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Quality Assessment of Various Bottled-Water Andtap-Water in Kirkuk - Iraq

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Abstract
This study was conducted to demonstrate the suitability of bottled water used in Kirkuk city - Iraq and Tap water processed by the Directorate of Kirkuk's water for human consumption, collected 20 type of bottled water (local made and imported) and nine Tap waters sample from different city regions , samples analysis both chemical& physical properties included (PH,Turbidity, E.C., T.D.S, T. Hardness, Alkalinity, T.S.S) with measuring elements (Ca^{+}, Mg^{+}, Cl^{-}, $So4^{=}$, Na^{+}&K^{+}) , all data compared with (IBWA, 2008) & (IS 470 /2001), bottled water results compare with brand labels .
Results showed the existence of discrepancies between the data obtained in vitro with what is listed on brands label , note that many of thebrands did not coverall properties should be known by the consumer for the purpose of safety of use, also the results showed that three regions in Kirkuk city and processed its water by the Water Directorate of Kirkuk is not suitable to drink.
Key words: Bottled water, Tap water, Quality assessment, Directory of Kirkuk water

I. Introduction

Water consumed by human comes in various forms and from the various sources, bottled water was once from that forms. Recently ithas been increase dramatically due to the ever increasing contamination of water resources (Baba & Others, 2008). bottled water consumption has been growing steadily worldwide during the last three decades and is regarded as fastest growing and most dynamic sector of all the foods & beverage industries (Semerjian,2007) .Interests bottled water first began in 1970, and with the promotion of this product bottled water market has grown, and by late 1990 multiplied by three times the soft drinks market (Ahmed &Bajahlan, 2009) . according to the latest statistically , the global consumption of bottle water reached 162 billion letters in 2005 (Khan &Arham, 2010) . The average consumption per capita in Europe (104.2 liters) in 2007 (Semerjian, 2007) .

In order to protect health, people turn to consume bottled water and spend a lot of money to buy bottled drinking with assumption that the bottled water is clean and safe than boiled water (Xayyavong& Babel, 2010) &(Ward, 2009).The non-arrival of useful water for consumers , presence of odors and unpleasant taste in the water supplying by municipallike chlorine, fluoride and other additives, believe consumers the impact of medical and therapeutic water bottled & depicting consumers that the use of bottled water gives a sense of height of the social level in addition to the promotion of media for this consumer, especially from consumers (children, the elderly and patients with little immunity) led to increase the use of bottled water in the world (Semerjian, 2007).

In Iraq The manufacturing bottled water becomes very popular especially after the last war in 2003, in which the number of factories represents 54.5% of the overall food and beverage factories that are officially approved by the General Directorate for Industrial Development in addition to the imported types (Al-Hassan H. Ismail, 2013),Failure accompanied this remarkable increase in the preparation laboratories sharp decline in the quality of the product represented by the increasing percentages in the application of health requirements contained in the standard of Iraqi private drinking water bottled No.1937 of 2000, which led to the flooding of local markets with many of the brands that lack of specifications health own(Razuki& Al-Rawi, 2010) ,Change the quality of the product itself due to changes in the quality of the source water used in processing plants, such as water, groundwater and variance of the season for another season and type of containers used for the storage of the product and the quality of the treatment (Al-Abbdula'aly& Khan, 1999) , these data led to questions among consumers about the benefit of using local or imported bottled water&which species most suitable compared to the use of drinking water supplied by the municipality.

For that, This study was conducted to indicate the duration of appropriate types of bottled water and drinking water supplied by the Directorate of Water Kirkuk through the study of physical and chemical properties and compare them with the specifications on the packaging With the

specification of the Iraqi water to indicate the most suitable species for consumers.

II. Material & Methods

Twenty bottled water's brand (17 local made & 3Foreign) were collected from many markets in Kirkuk city at 2011 , each brand name & Origin are given in (table1) according to the brands label , it was sold in (0.5 – 0.6) liters size in poly ethylene non-recyclable bottles , four samples are taken from each brands , Specifications mentioned in brands labels have written in table (2,3) , Also nine tap water's samples (supply by directory of Kirkuk water) were taken from different regions inside Kirkuk city , two liters are taken in sterile class bottle for each zone , (figure 1) shown sampling area in side Kirkuk .

All samples were analyzed for selected parameters according to the Iraqi Standards for drinking water (417 / 2001) included : pH , Turbidity, EC (Electrical conductivity), T.D.S. (total dissolved solids), Alkalinity, T.H. (Total hardness) , T.S.S. (Total suspended solid), & minerals (chlorides Cl^-, calcium Ca^+, magnesium Mg^+, sulphate $So_4^=$, sodium Na^+, Potassium K) .

Table 1 : (Composition Of Bottled Water)

No.	Brand's Name	Type	Place Of production
1.	Margan	Bottled Drink Water	Kirkuk – Iraq
2.	Kameran	Bottled Drink Water	Kirkuk – Iraq
3.	Jawharat Al- Bahir	Sterilized With Ozone & U.V.	Kirkuk – Iraq
4.	Crystal	Treated with Ozone & U.V.	Kirkuk – Iraq
5.	Mazi	Natural Spring water From Gare Mountain	Duhok – Iraq
6.	Rovian	Mineral Water Bottling .	Duhok – Iraq
7.	Jin	Bottled Drinking Water	Duhok – Iraq
8.	Lava	Bottled Drinking Water	Duhok – Iraq
9.	Life	Bottled Drinking Water	Duhok – Iraq
10.	Dareen	Treated With Ozone & U.V.	Musol – Iraq
11.	Sati	Treated With Ozone .	Kirkuk – Iraq
12.	Mina	Treated With Ozone & U.V.	Kirkuk – Iraq
13.	Kani	Baekhal Fountain	Erbil – Iraq
14.	Ala	Bottled drink water	Sulaimaniya – Iraq
15.	Al-Rayan	Mineral Water Ozone treated	Sulaimaniya – Iraq
16.	Hadeer	Treated With Ozone	Baghdad – Iraq
17.	Hayat (Danone)	Mineral Bottled Water	Turkey
18.	Volvic	Natural Mineral Water	France
19.	Preal	Bottled Drinking Water	USA/ Iraq
20.	Azbah	Bottled Drinking Water	Saudi Arabia

III. Result & Discussion

The physical & chemical composition of analyzed bottled drinking water & Tap waters is summarized in Table 2,3 and 4 . The number shown are average measurements of four replicates for each water brand .Results were compared to specifications mentioned on the label of each brand for the bottled water and then was comparable with international standards (IBWA,2008) , noted that there were not available for the Iraqi standard of Bottled water drinking , As for the results of analyzes of tap water samples has been comparable with Iraqi drinking water Standard (No.. 471/ 2001) & (WHO 2006) .

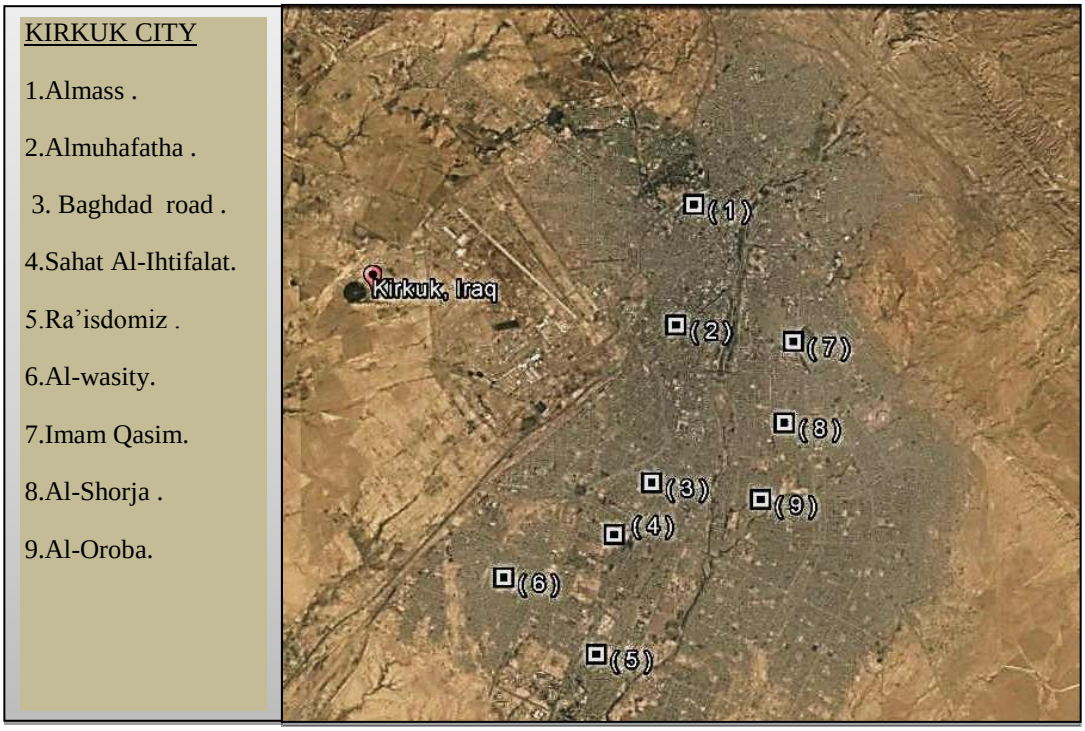

Figure1: Sampling area in Kirkuk city

IV. Bottled drinking water

pH value

The result shown (Table2) that all brands samples measurementpH Value are Fall within the permissible limits by (IBWA : 6.5 – 8.5), reaching the highest value 8.0and the lowest value 7.3, these result are compare with label for each brand themselves , it shown a different between pH Value , but in the allowable extent , pH value of some tested samples less than recorded in the brand's label like sample (4,7) it may be happen due to poor storage (Toma& others, 2013) ,other values higher than stated in attributable to an error in the data recorded on brand's label , with note that three of the analyzed samples did not touch on the values of pH in Label .

Turbidity

(Table2)appear that all measurements brand samples Turbidity Valueswithin the limits(IBWA : 0.0 - >0.5) except three brands sample 10 , 14 & 20 (0.90 , 4.28 & 0.72 NTU) respectively , it may be happen due to the water sources &No treatment the exact water samples, to be noted that the those three brands does not write turbidity rang in their labels .

EC (Electric conductivity)&T.D.S. (total dissolve solids)

The result of these physical properties for all samples(table2)Fall within the permissible limits,values shown relatively low for EC. & T.D.S., the treatment processing steps which are used by all brand factorieslead to reduce the values of T.D.S.which it is a strong function of the values for EC. (Razuki& Al-Rawi, 2010) , all brand labels Did not remember the values of EC Except two brands (2.6) there values shown high different between the measure sample & it's labels .

T. Hardness & Alkalinity

Two properties value also Appeared within the range permitted by theby (IBWA,2008),Is a numeric expression for the water content of minerals, particularly calcium and magnesium ions and other alkali metals and is directly related to the type of source water and the climate surrounding (Razuki& Al-Rawi, 2010) &(Toma& others, 2013) .

T.S.S total suspended solid

(IBWA) Refers to the need to be valued at zero because the presence of plankton in the water and of dust or sediment will reduce the desire of consumers,This is shown by the results of the samples measured for many products except sample No. 14 which it appear a high value in turbidity .

Calcium

The calcium ion of great significance in the water due to the adoption of brackish water quality concentration where, there is abundant in natural waters as a result of the melting of limestone in the water and is one of the important elements of the body in stages of fetal development and pregnancy, as well as its importance for the formation of bones and teeth and the work of the nervous system

(Razuki& Al-Rawi, 2010) , the result (table 3) showed All that has measured water samples contained calcium within the range specified by (IBWA,2008) the different between brands contain due to the source of water condition , sample No. 13 shown high contain of calcium 59.73mg\L due to it is source (Fountain water) from the Iraq north mountain .

Magnesium

Magnesium concentration ranged from (0.92 – 20.37) mg\L in all test samples (table 3) it also fall within IBWA standard , The role of magnesium is important for human health, but the rate of increase of the limit set will cause health problems (Razuki& Al-Rawi, 2010) &(Rabee& others, 2012) .

Chlorite (Cl)

The result shown very low concentration of Chlorite element in all samples (table 3) range between (5.97 – 28.78) ,The presence of chlorine is necessary to eliminate a lot of diseases such as cholera, typhoid, amoebic dysentery, but the rate of increase has caused health problems for the user, especially when increasing the rate of about 100 mg, so most of the institutions are moving to reduce its use.

Sulphates (So_4)

Sulphate level varied between (9.88 – 65.48)mg\L The sources of sulfates in the soil resulting from the oxidation Sulfide, which is derived from natural rocks As well as organic materials break sulphate is reduced Sulfates by anaerobic bacteria, as well as from sources Other sulfate natural groundwater (AL-Hayani, 2009) , table 3 shown very low percentage of shulphate contain in all samples ,but these values are different from the label's data .

Sodium (Na)

The Na levels varied between (1.0 – 13.0) mg\L , all brands contain Did not exceed the percentage specifiedby IBWA which determined it in 20mg\L . Central Department for Environmental Affairs (2007) noted that the increase rate of about 20 will give a taste of the water salinity and the increase would cause severe poisoning and other health damage**.**

Potassium (K)

The K levels ranged between(>0.10 – 0.6) , All values have emerged within the allowable amount and much less than the data recorded on the Label (table 2).

Compared to the quality of bottled water content mentioned on the packaging

Among the physical and chemical characteristics that have been studied in this research , we find that most of the packages do not remember the commercial traits, especially those related toturbidity,E.C.,T.D.S. T. Hardness , Alkalinity & T.S.S. shown in (Table 2) and limiting those devices mentioned metals.

It is noted that the data listed in the packages vary with the results obtained , has been interpreted in this case to change the sources of water used for packaging or differing characteristics as a result of variations of climate, or because of negligence where most of the

Table 2 : Physical & aggregate of investigated bottled water brand with brands label's document

Brand Code	PH		Turbidity NTU		E.C. µ s/cm		T.D.S Ppm		T. Hardness mg\L $CaCo_3$		Alkalinity mg\L$CaCo_3$		T.S.S.	
	M	L	M	L	M	L	M	L	M	L	M	L	M	L
1.	7.8	6.9	0.28	-	213	-	167	-	104	-	100	-	0.00	-
2.	7.7	6.9	0.05	0.00	292	46	146	29	115	40	54	156	0.00	-
3.	7.9	-	0.00	-	350	-	176	170	124	-	148	-	0.00	-
4.	7.3	8.0	0.26	-	250	-	125	125	95	-	94	-	0.60	-
5.	7.5	7.4	0.33	-	244	-	122	-	144	-	130	-	0.23	-
6.	8.0	7.2	0.00	-	337	10	167	124	94	-	100	-	0.00	-
7.	7.7	7.9	0.20	0.00	346	-	173	-	137	7.6	166	-	0.00	-
8.	7.7	7.2	0.0	0.2	223	-	112	-	93	10	62	-	0.00	-

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9.	7.6	7.2	0.00	0.20	232	-	126	-	95	10	46	-	1.00	-
10.	7.8	-	0.90	-	429	-	215	-	167	-	64	-	0.00	-
11.	8.0	7.3	0.19	0.00	417	-	209	-	163	140	148	-	0.11	-
12.	8.0	7.5	0.00	-	205	-	101	-	80	-	80	-	0.00	-
13.	7.7	7.4	0.00	0.00	464	-	232	-	190	-	188	-	0.00	-
14.	7.7	7.3	4.28	-	439	-	260	-	188	-	190	-	16.30	-
15.	7.9	-	0.00	-	280	-	190	150	114	-	144	-	1.00	-
16.	7.8	7.2	0.08	-	205	-	106	-	74	-	60	-	0.00	-
17.	7.9	7.6	0.08	-	318	-	159	-	144	-	166	-	0.00	-
18.	7.4	7.0	0.06	-	205	-	102	109	74	-	76	-	0.00	-
19.	7.5	5-7	0.00	-	140	-	90	<10	61	-	50	-	0.10	-
20.	7.8	7.2	0.72	-	236	-	106	125	45	37	44	-	1.00	-
IBWA	6.5 – 8.5		0.5		1000*		500		200*		200*		-	

IBWA, 2008 = International Bottled Water Stander Quality (Semerjian, 2007) .
* Standard depended on (Toma& others, 2013) .

packages have been printed since the establishment of laboratories and there were no data , knowing all the data is necessary for the consumer to avoid health problems for the user.

Table 3 : concentrations of major ions in investigated bottled water brands .

Brand Code	Ca^{+} mg\L		Mg^{+} mg\L		Cl^{-} mg\L		$So_4^{=}$ mg\L		Na^{+} mg\L		K^{+} mg\L	
	M	L	M	L	M	L	M	L	M	L	M	L
1.	33.36	12.40	05.06	05.34	20.55	-	34.80	31.00	5.4	21.4	1.10	3.80
2.	23.68	06.00	13.54	-	13.70	58.00	49.79	-	4.2	0.5	0.50	0.25
3.	38.00	20.00	06.95	09.60	16.63	-	36.62	10.90	11.0	9.8	3.00	0.30
4.	30.40	03.60	04.63	19.00	18.59	58.20	35.80	-	7.0	21.9	1.40	1.06
5.	35.72	28.00	06.02	3.04	05.97	0.40	19.34	04.20	1.0	2.9	0.20	-
6.	27.52	27.00	06.08	08.00	19.57	-	18.52	-	3.7	1.1	0.50	0.50
7.	44.40	57.00	06.32	09.00	06.85	-	13.17	15.00	3.3	-	0.80	-
8.	22.20	24.02	09.03	04.40	08.81	11.50	45.67	16.80	2.4	-	0.50	-
9.	22.80	24.20	09.27	04.40	14.67	11.50	55.14	16.80	2.5	-	0.50	-
10.	37.0	-	18.0	-	16.6	-	65.84	-	9.2	-	1.90	-

	0		0		3							
11.	45.60	43.00	12.05	12.00	17.61	15.00	30.04	-	8.8	14.0	1.50	17.00
12.	21.28	25.85	06.52	07.05	15.21	04.90	30.25	-	5.1	0.40	0.80	0.20
13.	59.28	70.00	10.20	10.00	17.61	02.50	42.26	13.60	3.8	3.10	1.40	1.50
14.	41.80	64.00	20.37	22.08	14.67	04.00	48.97	12.00	3.8	11.00	0.50	-
15.	24.32	24.00	12.98	08.50	08.80	-	35.39	08.00	11.6	13.50	0.40	-
16.	19.24	03.60	06.32	19.90	17.61	-	13.58	-	9.6	21.90	0.60	-
17.	25.90	19.37	19.41	04.02	17.61	04.10	09.88	02.74	2.0	02.20	0.30	> 0.2
18.	20.72	11.50	05.42	08.00	19.56	13.50	25.16	-	11.4	11.60	6.10	6.20
19.	15.96	-	05.21	-	18.59	-	46.50	-	8.2	-	0.10	-
20.	19.50	10.00	00.92	03.00	28.78	25.00	30.40	-	13.6	20.00	1.30	1.30
IBWA	100*		30*		250		250		20*		10*	

IBWA, 2008 = International Bottled Water Stander Quality (Semerjian, 2007) .
* Standard depended on (Toma& others, 2013) .

V. Tap drinking water

The result (table 4) shown that pH values for all regionIs within the limits permitted by the specification of the Iraqi and the World Health Organization, As for Turbidity values the results show negative indicators to override the limit values allowed, especially in the areas of study (1,2&6), Turbidity value it is indicated to Taste , odor & appearance it cause by Soil particles, suspended solids, algae organisms and bacteria which reduce iron from the effectiveness of chlorine in the disinfection of water boiling and therefore need larger quantities of chlorine to kill bacteria and other pathogens , all that may be happen due to the cracks in pipes , jointing parts or to the erosion of iron pipe when the storage tanks are clean (Central Department for Environmental Affairs , 2007) &(WHO, 2006) .

The results of E.C , T.D.S. , T. hardness & Alkalinity are in the limits permitted, (Razuki& Al-Rawi, 2010) indicated that T.D.S. Include positive ions such as calcium, magnesium, sodium, potassium and negative ions, such as sulfate, chloride, nitrate and carbonate , from table 4 we found that the results of these T.D.S. contain are low percentage , for that Decrease in the values of EC may be due to lower values of T.D.S. & it is contain .all these properties effect in water's taste & odor which it effect of Consumer acceptability of water.

Table 4 :Physical & Chemical analysis of major constituents for local tap water in different Kirkuk regions

Local Code	PH	Turbidity NTU	E.C. µ s/cm	T.D.S ppm	T. Hardness mg\L	Alkalinity mg\L $CaCo_3$	T.S.S.	Ca^+ mg\ L	Mg^+ mg\ L	Cl^- mg\ L	$So_4^=$ mg\ L	Na^+ mg\ L	K^+ mg\ L
1.	7.8	14.70	275	138	166	130	-	36.00	18.54	17.00	30.00	6.80	1.60
2.	7.8	09.39	277	138	160	130	56	39.00	15.30	18.00	28.00	6.60	1.60
3.	7.5	03.70	275	138	166	132	-	36.00	18.54	19.00	30.00	6.20	1.60
4.	7.8	02.84	276	138	156	130	-	38.00	14.88	19.00	26.00	6.60	1.70
5.	7.7	01.78	349	175	155	128	44	36	15.8	19.0	27.0	6.40	1.60

									0	0	0		
6.	7.7	07.10	278	139	166	134	46	36	18.54	18.00	30.00	6.80	1.60
7.	7.3	04.20	431	254	166	126	36	42	14.88	14.00	63.00	5.80	1.60
8.	6.8	01.88	441	220	170	128	47	45	11.6	16	63.00	5.30	1.50
9.	7.2	4.40	398	204	168	130	42	40	16.59	15	65.00	5.60	1.40
Iraq Standard 470/2001	6.5 - 8.5	5	1500	500	500	125	-	50	50	250	250	250	-
WHO** 2006	6.5 - 9.5	5	-	1000	500	-	-	-	-	250	250	-	-

* Iraq Standard for tap drink water (470\2001) (21)
**WHO : world Human Organization 2006

Also by studying the content of the items in the tested water table 4 and all regions of Kirkuk, we find that the contents fall within the allowable range and even rates low, which is due to the nature of the source of the water intake for the purpose of processing the citizen, knowing that the irrigation project Kirkuk depends primarily on the water agency has gone from Zab River.

VI. Conclusions

Through the results revealed by the study , we find that most bottled water domestic and imported is safe to drink except for type 10 , which showed the proportion of Turbidity high exceeded the standard required for the water -filled, and have compared the results with data producing companies and installed in brand's label , we find the existence of discrepancies high in percentages mentioned in Actions may be due to the variation of the water source accredited manufacturers from time to time ,collected season special spring water and do not update the labels data, on the other side found a significant lack of data listed on the packaging , causing big problems for consumers.

As for tap water and equipped by the Directorate of Water Kirkuk has been found to occur large variations between regions in the physical and chemical characteristics despite being processed from the same source was due to the poor quality of networks, processing and leaks in pipelines causing water pollution in areas without other private area number (1,2 & 6).

Recommendations

1. We recommend the Department of Water Kirkuk to conduct visits and periodic tests for laboratories producing bottled water to control the quality of water
2. Must be on the water analysis laboratories on an ongoing basis and to add specifications on the cover of the packaging
3. For containers that do not mention on the cover of the packaging specifications task, we recommend the addition of water, the real specifications on the cover of the package in order to gain the trust of the consumer
4. We recommend consumers not to use the packaging type (10) because he was not trusted by the consumer not to mention specifications on the packaging
5. We recommend consumers not to use the type (14) because he realizes the terms of the standard specifications due to high turbidity
6. For areas (3,4,5,7,8,9) recommend the use of tap water to clean it and check the standard specifications and especially that the cost per capita consumption of water sterilized at least 45 liters for the beautiful weather almost any $ 20 per person .
7. We recommend consumers living in areas (1,2,6) not to use tap water because it is water not suitable for drinking .

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