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Study on Microbiological Quality of Rural and Urban Drinking Water in Distribution Systems of Ijroud, Zanjan in 2013-2015

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ABSTRACT

Background: Providing safe drinking water has critical importance to human societies. The aim of this study was to investigate microbiological quality of drinking water in distribution system of urban and rural regions of Ijroud, in Zanjan province.

Methods: In present descriptive study, the microbiological examination of drinking water was conducted in 15 facilities with 401 samples. Transportation and test procedures were according to standard methods for the examination of water and wastewater.

Results: Total number of microbial samples were 401 and 66.66% of them were positive for total and fecal coliforms. Also, water of 10 villages were not suitable for drinking with respecting to national standards. In addition, samples of only 5 villages were suitable for human consumption. The range of fecal coliforms in distribution networks' samples were from 4 to 75 MPN/100 ml.

Conclusion: This study showed that as microbiological aspect, drinking water is not potable in some rural communities. The consumption of drinking water in this distribution networks can threaten the health of consumers, thus, the water supply organizations have to improve operation and maintenance measurements due to prevent the spread of water-borne diseases.

1. Introduction

Lack of water resources is one of the most important levers human life, plants and animals in many countries, including our country is threatened and is considered as one of agriculture and the economy predicament [1]. In other hand, the increase in population and urbanization, industrialization, misuse and overuse of land, several environmental issues have created which the contamination of water is one of important consequence [2].

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According to World Health Organization (WHO) (2008) mortality and waterborne disease have been brought more than 5 million people. In general development the risk of microbial contamination is mostly due to human activities. In other word, it is clear that environmental sanitation is causing water pollution [3, 4].

World Health Organization (WHO) has criteria to use drinking water and recommended local health authorities and has to respect these criteria. The same criteria supply safe and clean water for the population and sequential, and continuous protection during transmission, distribution, storage and using water [5].

The World Health Organization has priority criteria for continuous monitoring of drinking water in terms of microbiological aspect. Suitable water resources to the population have to carry out sampling and bacteriological tests. The evaluation of microbiological quality of drinking water helps consumers to protect them from diseases that can be transmitted because of drinking water. It is now one of the important challenges of water quality management [6]. In general, the presence pathogenic bacteria in soil or in sewage and polluted water. These bacteria are exerted by human and animal. The important pathogenic bacteria transmitted by water are such as *Salmonella*, *Vibrio cholera* and *E.coli*. Infectious diseases associated with bacteria, viruses, protozoa and parasitic worms are the most common health risks of drinking water using this contaminated water to drink, make food or contact with it when washing or bathing even breathe cause diseases [7, 8].

Water-borne diseases occur when pathogenic agent swallows by drinking water and causes a wide range of other diseases, including hepatitis, bacillary diarrhea, amoebic and parasitic diseases. All of the above diseases indicate to provide health and safe water for the human communities obviously [8].

According to the World Health Organization factsheets, globally, at least 2 billion people use a drinking water source contaminated with feces and contaminated water can transmit diseases such diarrhea, cholera, dysentery, typhoid, and polio. Contaminated drinking water is estimated to cause 502 000 diarrheal deaths each year [9]. From microbial aspect, the absence of pathogenic microorganisms in drinking water is ultimate goal because bacterial, viral, and protozoan diseases are caused the most common and widespread health risk of drinking water [10].

To reduce cases of diarrheal diseases, it's necessary to improve drinking water quality via efficient water treatment processes and storage. Therefore, planning and cost in order to provide clean water will be a considerable investment for the future [11].

Common indicators to evaluate the microbial quality of drinking water are to measure total coliform bacteria and thermotolerant coliforms. According to Iran's

microbiological standards of drinking water, bacteriological examination results of all drinking water and treated water to the distribution system must be negative in terms of fecal coliform [12].

Since water sanitation has direct relation with reducing of infectious diseases, this study aims to determine microbiological drinking water quality in Ijroud cities and villages.

2. Materials and Methods

This cross-sectional study was conducted to assess the microbiological quality of drinking water during 3 years (2013-2015) in 15 urban and rural distribution systems in Ijroud, Zanzan as they have shown in table 1. For this purpose, 401 microbial samples were taken from these water facilities.

In this study, multiple tube fermentation test, according to standard methods, was conducted as follows: to do that we were used three series of tubes containing lactose broth medium with Durham tubes, in each of these three tubes in the first, second and third series, 10, 1 and 0.1 ml of water sample was inoculated respectively. Then inoculated tubes were incubated in 35°C for 24-48 hours and then tubes were studied in term of gas production. Tubes in which gas bubbles were observed was considered as positive test result [11].

To confirm the presence of coliform bacteria, Brilliant green lactose bile (BGLB) broth medium, Himedia, India companies have been used. To do this step microorganisms from positive tubes in previous phase were transferred to the BGLB medium with a sterile loop and the tubes were incubated at 35°C for 48 hours. Again, gas production and/or turbid medium meant positive confirmatory test and the presence of coliforms. Also, for detecting of fecal coliform bacteria, EC Broth medium, Himedia, India Company was used. Bacteria from positive BGLB tubes were inoculated to EC broth and the tubes incubated for 48 hours at 44.5°C. The observed gas in Durham tubes indicated positive test and presence of fecal coliform bacteria.

Finally, data analysis was done using SPSS software version 20. The results were compared with national standards, US Environmental Protection Agency primary standards, and WHO's guidelines for drinking water quality to interpret the safety of water quality [9, 12, 13].

3. Results and Discussion

Population in the studied region was 44067 and 401 samples were taken for microbial quality in three years. Approximately, one sample per 109 people. Highest population was observed in Zarin Abad city and lowest population was in Daydar Sofla village.

Table 1 shows the details of population and number of samples with respect to year and communities' (village or city) name. The most taken samples were in Zarin Abad city, a microbial sample per 115 people and a chlorine sample per 3 people. The results of statistical analysis showed that significance difference between the desirability of microbial quality and residual chlorine in drinking water ($P < 0.05$).

Table 1: Number of microbial and residual chlorine samples of the drinking water in Ijroud during three years 2013 to 2015

Community (village/city)	2013			2014			2015			Total Number of microbial sample	Total Number of chlorine sample
	Number of chlorine sample	Number of microbial sample	population	Number of chlorine sample	Number of microbial sample	population	Number of chlorine sample	Number of microbial sample	population		
Sefid Camar	55	5	229	56	5	226	57	7	223	17	168
Yengi Kand											
Jamee Sara	793	6	483	641	6	469	553	7	463	19	1987
Gonbad	536	4	69	528	3	65	545	9	53	16	1609
Abojanloo	46	4	61	62	4	65	38	7	47	15	146
Daydar Sofla	51	4	60	69	4	62	40	7	49	15	160
Jooghin	734	7	3039	566	10	3088	558	10	3131	27	1853
Yengi Kand	112	3	175	61	8	172	48	7	171	18	221
Almasi											
Shive	488	6	1516	563	9	1480	567	10	1453	25	1618
Golaber	502	7	2400	550	11	2474	627	8	2510	26	1679
Ahmad Kandi	416	10	945	455	10	923	483	13	951	33	1354
Ouj Tape	243	11	801	145	10	793	422	12	746	33	810
Kooseh Iar	438	10	684	443	10	692	389	12	708	32	1270
Gare Seied	212	10	1084	396	10	1097	348	12	1106	32	956
Halab	1079	13	822	630	11	825	610	12	837	36	2319
Zarin Abad	671	13	2222	1162	13	2281	660	33	2317	59	2493
Total	6376	113	14590	6327	124	14712	5946	166	14765	401	18649

The most desirability was related to Almazi Yatigand, Ouj Tape, Kose Lor and Gare Seied villages (Figure 1). In general, Thermotolerant (fecal) coliforms in samples of Almazi Yatigand, Ouj Tape, Kose Lor, Gare Seied villages were not identified. However, in some villages, including Jogin, Shive, Sefidcamar, Ahmadi Kandi and Halab, density of thermotolerant coliforms were less than 10 MPN/100 ml. It is noteworthy that, in this conditions, the microbial contamination can be removed by a simple chlorination of water and no problem happen for consumers.

As shown in Figure 2, only in five distribution systems there were no fecal coliforms. In contrast, in the other systems fecal coliforms were identified. It means that 66.7% of drinking water distribution systems contaminated with fecal coliforms.

The main reasons for that were to be shallow water wells, no effective water chlorination, and not considering suitable distance between potable water well and sewage wells. Therefore, it is necessary to educate consumers on health hazards of contaminated water and to take the necessary measurements for sampling and treating of water.

Similar studies have confirmed contamination of water resources in rural areas in Iran. Shariat panahi and Anderson conducted a study in Tehran and reported nearly 86 percent of 124 wells were contaminated [14].

Azizi and Hashemi (2005) determined the level of microbial contamination of drinking water in villages in Babol town by identifying coliform bacteria in samples. They reported that about 84% of water samples in presumptive phase were positive and 85% of them were positive in confirmatory phase. They stated the reasons of these contamination were malfunction or absence of effective chlorination performance in some villages [15].

The assessment of microbiological quality of 76 rural water wells in Khoramdeh, showed that 31 wells (57.31%) are contaminated with fecal coliforms. This study showed that depth of the wells and seasonal fluctuations are affecting factors on the type of intestinal bacteria, but depth of the wells wasn't significant variable on the density of fecal coliforms [16].

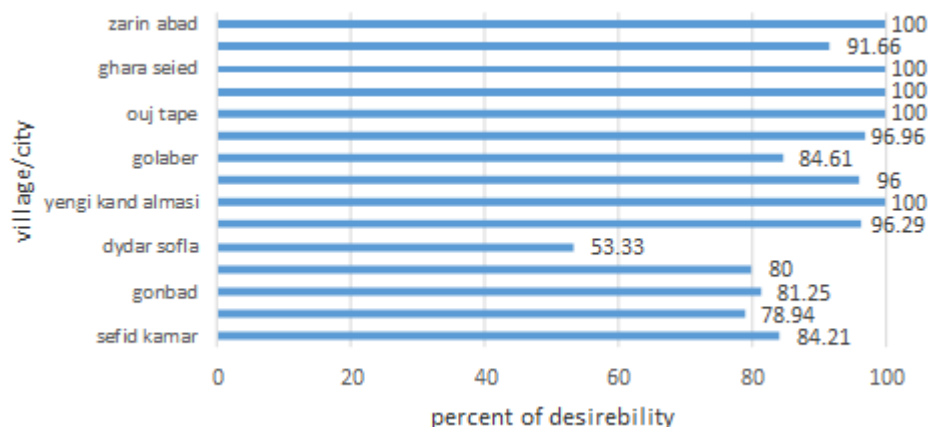


Figure. 1: Desirability percent of microbial samples in rural and urban Distribution Systems in Ijroud

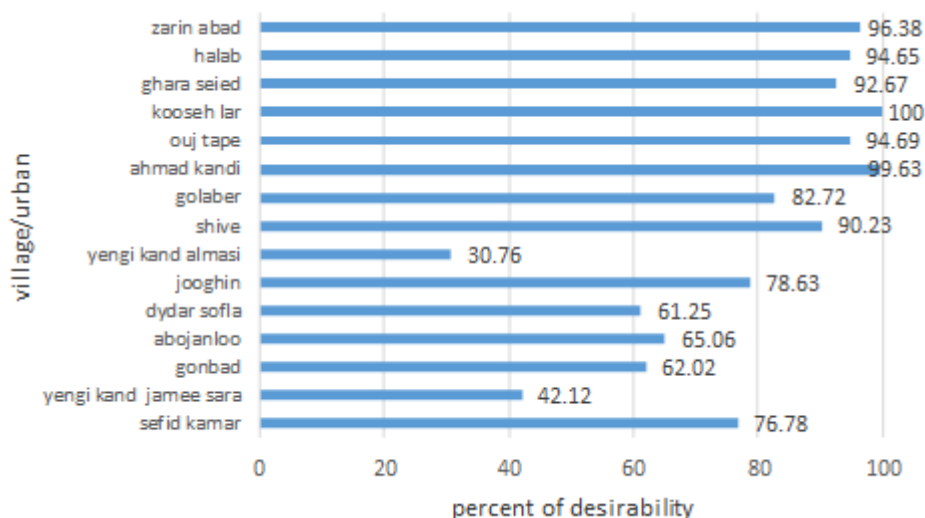


Figure. 2: Desirability percent of residual chlorine in rural and urban distribution systems in Ijroud

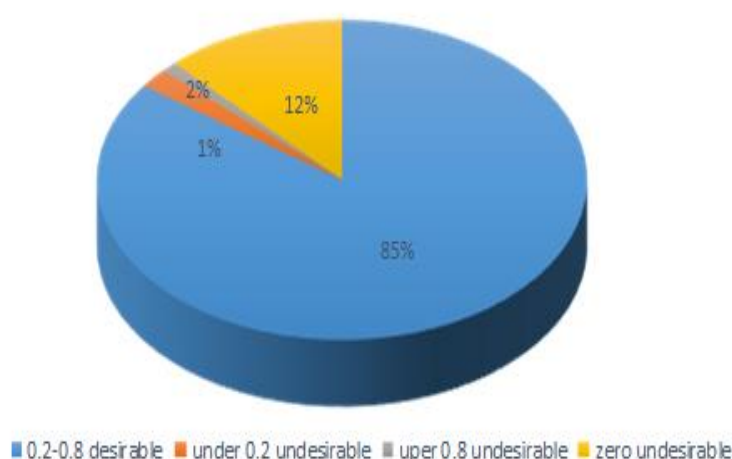


Figure. 3: Frequency of residual chlorine concentration desirability in Ijroud town's communities

Other study in rural water in Babol town showed that drinking water resources are contaminated with total and fecal coliforms up to 20 and 13.6%, respectively. They have stated the main reason for pollution of this water resources, are small distance to pollution, poor sanitation and lack of efficient chlorination [17].

Dehghani et al. (2009) evaluated the microbiological quality of rural drinking water in Saqqez. They reported that 49 of the samples were identified as contaminated to fecal coliforms and 88% of drinking water in Saqqez were not contaminated to fecal coliforms, which was contrary to results of this study. A reason for different findings be related to effective chlorination in rural drinking water in Saqqez [18]. In some rural water resources of Sabzevar MPN/100 ml of fecal coliforms were measured up to 1,100 in two villages. This investigation showed that 6.9% of drinking water resources were contaminated with coliforms [19].

Mohamadian Fazli and Sadeghi (2003) reported that no microbial contamination in water resources of Zanjan city [20]. The absence of fecal coliforms in urban drinking water is not unexpected and global standard water confirm that, but the high level of pollution in rural groundwater in this study verifies that there is no good situation in some rural areas of studied city. In some part of area, the quality of water was average or lower. Hasani et al. (2010) studied microbial pollution of 14 wells of Eslamshar region and showed that most of them especially in eastern and southern part of city and inly in one well are polluted. In contrast, water in 6 villages was contaminated with

coliforms because of using manure for soil fertility [21].

Bornamehr et al. (2009) had a research to determine type of the source of fecal contamination in Mashhad water distribution network that specified 70% of samples had no pollution and 23 of them were positive in terms of coliform bacteria which in comparison with present survey showed the lower level of contamination [22].

Furthermore, the results of this study showed that the most desirability from water disinfection was in koselor village with 100% acceptable residual chlorine level and also, the least amount was related to yengikand almasi with almost 31% acceptable level (Figure 2). As a whole, 85% of total samples had residual chlorine in desirable range (Figure 3).

4. Conclusion

Finally, this study showed that more than 50 percent (exactly 66.7%) of the samples taken from drinking water distribution networks were contaminated with fecal coliforms. Also, desirability of residual chlorine was 85 percent with significant deference between communities. Therefore, it can be declared there is an important concern about microbial quality of potable water and health hazard of consumers.

In general, field inspections emphasis there are many reasons for high level of fecal contamination of water resources in rural areas including, lack of proper sanitation of water wells and reservoirs, the unavailability of chlorine, defects in chlorinators.

Therefore, it should be applied much efforts to prevent contamination of available clean water. Furthermore, it is necessary to design a continuous quality control planning especially when resources are exposed to pollution and to protect health of the community.

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