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Dose Rate Investigating and Surface Contamination in Iraqi Tap Water Employing Radeye B20 Detector

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Annotation: Twenty-five Iraqi tap water samples were collected from various Iraqi cities and twenty-five mineral water sample collected from local markets; these samples kept inside certain plastic Polypropylene beakers and prepared for examination. Three important parameters were measured, Dose rate, Surface contamination and General Count Rate per second using a portable detector (RadEye B20) for the normal state of the samples once and after they were boiled again to explore the differences between them. The results showed that mineral water measurements are lower than tap water. After boiling, the detector readings were not affected (Except for the normal error rate of the detector and instrument sensitivity), However, the mean value of Dose rate, Surface contamination and General Count Rate per second measurements were (0.294 Bq/cm2, 0.204 µsv/h and 0.508 Cps) and (0.274 Bq/cm2, 0.184 µsv/h and 0.468 Cps) respectively for tap and mineral waters (Before boiling), Despite this, all samples did not pose an appreciable danger to human life.

Keywords: mineral water, Polypropylene beakers, portable detector, tap water, dose rate.

1. Introduction

Most local individuals use tap water for domestic purposes and drinking because mineral water is not always affordable (1). As a direct contribution to environmental and public health research, determining naturally existing radionuclides in tap and mineral waters is beneficial (2). It is now vital to investigate these waters and confirm any potential radioactive contamination and radiation risks (3). The radioactive decays of U-238, Th-232 and K-40 and their decay products, which are part of the natural decay series, the presence of these radioactive isotopes and their daughters in water depends on the geological composition of the area and the type of water source (4) (5). According to WHO guidelines, drinking water is safe as long as two liters are consumed per day from a radiological standpoint (6). Although locals have not experienced health issues as a result of radioactive contamination in tap water, the cumulative effects of continuously contaminated water could pose a threat to human health in the future (7). Local individuals use tap water and mineral water daily so it has become necessary to observe Dose rate, Surface contamination and General Count Rate, measure and verify (8). Many studies in different countries as South America (9), Croatia (10), Spain (11), Austria (12) , Brazil (13) and Hungary (14) have been conducted on the radioactivity of tap and mineral waters, although the majority of them only addressed a portion of radiation. In order to make sure that the location is free of elements that could affect the accuracy of the readings and the personal safety of laboratory workers (15), RadEye B20 measures the radiation doses around it or in the workplace (the laboratory). An alert will sound if there is an outbreak of radiation in a particular area. To remind the user that the measured value has been adjusted by that specific count rate value, the General Count Rate Measurements (cps) value is always shown in the top region of the LCD. The alarm threshold needs to be adjusted to the lowest value that doesn't result in failure alerts in order to find concealed radiation sources (16). Boiling the water won't eliminate or decrease the surface contamination(17), the amount of radiation dose received per unit time (dose rate) and the number of radiation events detected per unit of time (count rate per second). Therefore, if the water contains radioactive substances U-238, Th-232, K-40 and there decay products (18) (19), the measurements will remain the same regardless of whether the water is boiled or not (Except for the normal error rate of the detector). It is noteworthy that boiling water has a negligible effect on the detector's measurements (20).

2. Materials and methods

2.1. Samples Collection and preparation

Twenty five sample of mineral water were collected from local markets and Twenty five sample of tap water were taken from various locations across many Iraqi cities, as indicated in figure (1). Samples of tap water were taken from five locations in Baghdad (Zayyouna, Adhamiya, Al-Mansour, Al-Fahhama, Sadr City), two samples for each of Basra (Abu Al-Khasib, Al-Zubair), Hilla (Old Hilla, Fadak district), Diwaniyah (Al-Daghara, Al-Shamiya), Wasit (Kuk, Essaouira), Nasiriyah (Al-Saray, Eridu district), mayssan (Al-Marjar District, Al-Kahla District), Kirkuk (Daquq District, Hawija), Dohuk (Amadiya, Zakho), Al-Muthanna Governorate (Al Rumaitha, Al Khader), and Samarra (Al-Mu'tasim, Al-Tharthar). Each sample was stored in specific 1000 ml capacity containers (numerical graduated Polypropylene beakers molded of translucent plastic that resist acids, bases, and solvents. with a broad base for stability) called Polypropylene beakers. A modified process was carried out to clean the beakers (21). With a portable three-legged stand (Trypod 3110) employed as a platform to sustain the weight and maintaining the detector stable for the duration of the measurement. Table (1) shows all the details of samples.

Figure 1 Location of the investigated tap and mineral water samples.

Table 1 governorate, location and codes of water samples

No.	Governorate	location	Water samples			
			Tap water		Mineral water	
			Simple name	code	Simple name	code
1	Baghdad	Zayyouna	Zayyouna water	BT.1	Alrawa	RM
		Al-Adhamiya	Adhamiya water	BT.2	Pearl	PM
		Al-Mansour	Mansour water	BT.3	Alrawasi	RM.1

		Al-Fahhama	Fahhama water	BT.4	Rawea	RM.2
		Al-Sader City	Sader water	BT.5	Rim	RM.3
2	Basrah	Abu Al-Khasib	Khasib water	ZT.1	Khor	KM
		Al-Zubair	Zubair water	ZT.2	Kafeel	KM.1
3	Hilla	Old Hilla	Hilla water	HT.1	Kawthar	KM.2
		Fadak	Fadak water	HT.2	Dinar	DM
4	Diwaniyah	Al-Daghara	Daghara water	GT.1	Wareth	WM
		Al-Shamiya	Shamiya water	GT.2	Wafi	WM.1
5	Wasit	Kuot	Kuot water	WT.1	Aquafina	AM
		Essaouira	Essaouira water	WT.2	Afiat/Oyoun	AM.1
6	Nasiriyah	Al-Saray	Saray water	NT.1	AL ain	AM.2
		Eridu	Eridu water	NT.2	Masafi	MM
7	Maysan	Al-Marjar	Marjar water	AT.1	Hanaa	HM
		Al-Kahla	Kahla water	AT.2	Helwa	HM.1
8	Karkuk	Daquq	Daquq water	KT.1	313	313M
		Hawija	Hawija water	KT.2	Naqaa	NM
9	Dohuk	Amadiya	Amadiya water	DT.1	Life	LM
		Zakho	Zakho water	DT.2	Alyanabie	YM
10	Muthanna	Al-Rumaitha	Rumaitha water	MT.1	Forat	FM
		Al-Khadir	Khadir water	MT.2	Barada	BM
11	Samarra	Al-Mu'tasim	Mu'tasim water	ST.1	Alsuhoul	SM
		Al-Tharthar	Tharthar water	SW.2	Crystal	CM

2.2. Radiation detection (Digital detector)

In order to evaluate the radioactive contamination at low radiation levels, the gamma dose rate ranged from 17-1300 keV under an optional gamma energy filter, and the count per second, employing the sensitive Germanium tube detector RadEye B20. Measurements of RadEye B20 were taken by placing the detector on the surface of the sample for 3 minutes for each measurement, the samples had been kept in Polypropylene beakers as in figure 2.

Figure 2 instruments and samples.

Results and discussion

The maximum readings of tap water samples before boiling respectively for Surface contamination, Dose rate, and Count Rate are (0.32 to 0.31 Bq/cm^2, 0.23 to 0.22 µsv/h and 0.56 to 0.54 Cps) for GT.2 and MT.1 samples respectively, (0.3 to 0.29 Bq/cm^2, 0.21 to 0.2 µsv/h and 0.52 to 0.5 Cps) for WM and HM samples respectively in mineral water. On the other hand, BT.1 is the tap water sample with the lowest measurements values (0.26 Bq/cm^2, 0.17 µsv/h and 0.44 Cps), whilst RM is the lowest readings of mineral water samples (0.24 Bq/cm^2, 0.15 µsv/h and 0.4 Cps). The mean values of tap and mineral water samples before boiling were (0.294 to 0.274 Bq/cm^2, 0.204 to 0.184 µsv/h and 0.508 to 0.468 Cps) and after boiling (0.285 to 0.269 Bq/cm^2, 0.195 to 0.177 µsv/h and 0.49 to 0.455 Cps) for surface contamination, dose rate and count rate per second respectively displayed in Table 2 and 3. All readings for tap water were generally found to be greater than those of mineral water as shown in figure 3.

Table 2 location, water samples code and RadEye b20 measurements before boiling.

Location	Tap Water code	Mineral water code	RadEye b20 measurements					
			Surface contamination (Bq/cm^2)		Dose rate µsv/h		Count rate per second Cps.	
			Tap Water	Mineral water	Tap Water	Mineral water	Tap Water	Mineral water
Zayyouna	BT.1	RM	0.26	0.27	0.17	0.18	0.44	0.46
Al-Adhamiya	BT.2	PM	0.29	0.24	0.2	0.15	0.5	0.4
Al-Mansour	BT.3	RM.1	0.27	0.27	0.18	0.18	0.46	0.46
Al-Fahhama	BT.4	RM.2	0.3	0.28	0.21	0.19	0.52	0.48
Al-Sader City	BT.5	RM.3	0.29	0.27	0.2	0.18	0.5	0.46
Abu Al-Khasib	ZT.1	KM	0.31	0.29	0.22	0.2	0.54	0.5
Al-Zubair	ZT.2	KM.1	0.3	0.28	0.21	0.19	0.52	0.48
Old Hilla	HT.1	KM.2	0.29	0.27	0.2	0.18	0.5	0.46
Fadak	HT.2	DM	0.3	0.28	0.21	0.19	0.52	0.48
Al-Daghara	GT.1	WM	0.29	0.3	0.2	0.21	0.5	0.52
Al-Shamiya	GT.2	WM.1	0.32	0.28	0.23	0.19	0.56	0.48
Kuot	WT.1	AM	0.3	0.25	0.21	0.16	0.52	0.42
Essaouira	WT.2	AM.1	0.29	0.26	0.2	0.17	0.5	0.44
Al-Saray	NT.1	AM.2	0.3	0.29	0.21	0.2	0.52	0.5
Eridu	NT.2	MM	0.28	0.26	0.19	0.17	0.48	0.44
Al-Marjar	AT.1	HM	0.28	0.29	0.19	0.2	0.48	0.5
Al-Kahla	AT.2	HM.1	0.3	0.28	0.21	0.19	0.52	0.48
Daquq	KT.1	313M	0.31	0.29	0.22	0.2	0.54	0.5
Hawija	KT.2	NM	0.29	0.26	0.2	0.17	0.5	0.44
Amadiya	DT.1	LM	0.28	0.27	0.19	0.18	0.48	0.46
Zakho	DT.2	YM	0.31	0.29	0.22	0.2	0.54	0.5
Al-Rumaitha	MT.1	FM	0.31	0.26	0.22	0.17	0.54	0.44
Al-Khadir	MT.2	BM	0.29	0.27	0.2	0.18	0.5	0.46
Al-Mu'tasim	ST.1	SM	0.31	0.29	0.22	0.2	0.54	0.5
Al-Tharthar	SW.2	CM	0.28	0.26	0.19	0.17	0.48	0.44

Maximum	0.32	0.3	0.23	0.21	0.56	0.52
minimum	0.26	0.24	0.17	0.15	0.44	0.4
mean	0.294	0.274	0.204	0.184	0.508	0.468
Back ground	0.24		0.15		0.40	

Back ground is the radiation in the laboratory.

Table 3 location, water samples code and RadEye b20 measurements after boiling.

Location	Tap Water code	Mineral water code	RadEye b20 measurements					
			Surface contamination (Bq/cm^2)		Dose rate µsv/h		Count rate per second Cps.	
			Tap Water	Mineral water	Tap Water	Mineral water	Tap Water	Mineral water
Zayyouna	BT.1	RM	0.25	0.26	0.16	0.17	0.42	0.44
Al-Adhamiya	BT.2	PM	0.28	0.24	0.19	0.15	0.48	0.4
Al-Mansour	BT.3	RM.1	0.26	0.26	0.17	0.17	0.44	0.44
Al-Fahhama	BT.4	RM.2	0.29	0.27	0.2	0.18	0.5	0.46
Al-Sader City	BT.5	RM.3	0.28	0.25	0.19	0.16	0.48	0.42
Abu Al-Khasib	ZT.1	KM	0.3	0.27	0.21	0.18	0.52	0.46
Al-Zubair	ZT.2	KM.1	0.29	0.26	0.2	0.17	0.5	0.44
Old Hilla	HT.1	KM.2	0.29	0.27	0.2	0.18	0.5	0.46
Fadak	HT.2	DM	0.28	0.26	0.19	0.17	0.48	0.44
Al-Daghara	GT.1	WM	0.3	0.3	0.21	0.21	0.52	0.52
Al-Shamiya	GT.2	WM.1	0.31	0.27	0.22	0.18	0.54	0.46
Kuot	WT.1	AM	0.29	0.25	0.2	0.16	0.5	0.42
Essaouira	WT.2	AM.1	0.28	0.26	0.19	0.17	0.48	0.44
Al-Saray	NT.1	AM.2	0.27	0.27	0.18	0.18	0.46	0.46
Eridu	NT.2	MM	0.29	0.28	0.2	0.19	0.5	0.48
Al-Marjar	AT.1	HM	0.28	0.29	0.19	0.2	0.48	0.5
Al-Kahla	AT.2	HM.1	0.29	0.26	0.2	0.17	0.5	0.44
Daquq	KT.1	313M	0.3	0.28	0.21	0.19	0.52	0.48
Hawija	KT.2	NM	0.28	0.27	0.19	0.18	0.48	0.46
Amadiya	DT.1	LM	0.27	0.29	0.18	0.2	0.46	0.5
Zakho	DT.2	YM	0.3	0.29	0.21	0.2	0.52	0.5
Al-Rumaitha	MT.1	FM	0.3	0.28	0.21	0.19	0.52	0.48
Al-Khadir	MT.2	BM	0.29	0.26	0.2	0.17	0.5	0.44
Al-Mu'tasim	ST.1	SM	0.29	0.28	0.2	0.19	0.5	0.48
Al-Tharthar	SW.2	CM	0.27	0.26	0.18	0.17	0.46	0.44
Maximum			0.31	0.29	0.22	0.21	0.54	0.52
minimum			0.25	0.24	0.16	0.15	0.42	0.4
mean			0.285	0.269	0.195	0.177	0.490	0.455
Back ground			0.24		0.15		0.41	

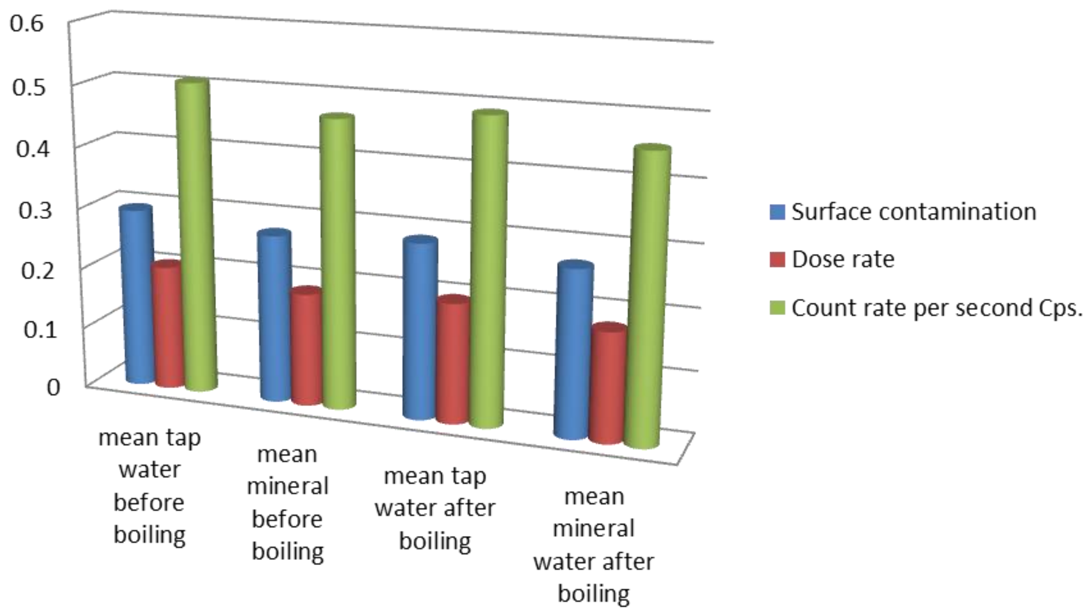

Figure 3 mean values of all samples before and after boiling.

Conclusion

The detector takes detects of dose rate, Surface contamination and General Count Rate per second for all water samples, both mineral and tap water, which is one of its most significant tasks. The components of the sample and the locations where these samples are collected affect the detectors reading for each sample. The samples of mineral water (Pearl and Aquafina) had the lowest measurements, while the samples of tap water (Al-Shamiya and Al-Rumaitha) had the highest measurements. We can see from all of these findings that drinking mineral water is safer and better for people than tap water. Although tap water can be used for domestic purposes, it should be avoided to drink until treating it. It turns out that boiling water has a negligible effect on the detector's reading, approximately 1% of its typical reading.

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