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Comparison of total hardness, calcium and magnesium concentrations in drinking water (RO), and municipal water with WHO and local authorities at Basrah province, Iraq.

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Abstract

Different drinking water including RO (reversed osmosis water) and municipal water where collected from ten principal locations at Basrah city through January, May and December 2012, using three samples a month, to obtain the concentrations of total hardness, calcium and magnesium ions, for comparison with Iraqi and WHO guidelines for drinking water. Results showed a decrease of total hardness, calcium and magnesium ions in RO water in comparison with permitted levels according to Iraqi and WHO guidelines. The average concentrations of total hardness, calcium and magnesium for RO water were 19.5-60 ppm, 5.9-11.8 ppm and 4.4-13.9 ppm respectively. The municipal water gave high or acceptable levels of hardness, calcium and magnesium ions in all study locations except Al Zubair region which recorded low concentration of magnesium ions at municipal water compared to Iraqi and WHO guidelines. According to the obtained results at the present study, RO water used for drinking in Basrah city is not found suitable for health, due to the deficiency of calcium and magnesium ions, such ions are demanded for human health.

Key word: RO water, hardness, calcium and magnesium, health, Basrah, Iraq.

1- Introduction

Drinking water is considered as one important topic that has been received a great attention due to the high demand of human consumption used daily, as water is one essential element of life. The individual daily demand from drinking water is 2 Liter providing that average weight is 60 kg according to climate, human activity and society culture (Frewtrell and Bratram, 2001). The drinking water should be pure, sterilized and is suitable for human consumption, and free from chemical pollutants such as lead, arsenic and benzene. Also should be free from microbiological epidemic such as bacteria of cholera *vibrio cholera,* hepatitis A virus and protozoa parasites such as *cryptosporidium parvum*, such microorganisms which are very dangerous for human health (OECD, 2003). Iraq is a part of arid and semi arid regions, it suffer from deficient of pure water, so the need for RO water is argent especially at the southern part of Iraq. The important issue in RO water lies in the deficiency of calcium and magnesium elements. Calcium and magnesium are both essential elements for human health. Calcium is a substantial component of bones and teeth. In addition, it plays a role in neuromuscular excitability (i.e., decreases , the proper function of the conducting myocardial system, heart and muscle contractility, intracellular information transmission and the coagulability of blood (WHO, 2009). Magnesium plays an important role as a cofactor and activator of more than 350 enzymatic reactions including glycolysis, ATP metabolism, transport of elements such as sodium, potassium, and calcium through membranes, synthesis of proteins and nucleic acids, neuromuscular excitability and muscle contraction (WHO, 2009). For all these reasons and others, this study in significant for Basrah citizens, because of the people in Basrah drink RO water, which is low in calcium and magnesium.

2- Materials and Methods

Different RO water samples, and municipal (governorate) water were collected from 10 populated regions with high populations at Basrah city, namely: Hartha, Qurna, Abul Khaseeb, Jazaaer, Junaina, Kebla, Khour Al Zubair, Tanuma, Hyania and Al Zubair, through January, May and December 2012, using triplicate samples for each month. The water samples were collected in polyethylene with 1 liter per each sample. Samples were collected in cool box, and transferred to the laboratory for analysis. Titration methods were used by titrating with Na2EDTA solution to measure total hardness for calcium and magnesium ions, according to APHA (2005).

3- Results and Discussion

Table 1 and figures 1, 2 and 3 show average concentrations of total hardness, calcium and magnesium ions for RO and municipal waters respectively, compared to Iraqi and WHO guidelines for drinking water.

The present study showed a decrease in the total hardness of RO water substantially in all regions of study, compared to Iraqi and WHO guidelines (Table 1 ,Fig. 1), the lower average of total hardness 19.5 ppm at Junaina region, and the highest value in at Qurna region 60 ppm. Also, the present study documented that RO water is low in calcium and magnesium in all investigated regions. The reported results gave 5.9-11.8 ppm and 4.4-13.9 ppm for calcium and magnesium respectively. Therefore, the recorded concentrations of total hardness, calcium and magnesium ions in RO water are less than, the excepted according to the Iraqi and WHO guidelines (Table, 1 ,Fig. 2,3). The difference in total hardness, calcium and magnesium concentrations in RO water may be attributed to the process of desalinization which remove the minerals from the raw water, and without the introduction of remineralization step. For the municipal water, the averages for total hardness are found within or higher than the proposed in all study regions, except Al Zubair region which gave hardness concentration lower than the permitted levels, according to Iraqi and WHO guidelines (Table, 1 and Fig. 1). Also, the municipal water showed higher concentrations than reported for calcium and magnesium ions, except for Qurna, Jazaair and Hyania regions; as those were within the permitted levels. Al Zubair region gave lowest concentration for municipal water compared to Iraqi and WHO guidelines (Table, 1, Fig. 2,3). The high concentrations of hardness, calcium and magnesium ions particularly in municipal water is due to the presence of these elements in water sources that taken from these regions (Moyel, 2010). Also, it is due to the low efficiency of the purification stations, which are contributed substantially for elements removals from water supplied in these regions.

Since early 1960's, epidemiological studies in many countries all over the world have reported that soft water (i.e., RO water) and water low in magnesium are associated with increased morbidity and mortality from cardiovascular disease (CVD) compared to hard water and water high in magnesium (Sauvant and Pepin 2002; Donato *et al.* 2003; Monarca *et al*. 2003. Recent studies also suggest that the intake of soft water, i.e. water low in calcium, may be associated with higher risk of fracture in children (Verd Vallespir *et al*. 1992), certain neurodegenerative diseases (Jacqmin *et al*.

1994), pre-term birth and low weight at birth (Yang *et al*. 2002) and some types of cancer (Yang *et al*. 1997; Yang *et al*. 1998). In addition to an increased risk of sudden death (Eisenberg 1992; Bernardi *et al*. 1995; Garzon and Eisenberg 1998), the intake of water low in magnesium seems to be associated with a higher risk of motor neuronal disease (Iwami *et al*. 1994), pregnancy disorders (so-called preeclampsia) (Melles & Kiss 1992), and some types of cancer (Yang *et al*. 1999a; Yang *et al*. 1999b; Yang *et al*. 1999c; Yang *et al*. 2000). More studies have provided additional information about minimum and optimum levels of minerals that should be in demineralised water, Based on this studies, various researchers have recommended that the following levels of calcium, magnesium, and water hardness should be in drinking water: For magnesium, a minimum of 10 mg/l (Novikov *et al*. 1983; Rubenowitz *et al.* 2000) and an optimum of about 20-30 mg/l (Durlach *et al.* 1989; Kozisek 1992); for calcium, a minimum of 20 mg/l (Novikov *et al*. 1983) and an optimum of about 50 (40-80) mg/l (Rakhmanin *et al*. 1990; Kozisek 1992); for total water hardness, the sum of calcium and magnesium should be 200 to 400 mg/l (Plitman *et al.* 1989; Lutai 1992; Muzalevskaya *et al.* 1993; Golubev and Zimin 1994). When comparing the concentrations of total hardness, calcium and magnesium ions in drinking water in the current study with the concentrations proposed by researchers above, we find that RO water used for drinking in Basrah city is not suitable from health, due to the deficiency of calcium and magnesium ions, such ions are demanded for human health.

Table 1: Average concentrations of total hardness, calcium and magnesium in drinking water (RO), and municipal water in comparison with Iraqi and WHO guidelines.

		Hartha	Qurna	Abul Khaseeb	Jazaaer	Junaina	kebla	Khour Al Zubair	Tanouma	Ilyania	Al Zubair
Total Hardness (ppm)	RO Water	24	60	33	22	19.5	32	28	30	36	25
	Tap Water	488	340	710	340	480	370	650	630	340	180
	WHO guideline	250	250	250	250	250	250	250	250	250	250
	Iraqi guideline	400	400	400	400	400	400	400	400	400	400
Ca (ppm)	RO Water	8.6	11.8	8.6	9	5.9	9.8	10.4	8.2	7.9	7
	Tap Water	86	90	88	122	88	66	56	110	102	86
	WHO guideline	50	50	50	50	50	50	50	50	50	50
	Iraqi guideline	75	75	75	75	75	75	75	75	75	75
Mg (ppm)	RO Water	5.4	13.9	7.5	4.8	4.4	7.2	6.2	6.8	8.3	5.7
	Tap Water	74.6	48	128.5	46.8	82.1	56	111.8	107.7	47.9	23
	WHO guideline	30	30	30	30	30	30	30	30	30	30
	Iraqi guideline	50	50	50	50	50	50	50	50	50	50

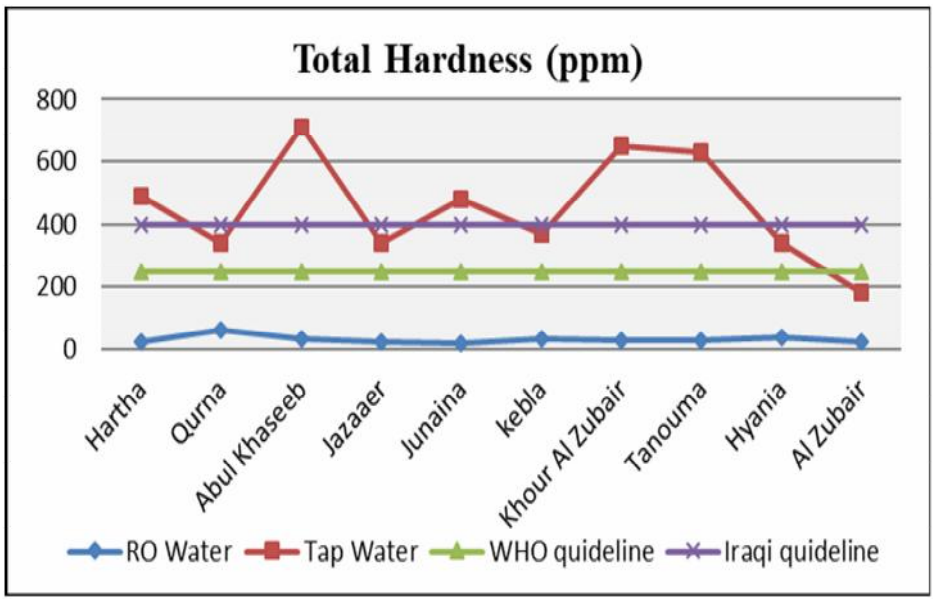

Fig. 1 : Average concentrations of total hardness in drinking water (RO), and municipal water in comparison with Iraqi and WHO guidelines

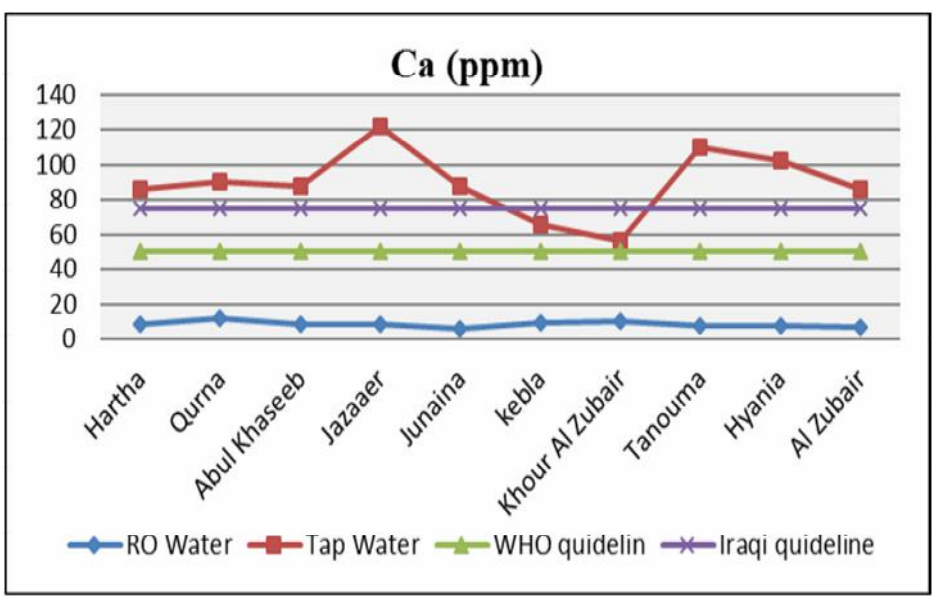

Fig. 2 : Average concentrations of calcium in drinking water (RO), and municipal water in comparison with Iraqi and WHO guidelines

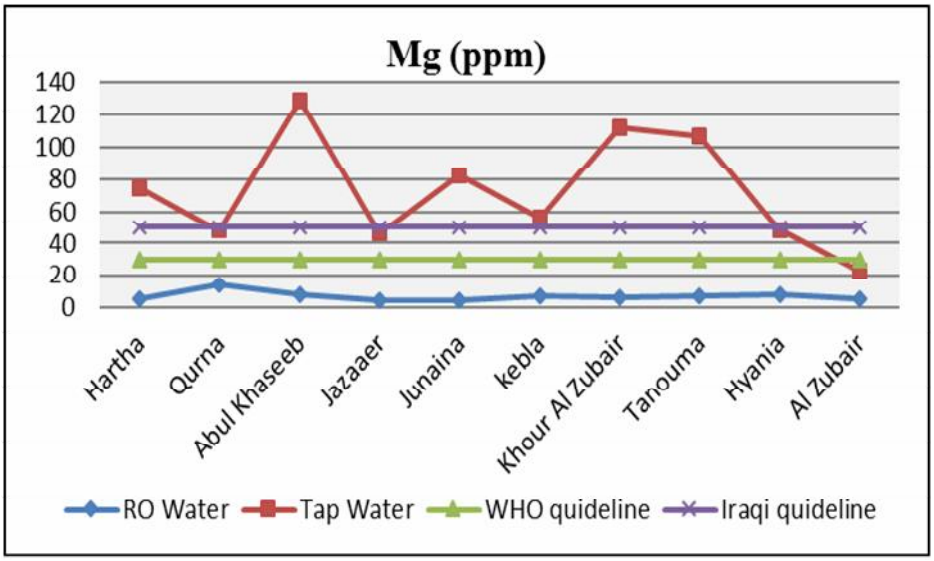

Fig. 3 : Average concentrations of magnesium in drinking water (RO), and municipal water in comparison with Iraqi and WHO standards.

4- Recommendations

To guarantee the lower permitted concentrations of calcium and magnesium ions in drinking water according to Iraqi and WHO guidelines, the following points are recommend:

1- Formulation of limited laws concerning water treatment and technology for decreasing calcium and magnesium in drinking water (such as RO water) to maintain the contents of calcium and magnesium within healthy limited ranges.

2- For the use of RO for drinking, the amounts of mineral contents has to be adjusted by using filter containing calcium carbonate or passing carbon dioxide in water or addition of calcium compounds, such as lime water (calcium hydroxide), which is added directly to the water. Unfortunately, such additions will increase the magnesium ions slightly. Therefore, a filter should be developed using calcium carbonate and magnesium carbonate or calcium carbonate and magnesium oxide to adjust the amounts of calcium and magnesium together.

3- The ratio of calcium to magnesium should be maintained at 1:2 calcium to magnesium.

4- Increasing the medical awareness for society and attention to educate people for the importance of mineral containing water, such as bottles containing calcium and magnesium ions, instead of drinking the available RO waters, which do not contain the accepted levels of calcium and magnesium ions

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مقارنة تراكيز العسرة الكلية وأيونات الكالسيوم والمغنسيوم في مياه RO المستخدمة للشرب ومياه الإسالة مع المواصفات المحلية والعالمية (WHO) لمياه الشرب في محافظة البصرة، العراق.

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الخلاصة

جمعت نماذج من مياه RO (Reverse osmosis water) (وهي مياه صناعية يكون محتواها من المعادن والأملاح الضرورية للجسم قليل جداً) المستخدمة للشرب ومياه الإسالة من عشرة مناطق رئيسة في محافظة البصرة خلال أشهر كانون الثاني وحزيران وتشرين الثاني لعام 2012 وبواقع ثلاث عينات شهرياً، لتقدير تراكيز العسرة الكلية وأيونات الكالسيوم والمغنسيوم ومقارنتها مع المعايير والمواصفات القياسية المحلية والعالمية. أوضحت نتائج الدراسة انخفاض تراكيز العسرة الكلية وأيونات الكالسيوم والمغنسيوم في مياه RO عن الحدود المسموح بها حسب المعايير والمواصفات القياسية، إذ تراوح معدل تراكيزها بين (19.5–60 ppm) و (5.9–11.8 ppm) و (4.4–13.9 ppm) على التوالي. أما مياه الإسالة فقد كانت معدلات تراكيز العسرة الكلية وأيونات الكالسيوم والمغنسيوم فيها ضمن أو أعلى مما هو مقرر في المعايير والمواصفات القياسية لمياه الشرب المحلية والعالمية في جميع مناطق الدراسة، عدا منطقة الزبير التي سجلت فيها تراكيز أوطأ لأيون المغنسيوم في مياه إسالتها عند مقارنتها مع المعايير والمواصفات القياسية المحلية والعالمية. اعتماداً على النتائج المستحصلة من الدراسة الحالية تبين أن مياه RO قد تكون غير آمنه صحياً لانخفاض تراكيز العسرة الكلية وأيوني الكالسيوم والمغنسيوم فيها والتي تمثل عناصر مهمة للصحة العامة.

كلمات دالة: مياه RO ، العسرة، الكالسيوم والمغنسيوم، الصحة، البصرة، العراق.