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RESEARCH TITLE

Radon Gas Concentrations in Water in Iraq Using the RAD-7. A Systematic Review

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Abstract

This research analyzes the levels of radon gas (Rn-222) in water sources throughout different areas of Iraq, utilizing the RAD-7 detector, a commonly employed electronic instrument for radon assessment. The study aggregates and examines data from many research initiatives to evaluate radon concentrations in drinking and groundwater. The results demonstrate that certain water samples have radon levels within the safety thresholds established by international standards (e.g., WHO and EPA), but others surpass these limits, especially in regions characterized by significant geological activity or uranium-laden soils. The assessment underscores the necessity of regular radon monitoring in water owing to the possible health hazards linked to prolonged exposure, including lung and stomach cancers. The text underscores the efficacy and dependability of the RAD-7 equipment for both in-situ and laboratory radon readings. The report advocates for more stringent environmental restrictions and public awareness initiatives to reduce radon-related health hazards in Iraq.

Key Words: Radon, Drinking Water, Groundwater, Iraq, RAD-7, Radiation, Environmental Assessment, Public Health.

عنوان البحث

تركيزات غاز الرادون في المياه في العراق باستخدام جهاز:RAD-7 . مراجعة منهجية

المستخلص

في هذا البحث، تم تحليل مستويات غاز الرادون (Rn-222) في مصادر المياه عبر مناطق مختلفة من العراق، باستخدام جهاز RAD-7 ، وهو أداة إلكترونية شائعة الاستخدام في تقييم الرادون. يجمع هذا البحث بيانات من العديد من الدراسات السابقة ويقوم بتحليلها لتقييم تركيزات الرادون في مياه الشرب والمياه الجوفية. تُظهر النتائج أن بعض عينات المياه تحتوي على مستويات من الرادون تقع ضمن الحدود الآمنة التي حددتها المعايير الدولية مثل منظمة الصحة العالمية (WHO) ووكالة حماية البيئة الأمريكية(EPA) ، بينما تتجاوز بعض العينات هذه الحدود، خاصة في المناطق التي تتميز بنشاط جيولوجي كبير أو تحتوي تربتها على نسب مرتفعة من اليورانيوم. تؤكد الدراسة على أهمية المراقبة المنتظمة لمستويات الرادون في المياه نظراً للمخاطر الصحية المحتملة الناتجة عن التعرض المزمن له، بما في ذلك سرطان الرئة والمعدة. كما يسلط النص الضوء على كفاءة ومصداقية جهاز RAD-7 في قياس الرادون سواء في الموقع أو في المختبر. ويوصي التقرير بفرض قيود بيئية أكثر صرامة وتنفيذ حملات توعية عامة للحد من المخاطر الصحية المرتبطة بغاز الرادون في العراق.

الكلمات المفتاحية: رادون، مياه الشرب، المياه الجوفية، العراق، RAD-7، إشعاع، تقييم بيئي، صحة عامة.

Introduction

Radon is a naturally generated radioactive gas and is both colourless and odourless, and therefore difficult to detect without specialised equipment. Produced as a decay product of uranium, it is naturally present at low levels in rocks, soil, and water[1].. While radon is typically associated with indoor air in homes built on soils that are likely to contain radon.its presence in water is also important, especially as a source of groundwater for wells and springs. The objective of introduction is to furnish a summary of the occurrence of radon in water, its health effects, methods of detection, and potential mitigation options. Radon is produced through the decay about uranium-238, a naturally occurring isotope in the earth's rocks and soil[2].. There are many different types of radioactive isotopes that uranium produces when it decays, but radon-222 is the predominant isotope released to the air. It's possible radon can get into homes and other buildings from the ground, working its way in through cracks in foundations or other holes. For water, radon is frequently found in ground water that is in contact with uranium-rich rock. Radon in water generally originates fromwerlls, springs and boreholes, particularly those in which water comes from a stratum containing high natural uranium concentration. Radon may also be present in surface wate.Radon concentrations are generally elevated in groundwater due to the presence of various dilution effects in the water. The primary concern regarding radon is that exposure poses health risks, as radon gas is a recognized carcinogen for lung cancer. Radon can be released from water into the air during domestic activities such as showering, dishwashing, and cooking, leading to inhalation and an elevated risk of lung cancer.[3-7]. The EPA of the US states that radon is the second primary cause of lung cancer within the United States preceded only by smoking. Although inhaled radon is a primary concern besides radon ingestion through drinking water has elicited health concerns. Drinking water that contains radon is a risk, but is not considered as serious a risk as exposure associated with the living environment as radon escapes from water to the air[7-10].. The reason for this is because the radon gas can be trapped indoors when water is heated or disturbed (e.g. showers, baths), and then inhaled. Beyond lung cancer, radon exposure has been associated with other health issues, including a higher chance of developing leukemia. But the relationship between waterborne radon exposure and leukemia is less clearly developed than that with lung cancer. The quantification of radon levels in water is relevant to environmental and public health practitioners due to radon being a naturally occurring radioactive gas which can concentrate to harmful levels, especially when inhaled. In Iraq, investigation on radon in water has received considerable attention in recent time as a consequence of exposure and its health hazard[10-16].

2. RAD 7 DETECTOR

One of the commonly used devices is the RAD 7 detector. With a high-quality detector that produces rapid readings for radon detection every 30 min, the RAD7 proves to be practical for both laboratory and field experiments. It provides a high-quality measurement with an easy application and cost-effectiveness We have realized the possibility of taking radon and isotopes measurements with the latest technology in just a short time. The researchers operate RAD7 in different environments of where the results are more accurate than other detectors.

Figure 1. A diagram of the RAD7

3. LITERATURE REVIEW.

Table (1) is a summary of reported radon 222 levels from research done on drinking water sources throughout several governorates in Iraq. Following smoking, Radon gas is recognized as the second leading reason for lung cancer. The table displays the quantified concentrations of radon-222 activity in drinking water throughout the governorates of Iraq.

Table1. Radon concentration from water was measured from.

No	Location	Average 222Rn Bq/L	year	references
1	ANBAR	6.44±1.8	2020	[17]
2	Najaf	1.6690.194	2024	[18]
3	Babylon	0.3	2014	[19]
4	ALQADISIYAH	42.43	2020	[20]
5	Baghdad	26.6 ±25.311	2024	[21]
6	Dhi-Qar	0.205±0.04.	2021	[22]
7	Kifel	1.15	2016	[23]

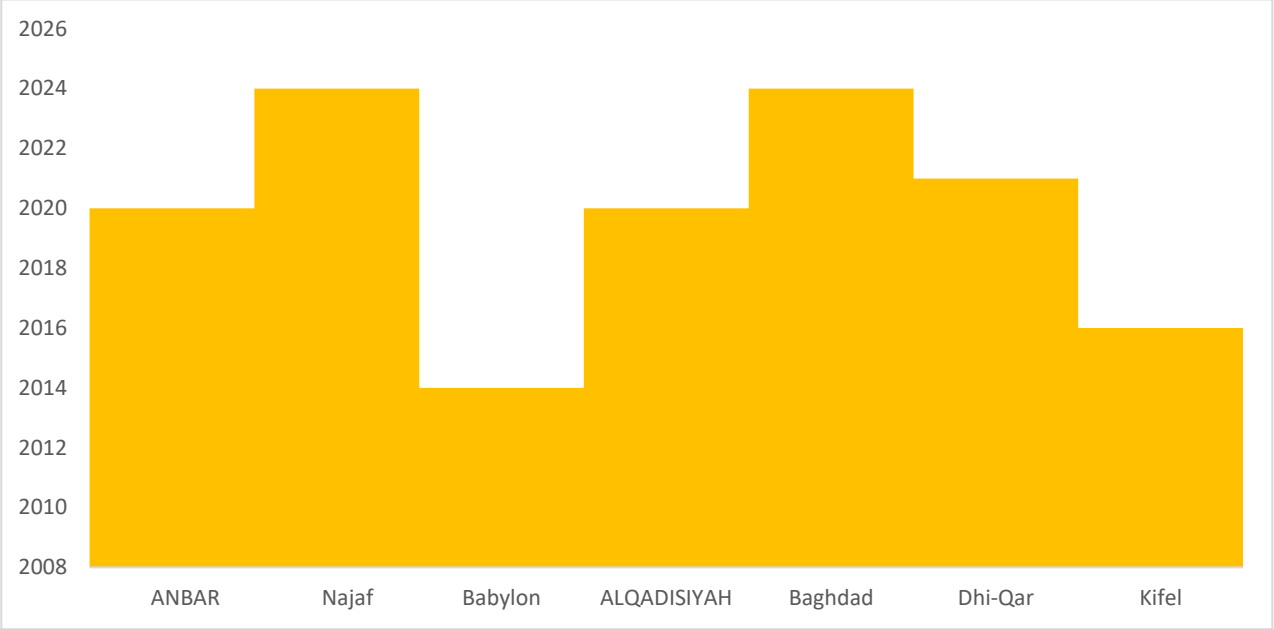

Figure (2) Concentrations in water in Iraq according to RAD-7

The research by A. O. Farhan, A. M. Ahmed, S. M. Awadh, and A. H. Al-Sulttani was published in 2020. This study utilized Rad-7 detectors to determine the concentration of radon gas and the effective dosage in shallow samples of groundwater from Abu-Jir Village in Anbar province. Up to 9.3 Bq/L of radon gas has been found in samples, with 2.1 Bq/L being the lowest. The average amount is 6.44±1.8 Bq/L.[17Ali, A. H., Jassim, A. S., Abojassim, A. A., & Dosh, R. J. Assessing the health risk of radon levels in water samples from certain areas north of the Al-Najaf governorates. Ten samples of well water from different places in the Najaf region were gathered so that the RAD7 technology could measure the amount of radon in the environment. Gamma radiation levels ranged from 2.42 Bq/L in the Al-Melad region to 0.712 Bq/L in the Al-Naser region, with a mean of 1.6690.194 Bq/L.[18].In 2014, Kadhim, I. H., and Almayyali, A. O. M. published their work. Determining the concentration of radon in water in the Al-Shomaly Area of Babylon, Iraq, and assessing the annual exposure levels for the population. This study investigated the radon concentration in water from the Al-Shomaly region of Babylon, about 140 kilometers south of Baghdad. Selected for the water research (Liquefaction, Rivulet, and groundwater) were 29 samples collected from 28 locations with the electronic radon detector RAD7. The mean concentration of radon for the water was 0.3 ± 0.1 Bq.L^{-1}[19] .In 2020, we examined the determined effective dose of Radon gas for drinking water at Al-Qadisiyah province, Iraq. The radioactivity results showed that the concentration of 222Rn in drinking water ranges from 0.05 to 0.47 Bq/L, with 0.24 Bq/L being the average. On the other hand, the concentration of 222Rn in the sediment ranges from 29.16 to 60.52 Bq/m^3, with 42.43 Bq/m^3 being the average. [20].In 2024, Abdulkhaleq, N. A., Dawood, S. K., Qader, K. M., and Taher, S. Y. Checking the amount of radon in drinking water sold in markets in Baghdad Governorate, Iraq .15 samples were used to measure radon dust. The amount of radon in drinking water from markets in Baghdad Governorate varied from 3.5 (Bq/m3) to 74 (Bq/m3), with 26.6 ±25.311 (Bq/m3) being the average [21]. A. Marzaali, A. A. Abojassim and M. A. Al-Shareefi, authored a paper in April 2021. A practical investigation was conducted to assess the presence of radiological radon gas for groundwater samples collected in Dhi-Qar Governorate. The RAD-7 (RAD-7 H2O) detector was utilized to evaluate the concentration of 222Rn in drinking water samples. The findings indicated that the concentration of 222Rn in Bq/L varied from 0.032±0.022 to 0.780±0.110, with a mean of 0.205±0.04. The annual dose of effectiveness (AED) and lifetime risk of cancer were also examined[22] Muttaleb, Hatif, K. H,M. K., & Abass, A. H. (2016).

Assessment of Active Radon Gas: The concentrations in Water at Kifel Schools.Radon is a chemical element that is not flammable, has no smell or taste, and is radioactive. It is also chemically inert and not flammable. Breathing it in is very dangerous and can cause cancer. The project's goal is to learn about the amount of radon contamination and thethe annual effective dose in the water that people in Babylon Governorate drink. This study identified the presence of the harmful gas radon in samples of water for drinking collected from schools in AL-Kifel, which is in the Babylon Governorate. A radon monitor called RAD H2O was used to pick water from 16 schools. The water samples with the highest concentration (1.15 Bq·L-1) and its lowest concentration (0.0362 Bq·L-1) were selected.

Discussion

Radon (Rn-222) is a radioactive noble gas that we can find in rocks, dirt, and groundwater. It is made when uranium (U-238), which is naturally radioactive, breaks down. Its abundance in water sources changes a lot based on many geological, environmental, and human-made factors.Composition of the RocksThe bedrock of the groundwater is the most important thing that affects the amount of radon in the water. Geographies with more granite, shale, or phosphate rocks tend to have more uranium, which makes more radon. As an example, groundwater from places with a lot of rock can have radon levels higher than 10,000 Bq/m³ [23].ExampleAs much as 100,000 Bq/m³ of radon was found in some private wells in the Appalachian Mountains in the United States by the USGS in 2005.Depth and Type of Water SourceRadon is usually more concentrated in groundwater (like wells and aquifers) than in surface water (like lakes and rivers). This is because it dissolves more easily in groundwater because it is under pressure and away from degassing in the air. Because shallow wells let more air in, they tend to have smaller amounts.Conditions of Temperature and PressureThe ability of gases to dissolve is affected by temperature and pressure. Higher pressures and lower temperatures make radon more soluble, which is why deeper, cooler groundwater may have more of it.Activities of People and Well ConstructionIf wells aren't properly covered or built, they can change the flow of groundwater in the area, letting radon-rich water move or leave. Also, mining, drilling, or hydraulic fracturing may make it easier for uranium to be released from underground.Case StudyIndia's mine areas had radon levels over 15,000 Bq/m³, which is a lot higher than the 100 Bq/L (¥100,000 Bq/m³) amount recommended by the WHO [24].Changes in the weather and seasonsChanges in the seasons, such as rain, melting, and drought, can affect the levels and flow patterns of groundwater, which can temporarily change the quantity of radon.

Conclusions

A summary of the current research on radon gas levels in water sources in Iraq, focusing on studies that used the RAD-7 monitoring method. The results show that levels of radon are generally below the safety standards set by groups like the WHO and EPA. However, there are some places with higher concentrations, especially those with geological features that make radon release easier. As a sensitive and reliable tool for measuring radon in water, the RAD-7 has made it easier to collect accurate and consistent data.The review reinforces how important it is to keep an eye on radon levels in drinking water, especially in places where natural background radiation is high. Regulatory frameworks and public information efforts are needed to lower long-term health risks like lung and stomach cancer. It is suggested that future study should look at a wider area, take into account changes that happen with the seasons, and see how well different water treatment methods work at lowering radon levels.

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