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Investigating the rate and factors of approach to desalinated water in Kashan and Aran-Bidgol cities

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Abstract

Objectives: In recent years, due to the inappropriate quality of distributed water by the public water network in many parts of Iran, especially in the central areas, the use of desalinated water has been widely developed. Therefore, for any planning and intervention, it is very important to have information about the current situation and social, cultural and economic factors affecting this development. As a result, this study was conducted with the aim of Investigating the rate and factors of approach to desalinated water in Kashan and Aran-Bidgol cities in 2018.

Methods: This study is an ecological study on the samples of Kashan and Aran-Bidgol people. The tool is a questionnaire completed over the phone. The collected data were analyzed using descriptive statistics and SPSS16 software.

Results: About 83.2% of the samples in Kashan and Aran-Bidgol cities use desalinated water for drinking, cooking and tea making, 44.2% of the samples use a small household water purifier and 39% buy purified water from sales centers. The filtration technology in both categories is reverse osmosis.

Conclusion: In the studied cities, the salty taste of water taken from the public network and samovar sediments are the most important reasons for consumers to switch to purified water, and demographic characteristics such as age, gender, educational and economic level, etc. did not play a significant role in this approach.

Keywords: Water Desalination, Reverse Osmosis, water treatment.

Introduction

With climate changes, population growth, reduction of water resources per capita, as well as an increase in physical, chemical and microbiological contamination of water resources, the water crisis is considered as one of the major global problems today.[1-3]

Along with the increasing need of communities for safe drinking water, due to environmental problems such as increasing solid waste, municipal and industrial wastewater and air pollution, we are witnessing increasing pollution of surface water sources, groundwater and even rainwater. On the other hand, providing safe drinking water has become a more serious need than ever before. Therefore, seawater and brackish water desalination technologies have received more attention.[4-6] More than 120 countries around the world use desalination plants. The Middle East accounts for 54% of the world's desalination capacity. It is followed by the United States with 23 percent, Europe with 10 percent and Africa with 5 percent. Membrane filtration processes have the highest application (about 64%) in the world.[7-13] After that, multi-stage flash distillation with 23%, multi-stage distillation with 8% are respectively the most used technology in the world. Electro dialysis technology accounts for 4% and other technologies for 1% of all desalination plants in the world.[14-16] Among the countries of the Persian Gulf, the fresh water production capacity in UAE is 35%, Saudi Arabia is 24%, Kuwait is 14%, Oman is 14%, Qatar is 8% and Bahrain is 5%.

Although desalination is a rapidly growing technology,

its environmental effects are not well known.[12,17,18] Recently, with the increase of total dissolved solids in drinking water, home reverse

osmosis water treatment systems have grown in the cities and some villages of Iran.[4]

Reverse Osmosis (RO) removes a wide range of water contaminants including microbial agents, organic and inorganic compounds. But the main limitation of this technology is the scaling of the membrane, which in addition to helping to destroy the membrane, is a good shelter for the growth of pathogens.[19-21]

The cities of Kashan and Aran-Bidgol are located in the center of Iran and have a dry desert climate. The main water sources for these cities are local underground aquifers in karstic formations.

High concentration of total hardness and dissolved solids of total water is the main characteristics of groundwater in this region.

With the development of RO desalination technology, private sector activists gradually established reverse osmosis desalination plants in response to public demand for fresh water, for example 16 units during 2008 in Kashan.[22] In parallel, in recent years, the use of home water desalination devices has become so common that to map their future use from a health, environmental and economic perspective, the need for basic information about the consumer population and their demographic characteristics is evident.

Since the increasing development of reverse osmosis for water desalination has potential health and environmental risks and demographic information of its users is essential for any planning, it is important to conduct this study. In addition, searches to find similar studies in Kashan and Aran-Bidgol and even nearby did not yield results.

Objectives

The current study was conducted with the aim of, investigating the desalinated water consumption in Kashan and Aran-Bidgol cities and factors affecting it.

Methods

This is a cross-sectional descriptive study on the people of Kashan and Aran-Bidgol cities. First, a draft of the questionnaire was prepared by the authors, then it was surveyed and revised in an expert panel, and finally, the questionnaire was completed over the phone as well as field data collection.

This questionnaire had 29 questions including demographic characteristics such as age, occupation and education of parents, number of family members and reasons for using desalinated water. Also, some questions about the parameters of the bad taste of tea, samovar deposits and the possibility of water contamination in the distribution network, etc.

The sample volume was calculated using a qualitative formula with the assumption of 50% positive and 50% negative, 95% confidence limit and 5% accuracy. Considering the heterogeneity of Kashan and Aran-Bidgol communities, it was modified by applying a factor of 3. The total sample for two cities was 1153 people, the number of samples in the cities was divided proportion to the population of each. Considering the average of 4 people for each family, 300 households were obtained, which in this study, 343 questionnaires were completed according to the household population.

Statistical analysis

The continuous variables were expressed as the mean±SD, and the categorical variables were presented as a percentage and frequency. All statistical analyses were performed with SPSS (version 16.0, SPSS Inc, Chicago, IL, USA). A “P-value” less than 0.05 was considered significant.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. this project has been registered in Deputy of Research and Technology of Kashan University of Medical sciences with ethical cod: IIR.KAUMS.NUHEPM.REC.1396.38.

Results

In this study, 343 questionnaires were completed, 247 questionnaires in Kashan and 96 questionnaires in Aran-Bidgol. According to users, the highest frequency of home desalination devices in Kashan and Aran-Bidgol was reverse osmosis (36.8%) and the rest (63.2%) did not know about the type of their desalination plant

Demographic characteristics of the samples including parents 'age, number of family members, occupation and parents' education were investigated. The most common age group for parents in the cities of Kashan and Aran-Bidgol was 40-60 years with a rate of 63.5%.

In both cities, families with four members had the highest frequency (33.81%). The average number of family members for Kashan and Aran-Bidgol was 3.6 and 3.7, respectively.

The highest frequency of education for fathers in Kashan

and Aran-Bidgol cities was 12 years (26.72%) and 9 years (28.12%) respectively.

And the highest frequency of mothers' education in Kashan and Aran-Bidgol is primary, which is 32.79% and 36.46% in Kashan and Aran-Bidgol, respectively.

Table 1 shows the duration of desalinated water consumption in the two cities. As can be seen, the highest frequency is related to households that have used desalinated water for less than 5 years at the time of the study. There was no significant difference between the use of household desalination plants in Kashan and Aran Bidgol (P=0.837), but for purchasing water from desalination centers, this difference was significant (P=0.049).

Table 1. Duration of using desalinated water based on its supply source (Household devise and commercial center)

The source	Household devise		Buy desalinated water from Commercial center	
Duration	Kashan	Aran-Bidgol	Kashan	Aran-Bidgol
<5	58.50%	50.00%	50.00%	52.40%
5-10	30.80%	39.30%	43.30%	28.60%
10-15	7.70%	7.10%	1.70%	19.00%
>15	3.10%	3.60%	3.30%	0.00%
Missing	0.00%	0.00%	1.70%	0.00%
Total	100%	100%	100%	100%
P value	0.837		0.049	

For those who used a home desalination device, the per capita consumption of desalinated water in Kashan and Aran-Bidgol users was calculated at 2.916 and 2.634 liters per capita, respectively.

Table 2 shows Volume of desalinated water purchased in a week in liters for each family. There was no significant difference between the volume of water purchased from purified water sales centers in Kashan and Aran-Bidgol cities.

Also, the results showed that a total of 83.2% of participants in Kashan and Aran-Bidgol cities use purified water for drinking, cooking and preparing tea. (Home water desalination 44.2% and purchased water from commercial centers 39%), all of which are reverse osmosis type.

The use of household water softeners in Aran-Bidgol and Kashan was 50.9% and 40.8%, respectively. The frequency of the population consuming water purchased from commercial desalination centers in Kashan and Aran-Bidgol is almost the same, 42% and 42.1%, respectively.

Table 2. Volume of desalinated water purchased by each family in liters per week

Volume (Liter)	Kashan	Aran-Bidgol
<20	41.00%	65.20%
40	32.80%	21.70%
60	21.30%	4.30%
100	1.40%	8.70%
>100	3.30%	0.00%
Total	100%	100%
Significance level	0.069	

The average frequency of filter replacement for household water softeners is 2.33 times per year, the most frequent filter replacement is 12 times per year (once a month) with a frequency of 1 case (1.1%) and the lowest frequency of filter replacement is 0 times per year with a frequency of There were 4 cases (4.4%) and the average cost of each filter replacement for these devices was calculated as 1,367,950 Rials.

The reasons of the respondents for using desalinated water are shown in Figure 1. The most common reason for using desalinated water is the unpleasant taste of tea prepared with tap water (46.4% in Kashan and 38.6% in Aran-Bidgol). Only 5.3% of respondents in both cities stated the possibility of tap water contamination as the main reason for using purified water.

The level of satisfaction with the quality of desalinated water by home desalination in the cities of Kashan and Aran-Bidgol was 100%. While 2% of the customers of commercial water desalinations in Aran-Bidgol declared their satisfaction with the purchased water at a low level.

Families with father's Self-employed people in both Kashan and Aran Bidgol cities were the most users of household water purifiers in these cities with 46.15% and 32.5% respectively.

And regarding the users of water purchased from commercial water softeners in both cities, the highest frequency was observed in families whose father's job was self-employed (11.41%) or employee (23.53%). There was no correlation between parents' occupation also, their level of education with the use of household or commercial water softeners in Kashan and Aran Bidgol cities (pv>0.05).

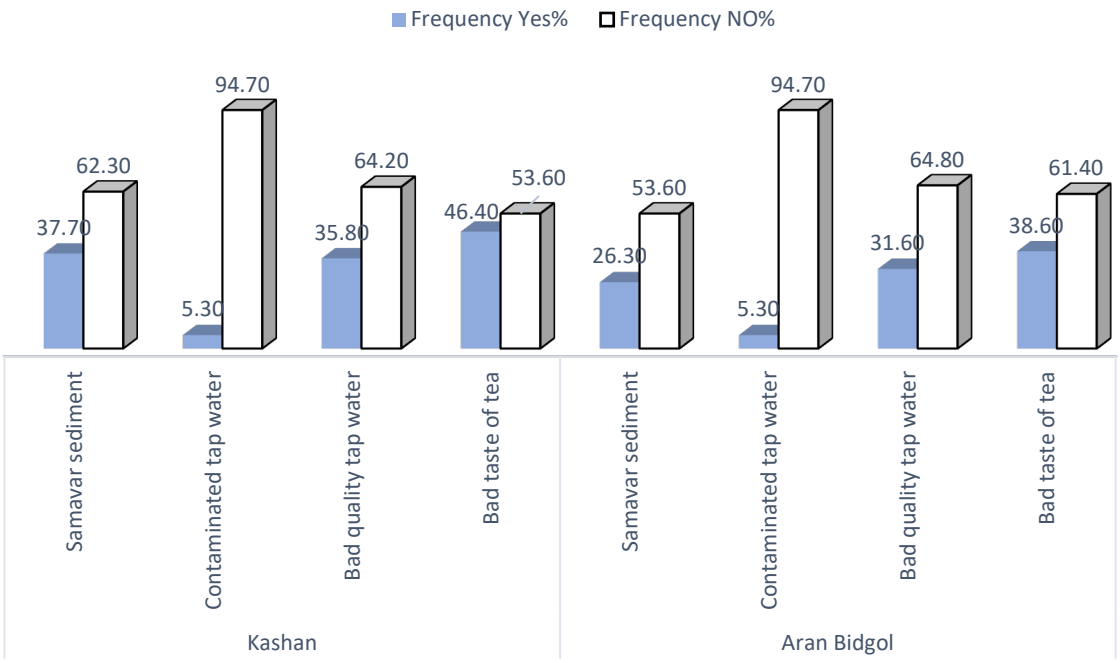

Figure 1. The reasons of the respondents for using desalinated water

Discussion

The results showed that a total of 83.2% of the participants in the cities of Kashan and Aran-Bidgol use purified water (home or commercial) for drinking, cooking and making tea. This can result from the non-acceptance of water from the distribution network for such uses. While according to the spoken expression of Kashan Water and Wastewater Company and some studies, the water quality of these two cities is lower than the maximum concentration limits in the drinking water quality standard of Iran.[22]

According to Zazouli's studies in Sari city, 11% of the interviewed people use a home desalination device, which is not consistent with the results of this study. This difference can be attributed to the more suitable water quality of Sari urban network.[23]

Base on the study conducted in Qom, it has been determined that 15% of the population of Qom use a home reverse osmosis device to supply their drinking water to the amount of 157,67 cubic meters per year. Considering that in home reverse osmosis systems, the percentage of purified water to raw water input is about 30%, 367,920 cubic meters of wastewater are produced annually, and its required energy is 1,419,200-kilowatt hours.[24]

According to Varbanets et al.'s report on the benefits of drinking water treatment using decentralized home-scale treatment systems, these systems are suitable due to their low price, ease of use, and low maintenance cost.[25]

In this study, about two-thirds of the users did not know the type of their water softener, which indicates that users did not choose the standard, and they chose their device base on the advertisements of the sellers and the statements of previous users.

According to the accessible records in obtaining the license to establish commercial desalination plants in Kashan, the duration of the use of this technology practically goes back to about twenty years ago, but the use of this technology in both cities under study has grown significantly in the last 5 years. The decrease in import prices and competition among sellers are among the reasons for the development of its use in recent years.

No significant relationship was observed between the consumption of domestic or commercial desalinated water and the occupation of the father of the family ($p=0.05$).

No significant relationship was observed between the consumption of desalinated water, whether domestic or commercial, with the occupation of the father of the family ($p=0.05$).

Also, there was no significant relationship with mothers' education in the studied cities ($p>0.05$). This means that the use of water softeners is based solely on the taste and pleasantness of water, tea, food and the observation of sediments on the surface of the kettle and is independent of the level of education and occupation. Searches to find similar studies for comparison both, in Iran and other countries were unsuccessful and only two less relevant studies were found. In a study that was conducted in Anuradhapura district, Sri Lanka, 58% of the consumers of

water produced by reverse osmosis devices in 4 types of social, domestic, commercial and school believed that the quality of water produced by these devices It is very good and 41% believed that the quality is good and only 1% believed that the quality is poor. Meanwhile, most of the respondents had good educational records and better knowledge about water quality. And nearly 95% of the consumers were very satisfied with the water quality of the devices. People with low income were more satisfied and people with high income preferred to use bottled water.[26] In another study that was conducted in Taman Tunku, Miri Sarawak, 90.9% of the respondents used a water filter and 95% of them were aware of the type and function of the filter.[27]

The amount of desalinated water per capi/ta per day obtained in this research is more than the Iranian standard for the basics and design criteria of water supply projects, which can be justified due to the hot and dry climate of the region.[28]

More studies on health and environment impacts assessment of the developing application for reverse osmosis process is recommended. Also, due to the low efficiency of these types of desalination devices, it seems necessary to search for methods with higher efficiency in terms of fresh water production and energy consumption.

Conclusions

In the studied cities, the salty taste of water taken from the public network, the unpleasant taste of tea and samovar sediments have been declared as the most important reasons for consumers to switch to purified water. Demographic characteristics such as age, gender, education level, economic, etc. did not play an important role in this approach. Reverse osmosis is the dominant process for this purpose with a rate of 83%.

Acknowledgment

None.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

Reverse Osmosis: RO.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. this project has been registered in Deputy of Research and Technology of Kashan University of Medical sciences with ethical code: IIR.KAUMS.NUHEPM.REC.1396.38.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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