SPSS, IBM Corporation, Armonk, NY, USA) version 16 software. Mean fluoride concentration before and after filtration and mean difference in fluoride concentration were reported using descriptive statistics. $P < 0.05$ was considered statistically significant.

3. Results

The fluoride concentration before and after RO filtration, mean difference in fluoride concentration, and percentage reduction were determined for both of the test groups. Paired t-test was used to determine the difference between paired observations. While the unpaired t-test was used for comparison of fluoride reduction by different water purification systems. Significance for all the statistical tests was predetermined at a *P* value of 0.05 or less. The baseline source (before RO filtration) water fluoride concentration was determined to be 0.9 ppm.

In the present study, most of the water samples showed a reduction in fluoride content in the range of 0.1-0.8 ppm after passing through various RO filters (Table 1). Furthermore, mean difference in the fluoride removal was compared for RO filters with cellulose based or thin film composite membrane (Table 2). Mean difference in fluoride removal was found to be (0.4) and (0.45) ppm for RO filters with cellulose based or thin film composite membrane, respectively.

Table 1. Fluoride concentration in drinking water before and after filtration

Filtration technology (Number of stages)	Mean ± SD fluoride concentration (ppm)		Mean reduction in PPM (Percentage reduction)	*P*
	Before filtration	After filtration		
Cellulose based (1)	0.9 ± 0.01	0.89 ± 0.01	0.01 (1.1%)	0.9
Cellulose based (2)	0.9 ± 0.01	0.82 ± 0.01	0.08 (8.8%)	0.5
Cellulose based (3)	0.9 ± 0.01	0.81 ± 0.01	0.09 (10%)	0.46
Cellulose based (4)	0.9 ± 0.01	0.27 ± 0.01	0.63 (70%)	**0.02**
Cellulose based (5)	0.9 ± 0.01	0.25 ± 0.01	0.65 (72.2%)	**0.02**
Cellulose based (6)	0.9 ± 0.01	0.24 ± 0.01	0.66 (73.3%)	**0.02**
Cellulose based (7)	0.9 ± 0.01	0.18 ± 0.01	0.72 (80%)	**0.01**
Thin film composite (1)	0.9 ± 0.01	0.73 ± 0.01	0.17 (18.8%)	0.2
Thin film composite (2)	0.9 ± 0.01	0.68 ± 0.01	0.22 (24.4%)	0.15
Thin film composite (3)	0.9 ± 0.01	0.61 ± 0.01	0.29 (32.2%)	0.1
Thin film composite (4)	0.9 ± 0.01	0.39 ± 0.01	0.51 (56.6%)	**0.03**
Thin film composite (5)	0.9 ± 0.01	0.36 ± 0.01	0.54 (60%)	**0.03**
Thin film composite (6)	0.9 ± 0.01	0.19 ± 0.01	0.71 (78.8%)	**0.019**
Thin film composite (7)	0.9 ± 0.01	0.15 ± 0.01	0.75 (83.3%)	**0.017**

Table 2. Comparison of filtrate fluoride concentration for each stage of both filtration mechanisms

Number of stages	Cellulose based water filtration system	Thin film composite filtration system	*P*
1	0.89 ± 0.01	0.73 ± 0.01	0.2
2	0.82 ± 0.01	0.68 ± 0.01	0.3
3	0.81 ± 0.01	0.61 ± 0.01	0.18
4	0.27 ± 0.01	0.39 ± 0.01	0.35
5	0.25 ± 0.01	0.36 ± 0.01	0.38
6	0.24 ± 0.01	0.19 ± 0.01	0.6
7	0.18 ± 0.01	0.15 ± 0.01	0.79

4. Discussion

Reverse Osmosis (RO) is a method used by spiral wound membranes to separate and extract dissolved solids, organic, pyrogens, submicron colloidal matter, colour, nitrate, and bacteria from water. These membranes are semipermeable and, while allowing the water molecules to pass, dismiss the salt ions. [10] RO systems provided from 1 to 7 with various phases. First stage aims to remove precipitate, oxidization, and dust, while the primary objective of second and third stages of carbon filters is to separate chlorine and other organic chemicals from water in order to enhance the flavour and smell of water. The membrane of the fourth stage consists of a very good material which usually only allows the passage of particles smaller than 0.0005 microns (0.00000005 cm). The fifth stage is to purify the flavour before the tap comes out of the water. The odour and coloration can also be enhanced at this point. The sixth and seventh stages are additional filtration phase to return to the water healthy minerals that may have been removed during the filtration phase.
It also has been shown to increase the pH to higher concentrations of alkaline. [11]

The RO purification system has increased dramatically in the latest years due to the increased popularity of RO in Saudi Arabia, which is why the RO system has been selected for the present study. The concentration of fluoride was determined to be 0.9 ppm in the current research. Which is to be (0.7–1.2 ppm) in drinking water at optimal fluoride concentrations. [3,4] This is the first effort to assess the extent to which different commercial RO filters in drinking water markets in Saudi Arabia can remove fluoride.

The results of the present study showed Significantly decreased concentration of fluoride in drinking water (range, 1.1%–83.3%) after filtration in both systems and variation in fluoride removal of different RO filters. RO filters with stage 4, 5, 6 and 7 in both systems show more fluoride reduction as compared to 1st, 2nd and 3rd stages and the study also illustrate that there is no significant difference between Cellulose-based and Thin film composite Filtration technology in amount of fluoride reduction. The findings of this study differ from earlier research. [12,14,15,16] Earlier authors noted fluoride decrease in the range of 22%-100%. Differences in the stage number and kinds of membranes used, multiple water sources, water sampling method, temperature, pH and water pressure can explain the inconsistency in the fluoride reduction ability of RO devices in different research. The increased temperature causes the solvents to disintegrate and can readily pass through the membranes. While at acid pH, hydrogen particles attach to fluoride where the RO membrane's filtering capability was restricted. Where the pressure increases the solvent's driving energy and decreases osmotic pressure to allow more water to be transported through the membrane with an elevated salt rejection rate. [17] In our study, we used one source of water with similar fluoride content, temperature, and pH level and new water filtration system used to have the same pressure capacity. Drinking water is the human being's most significant source of fluoride, and awareness of drinking water's fluoride content is crucial for both the public and health practitioners, particularly dentists, to understand. Available literature demonstrates that non-fluoridated community consumption and bottled water can put children at danger of developing dental caries. [19] According to the guidelines of the American Dental Association (ADA) and the American Academy of Pediatric Dentistry (AAPD), children receiving water that is fluoridated at less than 0.7 ppm should receive fluoride supplements.

5. Conclusions

The Results of the study showed that the use of reverse osmosis water filtration technologies has a substantial distinction in reducing the level of fluoride in drinking water. Optimally fluoridated drinking water may not have the same preventive impact when exposed to home water filtration technologies that substantially decrease fluoride. In order to prevent dental caries, fluoride supplementation may be necessary.

References

[1] McDonagh MS, Whiting PF, Wilson PM, et al. Systematic review of water fluoridation. BMJ. 2000; 321: 855-859.

[2] Petersen PE, Lennon MA. Effective use of fluorides for the prevention of dental caries in the 21st century: The WHO approach. Community Dent Oral Epidemiol. 2004; 32: 319-321.

[3] Horowitz HS. The effectiveness of community water fluoridation in the United States. J Public Health Dent. 1996; 5: 253-258.

[4] Cortes OF, Ellwood RP, O'Muliane OM, Bastos JR. Drinking water fluoride levels, dental fluorosis, and caries experience in Brazil. J Public Health Dent. 1996; 4: 226-228.

[5] Jobson MD, Grimm SE 3rd, Banks K, Henley G. The effects of water filtration systems on fluoride: Washington, D.C. Metropolitan Area. ASDC J Dent Child 2000; 67: 350-354.

[6] Matsui T, Kajima J, Fujino T. Removal effect of the water purifier for home use against Cryptosporidium parvum oocysts. J Vet Med Sci. 2004; 66: 941-943.

[7] Prabhakar AR, Raju OS, Kurthukoti AJ, Vishwas TD. The effect of water purification systems on fluoride content of drinking water. J Indian Soc Pedod Prev Dent. 2008; 26: 6-11.

[8] Buzalaf MA, Levy FM, Rodrigues MH, Bastos JR. Effect of domestic water filters on water fluoride content and level of the public water supply in Bauru, Brazil. J Dent Child. 2003; 70: 226-230.

[9] American Public Health Association. Standard Methods for the Examination of Water and Wastewater Method 4,500 FD; 1998. Available at: https://law.resource.org/pub/us/cfr/ibr/002/apha.method.4500-si.1992.pdf Accessed May 20, 2017.

[10] Garud RM, Kore SV, Kore VS, Kulkarni GS. A short review on process and applications of reverse osmosis. Universal J Environ Res Technol. 2011; 1: 233-238.

[11] Waterfilteranswers, Jon Godfrey; 2019. https://waterfilteranswers.com/about-us/ Accessed September 15, 2019.

[12] Brown MD, Aaron G. The effect of point-of-use water conditioning systems on community fluoridated water. Pediatr Dent. 1991; 13: 35-38.

[13] Robinson SN, Davies EH, Williams B. Domestic water treatment appliances and the fluoride ion. Br Dent J. 1991; 171: 91-93.

[14] Prabhakar AR, Raju OS, Kurthukoti AJ, Vishwas TD. The effect of water purification systems on fluoride content of drinking water. J Indian Soc Pedod Prev Dent. 2008; 26: 6-11.

[15] Glass RG. Water purification systems and recommendations for fluoride supplementation. ASDC J Dent Child. 1991; 58: 405-408.

[16] Khairnar MR, Jain VM, Wadgave U, Dhole RI, Patil SJ, Chopade SR. Effect of different reverse osmosis water filters on fluoride content of drinking water. J Indian Assoc Public Health Dent. 2018; 16: 165-168.

[17] Gedam VV, Patil JL, Kagne S, Sirsam RS, Labhsetwar P. Performance evaluation of polyamide reverse osmosis membrane for removal of contaminants in ground water collected from Chandrapur district. J Membra Sci Technol. 2012; 2: 1000117.

[18] Arora M, Maheshwari RC, Jain SK, Gupta A. Use of membrane technology for potable water production. Desalination. 2004: 170; 105-112.

[19] Ismail AI, Brodeur JM, Kavanagh M, Boisclair G, Tessier C. Picotte L. Prevalence of dental caries and dental fluorosis in students, 11-17 years of age, in fluoridated and non-fluoridated cities in Quebec. Caries Res 24: 290-97, 1990.