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Survey of Microbial Quality of Drinking Water in Rural Areas of Saqqez, Iran

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Abstract: Safety drinking water providing is one of the main purposes for community development and improvement. Having a healthy community is related to the safe drinking water. In this study, we surveyed the microbial quality of 116 villages under cover of the Saqqez water and wastewater Company in 2007. Drinking water of these rural areas have provided of deep, semi-deep wells and spring water sources. Because of the both sources were used in the rural areas and also due to use of different storage sources (new and old sources), we collected 359 samples during a month period to test for microbial quality. We also used linear Regression statistical analysis for collected data. Results show that residual chlorine content in drinking water in 33.88 percent of rural areas population was in range 0.2-1 mg/l. In 98.3 percent of the Saqqez rural areas the turbidity level was less than Iranian maximum permissible levels (5 NTU). There was no *E. coli* contamination in 88 percent of drinking water in Saqqez rural areas. Based on WHO guidelines concerning microbial quality of water published in 2006, average indicator for absence of *E. coli* in rural water of Saqqez was 88 percent.

Key words: Drinking water rural areas · *E.coli* coliform bacteria · Residual chlorine · Turbidity

INTRODUCTION

Human health depends on safe water more than any other thing. Basically the life of human is related to safe water. And try in safe water supply is a very important. Most of the problems in developing countries are mainly due to the lack of safe drinking water[1]. Safe water supply is one of the main purposes in community. And development and improvement depend on healthy community. And it is apparent that health of individuals depends on safe drinking water[2].The growing population of the world has increased the water need to drinking, agricultural, industrial and recreational and etc. It has decreased not only the quantity of water but also the quality of water by civilization, industry and agriculture development nowadays, most of the countries in the world have lack of safe and also the polluted water sources. And causes the future trend in water use become somewhat difficult to evaluate. Among them the pollution of water sources is very important of view point of health and considerable attention is necessary for it. Therefore special studies and also setting guidelines is necessary for public health[3].The importance of pollution control for surface and ground water that is being used for drinking is obvious to everyone. One of the parameters of water that is too important in safe drinking water is sensory parameters (organoleptic).But among them biological and chemical parameters are more important because they cannot be seen by direct vision. Thus it is necessary to monitor water quality to achieve safe water[3,4].

There are some factors such as lack of drinking water sources, the need to maintain the current available sources and planning to better use of sources that their influence is as important as above discussed factors[4]. In 2007, more than 54% of rural areas having the population above 20 thousand persons (which included 93.4% of the residents)were receiving water and wastewater services[5]. In the other word in 2007, 64% of rural areas populations were receiving water and wastewater services. According to the common report of Asian Development Bank (ADB), United Nation

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Development Program (UNDP), United Nation Economic and Social Commission for Asian and the Pacific (UNESCAP) and World Health Organization (WHO), the rural population of Iran in years 1990 and 2002 was 24.949 and 23.144 million, respectively.

In both times 83% of rural population was under the cover of safe drinking water services. According to this report, Iran rural population will decrease to 21.245 million in 2015 [6]. Typically, Saqqez city have 276 villages, 3 towns and 11 small villages. Saqqez city located 156 Km away in north western of Sanandaj city in west of Iran. It is 1476 m above sea level. Population of the city is above 205280 persons. 72442 persons were living in rural areas. Approximately, 53.29% of the population was in rural areas. Among them 79% were in rural areas above 20 residents and 21% were in rural areas less than 20 residents. Among them 42.2% (116 villages) were receiving water and wastewater services. Drinking water supplies for these rural areas were from springs and deep and semi-deep wells. Because of considerable role of water quality on human health and the necessity of measurement of its different parameters, we did this study to determine the water quality of Saqqez city in 2008.

MATERIALS AND METHODS

To determine microbial quality of the rural areas, we examined the parameters such as turbidity, residual chlorine, Oxidation Reduction Potential (ORP), fecal coliform indicators (fecal coliforms) and Heterotrophic Plate Count (HPC) according to the latest guidelines of WHO[7]. We examined three parameters such as free residual chlorines, fecal coliform indicators (fecal coliforms) and turbidity as a basis for our analyses. This study was done in Saqqez city to survey water quality in 2007. Drinking water supply in Saqqez city is from springs, deep and semi-deep wells. Because of the both sources were used in the city and also due to use of different storage sources (new and old sources), we collected 359 samples during a month period. All the examinations were done according to the 21st edition of Standard Methods for the Examination of Water and Wastewater in 2005 [8]. The results were analyzed using the Statistical software SPSS and Excel. Free residual chlorine was measured by a colorimeter kit on a annually basis. Most Probable Number (MPN) was done on nine tube cultivation basis. And also Turbidity test was done using HACH turbidimeter.

RESULTS

The results showed that the amount of residual chlorine in community water distribution system in 95% of samples was in the range 0-0.8 mg/l and standard deviation was 0.32 (Fig.1). Results showed that total coliforms in 95% of drinking water samples in Saqqez city was in range 0-64(MPN/100).The mean value and standard deviation for total coliforms were 43.33 (MPN/100) and 2.01, respectively (Fig. 2). The results showed that turbidity in 95% of samples was in the range 0-3.37 NTU. The mean value and standard deviation for turbidity were 1.27 and 1.23 respectively (Fig. 3). The results also showed that fecal coliforms in 95% of samples of drinking water were in the range 0-9 (MPN/100). The mean value and standard deviation for fecal coliforms were 6.223 (MPN/100) and 1.19 respectively (Fig. 4). We also analyzed the relationship among fecal coliforms, turbidity and residual chlorine using linear regression methods (Table 1 and 2).

Table 1: Relation of residual chlorine with fecal coliform in rural areas of Saqqez basis on simple linear regression[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1424.542	1	1424.542	4.569	0.034[b]
Residual	73579.836	236	311.779		
Total	75004.379	237			

Table 2: Relation of turbidity with fecal coliform in rural areas of Saqqez basis on simple linear regression[b]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	27539.891	1	27539.891	1.834	0.177[a]
Residual	5000532.518	333	15016.614		
Total	5028072.409	334			

a.Predictors: (Constant), residual chlorine

b.Dependent Variable: fecal coliform

Table 3: WHO guidelines for safe water in 2006 [12]

Quality indicator test for E.coli (%)			
	Population (person)		
Criteria	>5000	5000-100000	<100000
High quality	90	95	99
Good	80	90	95
Fair	70	85	90
Poor	60	80	85

Table 4: Indicators for microbial quality of rural areas in 2007 [11]

Parameter	%
Absence of fecal *E.coli*	93.07
Free residual chlorine	91.43
Turbidity	95.60

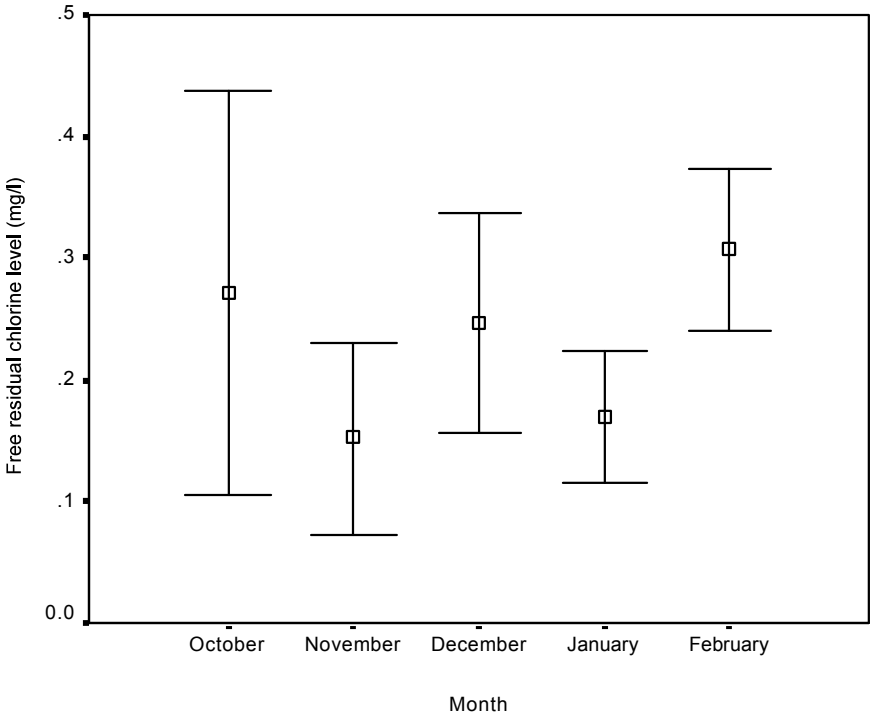

Fig. 1: Variations of free residual chlorine in water distribution systems in rural areas of Saqqez

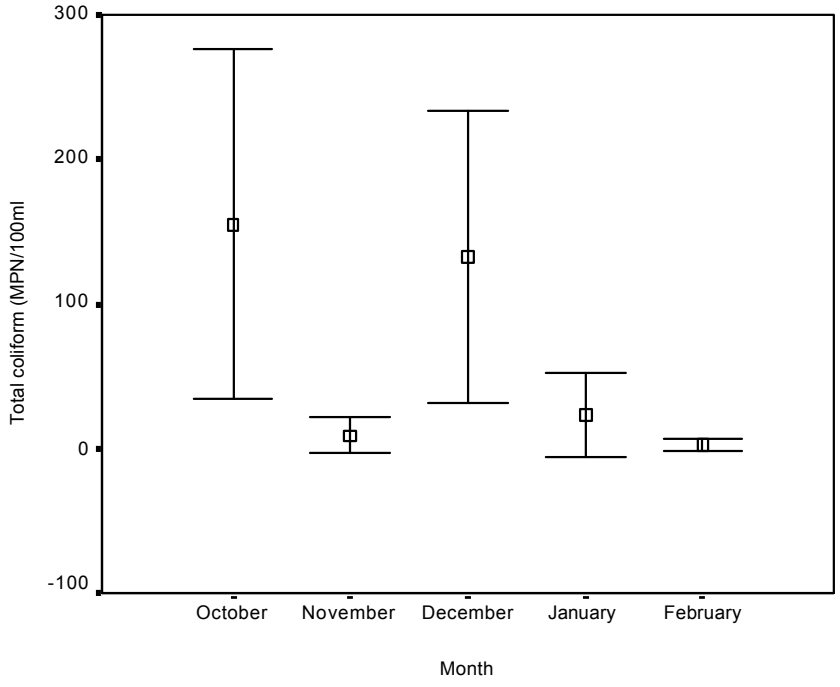

Fig. 2: Variations of Total coliform in water distribution systems in rural areas of Saqqez

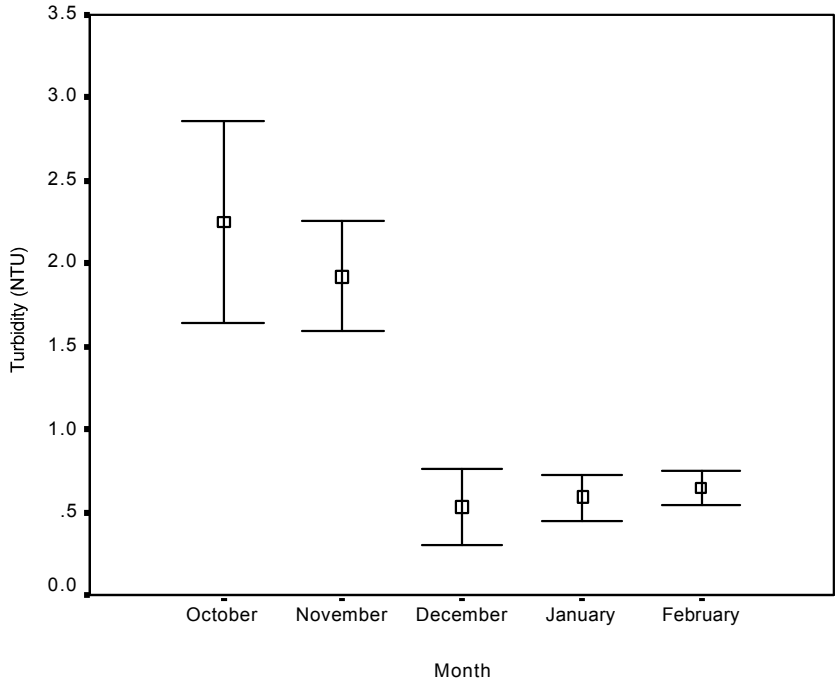

Fig. 3: Variations of turbidity in water distribution systems in rural areas of Saqqez

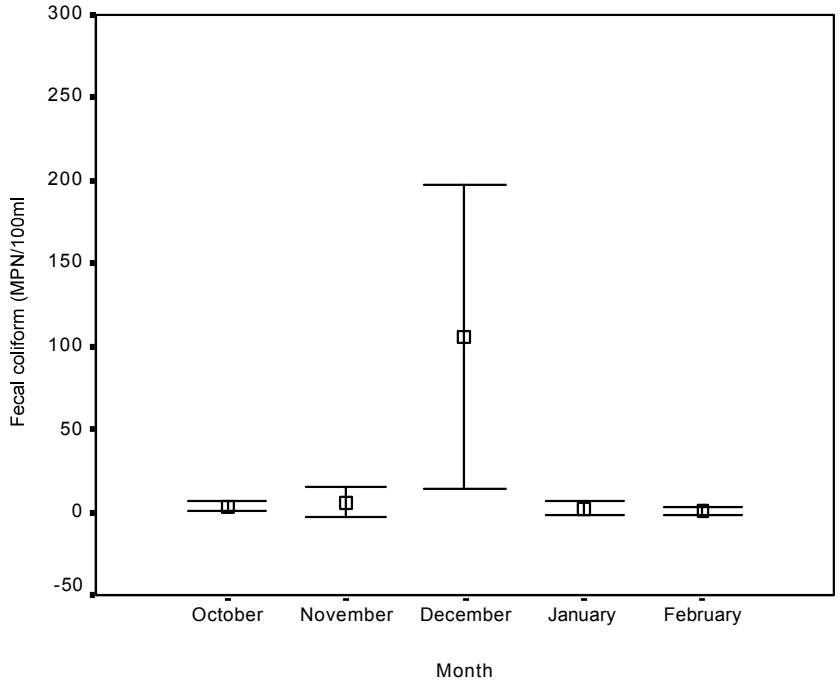

Fig. 4: Variations of Fecal coliform in water distribution systems in rural areas of Saqqez

DISCUSSION

The optimum concentration of free residual chlorine in any point of community water distribution system after half hour of chlorination by considering pH is in the range 0.5-0.8 mg/l according to Iranian drinking water guidelines. But in epidemic conditions and disasters it must be 1 mg/l [9]. Drinking water in some rural areas of Saqqez was consumed raw or without any disinfection process. Results showed that amount of free residual chlorine for only 29.5% of Saqqez city was in the range 0.2-0.8 mg/l. According to WHO amount of free residual chlorine has no any harmful effect on human health up to 5 mg/l. amount of 1 mg/l is not unpleasant in community water distribution system. The study showed that 33.88 % of Saqqez rural areas populations receive water with a free residual chlorine range 0.2-1 mg/l which is much less than Iran means values (91.42%) [9]. According to WHO and Iranian standards for drinking water, fecal bacteria indicators must not be detectable in any 100 ml sample. In the case of large supplies, where sufficient samples are examined, fecal coliform must not be present in 95% of samples taken throughout any 12-month period [9, 10]. The high mean values and standard deviations of total and fecal coliforms in water of some rural areas inJanuary were due to events such as lack of enough chlorine for disinfection and in some cases breakdown of chlorination systems. Thus, drinking water in some of these rural areas was consumed without chlorination. And caused total and fecal coliforms increase in the drinking water. In 49 samples fecal coliforms were positive in this period. The results indicated that 88 % of drinking water of Saqqez rural areas was free of fecal coliforms. In some cases especially in rural areas which were consuming drinking water without disinfection, the number of fecal coliforms was indicated 1100 (MPN/100 ml). In Iran drinking water standards optimum and Maximum Permisible Levels for turbidity are 1 and 5 NTU respectively. According to national guidelines, the mean values for drinking water turbidity in Saqqez rural areas was good in 61/8% and in 98/8% it was less than national standards [9,10].

By analyzing the relationship between free residual chlorine and fecal coliforms using linear regression methods, we did not observe a significance difference between them with a correlation of 0.074 and P value 0.117 (P value>0.05) (Table 1) and also by analyzing the relationship between turbidity and fecal coliforms using linear regression methods, we observed a linear significance difference between them with a correlation of 0.14 and P value 0.034 (P value<0.05). The linear relationship between them is Y= 0.151+1.99X (Y and X are turbidity level and fecal coliforms, respectively) (Table 2).

The survey indicated that drinking water of 33.88% of Saqqez rural population has free residual chlorine in range 0.2-1 mg/l which is less than its national mean value (91.42%) in 2007 (ghanadi and mohebbi). Drinking water for 95 % of rural areas of Saqqez city was in the range 0.2-0.8 mg/l which is 61.96 % lower than the mean value of the country in 2006. The mean value in the survey for absence for fecal *E. coli* was 88% (Table 3). By comparing to world health organization guidelines published for small communities in 2003, the microbial quality of Saqqez rural areas was good. This was 5% less than its national mean value reported in 2006 (93.07 %) (Table 4). The mean value for turbidity of drinking water in the population of Saqqez rural Areas was pleasant for 61.8% and in 98.3% it was less than national maximum permissible levels. This is somewhat more than national mean value (ghanadi and mohebbi 2008) (96%). We found that both old distribution systems and also lack of chlorine due to breakdown of chlorination system have the main effect in microbial pollution of some rural areas. When the turbidity of water increased or amount of free residual chlorine was zero, the pollution was more. Although by comparison of microbial parameters according to WHO (Table 3) the water quality of these rural areas seem safe, but the high differences in maximum and minimum variables indicated the water quality in all of these areas in not safe to drink. The quality of water in some of these areas was fair or poor. So it is necessary to prevent of pollution of available drinking water. The following recommendations are necessary for this purpose:

- To prevent water pollution, we must first have a suitable wastewater treatment system by considering the geographical and economic condition.
- providing chlorination systems for all rural areas which receive water and wastewater services.
- Training and monitoring performance of personnel
- Control of piping network and repairing when necessary.
- Prevention of storm flooding into springs, wells and also and doing enough sanitation.

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