Study of Microbial and chemical contamination for drinking water and locally bottled drinking water in Al-Muthanna province

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Abstract

The current study included assessment of drinking tap water for seven region in Al-Muthanna province, the study regions are (Al-Majed , Gaber saed , Al-Rahman, Health Center, Al-Jawadin, Al-Tamem and College of Science \ Al- Muthanna University) during January 2019, and according to Iraqi standard specification2009 for drinking water, we will determine its suitability for drinking. In addition to, the present study included examination of 6 types from locally bottled drinking water such as;(Nahr-Al-amal, Mawj, Naba Al-karam, Salem, Masa and Lojin). The results showed that all drinking tap water and bottled drinking water samples were approved and suitable for drinking due to these samples were within the Iraqi standard of drinking except Al-Rahman region water and Salem bottled water were polluted with bacteria 67colony for M.P.N and 89 colony for A.P.C respectively. While Salomnella and V.cholera weren't found in all samples of this study.

Key word : bottled water , Tap water, Turbidity, Sulfate .

الملخص:

الدراسة الحالية تضمنت تقييم مدى صلاحية مياه الحنفيات المخصص للشرب ولسبعة مناطق في محافظة المثنى في جنوب العراق تلك المناطق تتضمن كالتالي (منطقة حي المجد ، منطقة سيد جابر ، منطقة الرحمن، منطقة المركز الصحي ، منطقة الجوادين ، منطقة التميم ، وكلية العلوم في جامعة المثنى) خلال شهر يناير لعام 2019 وطبقا للمواصفات القياسية العراقية لعام 2009 لمياه الشرب نحن سوف نحدد مدى صلاحيتها للاستهلاك البشري ، بالإضافة الى ان الدراسة الحالية تضمنت فحص ستة اصناف محلية الصنع لمياه الشرب المعبأة تلك الاصناف هي كالتالي (نهر الامل ، موج ، نبع الكرم ، سالم ، ماسة ، ولجين) . نتائج الدراسة الحالية اظهرت ان كل عينات مياه شرب الحنفيات و عينات مياه الشرب المعبأة كانت مقبولة ومناسبة للشرب بسبب ان قيم فحوصات تلك العينات كانت ضمن المواصفات القياسية العراقية عدا مياه منطقة الرحمن ومياه الشرب المعبأة صنف سالم كانت ملوثة بالبكتريا 67مستعمرة بالنسبة للعدد الاكثر احتمالية و 89مستعمرة بالنسبة للبكتريا الهوائية على التوالي . بينما بكتريا السالمونيلا والكوليرا لم تكن موجودة في كل عينات الدراسة الحالية .

الكلمات المفتاحية : المياه المعبأة ، مياه الحنفية ، العكورة ، الكبريتات .

Introduction:

Drinking water is defined as water can be consumed by drinking by humans and regarded one of the most topics of interest to scientists and specialists in the pollution field because of the importance of water , it participate in all biological , industrial processes and living organism cannot live without it due to the water is an important component in composition of the cell as a building unit in each organism, whether plant or animal, as it is the necessary medium for the occurrence of all interactions and transformations that take place within the bodies [1]. Therefore, water pollution sources are very dangerous due to causes defects in the environmental balance, water pollution is mixing of water streams, wells, rivers, seas, rains and groundwater, which makes the water inappropriate for humans, animals and plants. Thus , Water is contaminated by human, animal, plant and industrial waste [2]. The bottled water is one of the most important needs of the human indispensable in daily use , as well as, estimated the individual needs of drinking water is about 2 liters per day for a person who weighs 60 kg from drinking water and other drinks such as juices, tea ,other soft drinks and free water contained in food ingredients [3][4]. Drinking bottled water should be clean and free from all types of pollutants, whether chemical, physiological or microbial, which are considered to be threatening to human health [5]. In recent years, there has been a noticeable increase in bottled water industry in Iraq, as well as, the various sizes of bottled drinking water ,especially plastic, constitute a high percentage of the consumer predominantly in drinking. Due to the importance of the subject, many studies have been conducted to determine the characteristics of this type of water such as Alzubaidi and Almosawi, 2010[6] who studied 47 drinking bottled water samples were local and imported . Another study conducted by Razouqi and Al-Raawi, 2010[7] showed physical, chemical and biological properties of domestic and imported bottled water samples in Baghdad province. Regular monitoring of bottled drinking water is essential, this will help the double purpose of checking the standards of bottled water samples industries as well as in order to give reassurance about the good quality of consumers. This study includes assessment of drinking tap water and purification efficiency in some stations in Al-Muthanna province by approximating amounts of soluble and insoluble chemicals impurities, microbial contamination and compares results with Iraqi standards , as well as , assess quality of some locally bottled drinking water which available in Al-Muthanna markets and their suitability for consumption as specified by the Iraqi standard for bottled drinking water.

Materials and methods :

Sampling: Water samples were collected during January 2019 for seven regions in Al-Muthanna governorate included (Al-Majed , Gaber saed, Al-Rahman, Health Center, Al-Jawadin , Al-Tamem, College of Science \ Al- Muthanna University, two sets of containers we used for collecting tap water samples ; the first set of is 500ml glass bottles to collect water samples for microbial testing and second set of sealed plastic bottles were homogenized with distilled water and intended to collect water samples for chemical tests. Also, water samples were collected from the taps after opening tap for 2 minutes followed by opening the bottle cap near the tap and filling with water and closing tightly to avoid any contamination may occur. As well as, the study also included collection of 6 sorts of bottled water from local markets during

August 2019 , we took two samples for each type included ; one for microbiological tests and other for chemical tests . These samples are: (Nahr-Al-amal, Mawj, Naba Al-karam, Salem, Masa and Lojin) in various sizes .

Instruments and Equipments:

Chemical and physical tests :

The pH of samples was measured by pH meter (HANA) while turbidity of samples measured by turbidity Meter (HANA-LP2000) . Moreover , Total dissolved salts (T.DS) measuring device (Hanna. Besti) type, while Na and Fe we used Flame photometer according to APHA,1998[8] . Nitrates and sulfates were estimated according to APHA,1985 [9]by using spectrophotometer CEL.CE.7200 type . The calcium, chloride, and aluminum were measured according to APHA, AWWA and WFF, 2005[10].

Biological tests: Most Probable Number (MPN) was used as a statistical method based on the presence of low live numbers in drinking water samples and their development to detect coliform and streptococci to examine large numbers of different sizes for each sample according to [11],[12]. We used Aerobic Plate Count (APC) as an indicator of bacterial contamination for each sample according to [13]. Detection of *E.coli* , *Salmonella* and *V.cholera* bacteria for each sample according to [11],[14] ,[15],[16].

Results and discussion :

Description of research regions and samples: The research began in January and included investigation of chemical and microbial properties for seven drinking tap water samples prepared for human consumption and these samples were collected from seven population regions in Al-Muthanna province, the drinking water from taps in some population regions of Al-Muthanna included the following areas: Al-Majed , Gaber saed , Al-Rahman, Health Center, Al-Jawadin, Al-Tamem and College of Science \ Al- Muthanna University supplied with drinking water from Al-Rumaitha project.

Chemical and physical tests :

Table: (1) shows the highest value of the total dissolved salts(T.DS) in health center region 989mg/l while gaber saed region was the lowest value of 361mg/l and the allowed value in Iraqi standard for 2009 was 1000mg/l. These measured ratios are normal at this time of year and they are within approved limits. As well as, T.DS in drinking water are an essential indicator of their suitability [17] . There is no documented information about health effect of T.DS in drinking water and studies indicate that it has recorded adverse effects in both directions (increase and decrease) [18], [19] and[20]. An Australian study noted a direct correlation between heart disease mortality and T.DS in drinking water [21]. The increase of T.DS proportion in drinking water gives unacceptability of water by the consumer as well as this increase gives the following indicators:1- Accelerate the erosion of water distribution networks 2- Many high levels of ions are higher than drinking water standards such as high nitrate, arsenic, aluminum, copper, etc. 3- There is a relationship between concentration of T.DS and electrical conductivity of water. This relationship is a function of the quality and nature of the positive and negative ions dissolved in water

or any other suspended matter 4- The positive ions associated with carbonate and bicarbonate such as calcium and magnesium are evidence of hardness , calcification and bitter taste of water 5- The positive ions associated with chloride such as sodium and potassium are evidence of the salty taste of water and calcification increased [22] .

Table: (2) shows the highest value of T.DS in salem bottled water 340mg/l while Mawj bottled water was the lowest value 17mg/l . When comparing obtained results with standards, it was found to be within the allowed limits specified in the Iraqi standards so as this result is compatible with Mohammed, 2013[23] but not compatible with Hussain et. al.,2017[24] results.

As shown in (Table 1), the chloride proportion in Al-Jawadin area is normal 197mg/l and within the approved limits 350mg/l while Al-Majed, Health Center and gaber saed region the chloride proportion was 88,99,94mg/l respectively. These ratios are incompatible with Ahmed and Muhammed, 2010[25] which found high chloride ratio in Dora area 975 ppm and 620 ppm in Adhamiya, Qadisiyah and Al-Turath region. The human body has the ability to tolerate 2000 mg / l of chloride ion and the chlorine itself causes abdominal pain if proportion increased in the drinking water, as well as it reacts with organic substances in water as a result of contamination and lead to formation organic compounds chlorinated that increase the risk of cancer [26]. As for bottled water, table 2 showed the chloride proportion in Naba Al-karam is 130mg/l salem 87mg/l and 98 Lojin all these ratio within the approved limits which 250mg/l. This result also compatible with Mohammed,2013[23] results.

Table :1 shows that all regions have recorded PH values within approved limits for drinking water , but three regions are Al-Rahman, Al-Jawadin and College of Science , PH values reduced to 7.0, 7.4,7.0 respectively. This may be supplied with river water after being polluted by city's wastewater, which was mainly low pH=7.4 as the regulatory action of the plant's water has decreased compared to river water. Although there is no direct effect of PH on human health, it is an important factor that indicates the quality of drinking water and should be carefully considered. On the other hand, extreme PH values damage distribution networks. Table :2 shows PH values of all tested bottled water ranged between (7.4- 8.2), all these ratios matching when compared to Iraqi standard for bottled water . This result is identical to a previous study completed by Alzubaidi and Almosawi, 2010[6] who found PH values of all tested bottled water samples were within permitted limits of Iraqi standard for bottled water. As well as , the result of this study showed an approximation in the turbidity values , which ranged from 3.0- 5.0N.T.U. which was within allowed international standards table:1 . while bottled water samples , the turbidity ranged between 0.6-4.1 N.T.U which was also within allowed international standards table:2. So as , the water turbidity is a measure of its transparency and can be attributed to suspended solids in water or high proportions of pathogenic organisms such as viruses and bacteria. The high levels of turbidity can protect microorganisms from disinfection effects, stimulate bacterial growth and lead to excessive use of chlorine as a disinfectant [27].

The current results recorded low ratios for sulfate but are within permitted drinking water standards table:1. The sulfates are also one of the naturally occurring ions in water and available information about high sulfates concentration leads to diarrhea, in addition to give water unacceptable taste, and financial losses due to the erosion of water distribution networks, sulfate concentration increases as a result of industrial

processes and acid rain lead to decrease in pH value of water [28]. This result is compatible with Al-Samarrai, 2007 [29]. While bottled water samples , sulfate values were within permitted drinking water standards which ranged between 60-150mg/l table:2. Hence, one causes of water hardness presence of sulfate ions in water and may be lead to low solubility so as sulfate ions present at night in surface water[30]. This result was higher than previous study conducted by Hussain et. al.,2017[24] which found the highest ratio of sulfate ion is 77.3 mg / l of oasis water and the lowest ratio was 15.9 mg / L. The nitrates recorded low values in drinking water in selected areas compared to global standards table:1, not because of the decrease nitrate sources but due to lack of oxygen content of river water, which is very important for the bacteria during decomposition and oxidation of organic matter [31]. The nitrates and nitrites effect on human health in two ways. First, they cause what is known as methaemoglobinaemia syndrome for children under six months, where the nitrate reduce to nitrite in children's stomach so as the nitrite oxidizes hemoglobin to methamoglobin, and blood cannot transfer oxygen to rest of the body[32]. Also, nitrates recorded low values in bottled drinking water samples compared to global standards table:2, where the nitrates values ranged between0.2 – 10.1 mg/l. Another study conducted by Al-dory, 2012[33] who found nitrate concentration in local bottled water ranged between4.8 – 0.9 mg/l . Calcium ion is essential for health of living organisms including humans , so as it is responsible for decrease of damaging effects of sodium ions and is essential in development of hardness. Commonly, one of the characteristics Iraqi soils are calcareous, which a provide the water with calcium ions in addition to several civil actions which support increase this ion in water[30] . The highest ratio was in College of Science water which reached about 100 mg/l and the lowest ratio of the water of region Al-Majed was 64 mg/l and all ratios in this study were approved within Iraqi standard for drinking water 150 mg/l table:1, While bottled drinking water samples highest ratio was in Mawj, which reached about 27 mg/l and the lowest ratio was in Nahr-Al-amal 9 mg/l and all the ratios in this study were approved within the Iraqi standard for bottled drinking water 750mg/l table:2. , this study is comparable to another study done by Hussain et.al.,2017[24] who found highest calcium ratio in bottled drinking water samples 152 mg/l and the lowest ratio was 88 mg/l . As for the Aluminum, sodium and iron were within approved limits in the Iraqi standards for both drinking and bottled drinking water table: 1 and 2. This study consistent with a previous study completed by Alzubaidi and Almosawi, 2010[6] who found all tested bottled drinking water samples contain on iron within allowed limits by the Iraqi standard for bottled drinking water Fe = 0.1. While Ahmed and Muhammed, 2010[25] who found the iron concentration did not record any significant increase in drinking water for some areas of Baghdad province except Al-Zafaraniyah region, the iron concentration was elevated 0.53 mg/l whereas sodium concentration was in the range 53.8-85mg/l. In addition to Smedley , 2010[34] examined 85 samples of bottled drinking water in Britain and pH, calcium, magnesium, sodium, chloride, sulfates and nitrates concentrations were as follows: (8.49-6.48), (1335- 3.37), (58-1.88), (91.6-4.57), (14.3-4.43),(145-0.31),(6.33-0.05) respectively.

Table (1): Shows the ratios of physical and chemical tests for each water sample.

Fe	Na	Al	Ca	SO4	NO3	CL	TUR	T.DS	PH	Region
S.S* 0.3	S.S* 200	S.S* 0.2	S.S* 150	S.S* 400	S.S* 50	S.S* 350	S.S* 5	S.S* 1000	S.S* 6.5-8.5	
0.2	56	0.02	64	140	4.3	88	3.0	488	8.0	Al-Majed
0.09	52	0.06	66	250	2.2	94	4.4	361	8.3	Gaber saed
0.1	33	0.01	77	3.4	7.5	165	3.8	377	7.0	Al-Rahman
0.06	25	0.01	72	5.2	3.6	99	4.9	989	8.2	Health Center
0.07	35	0.01	99	32	5.9	197	4.5	750	7.4	Al-Jawadin
0.2	37	0.01	93	38	3.1	150	3.7	777	8.4	Al-Tamem
0.06	29	0.01	100	30	4.1	188	5.0	855	7.0	College of Science

*** standard specifications according to Iraqi standard 2009[35].**

Table (2): Shows the ratios of physical and chemical tests for bottled water samples.

Fe	Na	Al	Ca	SO4	NO3	CL	TUR	T.DS	PH	bottled water
S.S* 0.3	S.S* 200	S.S* 0.2	S.S* 750	S.S* 250	S.S* 45	S.S* 250	S.S* 5	S.S* 1000	S.S* 6.5-8.5	
0.2	22	0.01	9	60	4.6	70	2.0	50	7.7	Nahr-Al-amal
0.1	15	0.02	27	90	0.2	25	3.5	17	8.1	Mawj
0.1	28	0.02	16	150	5.4	130	2.9	84	7.5	Naba Al-karam
0.1	18	0.06	19	70	0.9	87	3.4	340	8.1	Salem
0.1	26	0.04	11	70	10.1	46	4.1	95	7.4	Masa
0.1	19	0.01	22	121	3.8	98	0.6	99	8.2	Lojin

*** standard specifications according to Iraqi standard 2009[35].**

Biological tests:

The result of this study showed there was no microbial contamination in drinking water samples, this confirms interest of treatment units in purification plants for liquefied water in Al-Muthanna province to sterilization, except Al-Rahman region where the most probable number was 67colony which supports water of this area is not suitable for drinking according to Iraqi standard which should not exceed one colony per 100 ml of the sample . The emergence of these bacteria gives biggest evidence that this water is not safe for drinking due to many reasons, including lack of attention for sterilization of drinking water in the filtering projects in addition to old distribution network which serve as another source of drinking water pollution . Therefore, we recommend use of education and media means for purpose of raising environmental awareness to clarify danger use of such water and reduce river water pollution especially in villages and adjacent areas. Furthermore , follow-up presence of pathogenic microorganisms in drinking water stations and distribution networks ,so as dispose of them in appropriate ways. In addition to repair any defect in old tubes specialized for water distribution from these stations. These results similar to a previous study results done by Ahmed and Muhammed, 2010[25] but not consistent with results of Al-Samarrai, 2007[29]. Table(4) shows all samples of bottled water are free from bacterial contamination and support its viability for human consumption according to Iraqi standards, except salem water sample containing 89 colony, this is higher than allowed microbial limits in Iraqi standard for bottled drinking water 5colony, as well as this indicates an inefficient sterilization process. This study incompatible with Hussain et.al.,2017[24] who found most of bottled water samples contained bacteria.

Table (3): Shows the microbial limits and results of the study for each water sample.

V.cholera	Salmonella	E.coli	M.P.N	A.P.C	Region
Zero	Zero	Zero	Zero	Zero	**Al-Majed**
Zero	Zero	Zero	Zero	Zero	**Gaber**
Zero	Zero	Zero	67	Zero	**Al-Rahman**
Zero	Zero	Zero	Zero	Zero	**Health Center**
Zero	Zero	Zero	Zero	Zero	**Al-Gawadean**
Zero	Zero	Zero	Zero	Zero	**Al-Tamem**
Zero	Zero	Zero	Zero	Zero	**College of Science**

Table (4): Shows the microbial limits and results of the study for each bottled water sample.

V.cholera	Salmonella	E.coli	M.P.N	A.P.C	bottled water

Zero	Zero	Zero	Zero	Zero	**Nahr-Al-amal**
Zero	Zero	Zero	Zero	Zero	**Mawj**
Zero	Zero	Zero	Zero	Zero	**Naba Al-karam**
Zero	Zero	Zero	Zero	89	**Salem**
Zero	Zero	Zero	Zero	Zero	**Masa**
Zero	Zero	Zero	Zero	Zero	**Lojin**

Conclusion:

We concluded from present study most of the chemical and physical tests for drinking water in Al- Muthanna province regions, which include total dissolved salts, turbidity, chloride, NO3,SO4,Ca,Al,Na ,Fe and PH were within allowed limits according to Iraqi standard . This confirm water of these regions suitable for human consumption except Al-Rahman region, water of this area is not suitable for drinking according to Iraqi standard due to microbial contamination . Besides, bottled drinking water in local markets also all chemical, physical and biological tests were within allowed limits. This support its viability for human consumption according to Iraqi standards except Salem bottled water samples was contaminated with aerobic bacteria, this confirms Salem bottled water unsuitable for drinking.

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