Review Article

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Radiological Conditions in Al-Basra Province of Iraq with Residues of Depleted Uranium in Food Animals: Review Article

Aqeel Chekhyor Hussein

Department of Veterinary Public Health, College of Veterinary Medicine, University of Basrah.

Corresponding Author Email Address: aqeelhussein@uobasrah.edu.iq

ORCID ID: https://orcid.org/0000-0001-8602-1416

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Abstract

Naturally occurring uranium ore is abundant in nature and contains several isotopes of uranium. All uranium isotopes are radioactive. However, only uranium-235 (U-235) is used to produce nuclear power and nuclear weapons. Uranium-235, necessary for nuclear weapons, is concentrated through uranium enrichment. In the 1970s, due to its high density, the USA started using DU to create bullets and mortar shells. The uranium oxide produced from the dust is mostly deposited inside the vehicle. depleted uranium mainly emits alpha particles. Alpha lack sufficient energy to penetrate through the skin. Exposure to DU outside the human body is not believed to be a serious hazard, but ingestion or inhalation of DU is a significant health threat. Exposure to alpha particles can have a detrimental impact on living cells, potentially leading to kidney damage. Dust that escapes from uranium metal does not usually travel far due to its density. Urine samples from soldiers and civilians in DU ammunition areas show low DU exposure. Contaminated soil taken by cattle and sheep can contaminate the food chain. However, the transfer factor in animals is relatively low, comparable to the one for plant transfer.

Keywords: Depleted Uranium, Basrah, Al-Zubair, Food Animals.

Definitions and Unit

Uranium (chemical code U) is a silver-colored heavy metal. Comparable to tungsten, it is very dense, about 19 grams per cubic centimeter. Thus, a 10 cm cube would weigh 20 kilograms (1). All rocks, soil, water, and air contain this substance. The average soil concentration is about two parts per million, equal to 2 g per ton (2). The Becquerel (Bq) serves as the unit of radioactivity, and a measurement of 1 Bq corresponds to one decay per second (3). The primary cause of damage from ionizing radiation is the absorption of energy by body tissues, also known as the radiation dose. The Sievert (Sv), also known as the millisievert (1 Sv equal to 1000 mSv), serves as the unit for measuring radiation doses, connecting the activity of a radioactive material (in Bq) to the radiation dose it generates (in Sv). Determining the body's internal or external exposure to radiation, its type (alpha, beta, or gamma), and its energy is crucial (4).

Depleted uranium (DU)

Nuclear energy and weapons production use an enriched form of uranium with a high concentration of uranium-235. The uranium mixture that remains after removing enriched uranium is called depleted uranium, as it has reduced concentrations of uranium-235 and uranium-234 isotopes (DU) (2). Half-lives (radioactive decay) are the processes of radiation emission by unstable atomic nuclei. This emission refers to the period it takes for radioactivity to dissolve by half the original value of uranium radioisotopes: 244,000 years for 234U, 710 million years for 235U, and 4.5 billion years for 238U. The longer the half-life, the lower the radioactivity of a given mass of material (5). A shell penetrating an armored target creates both DU fragments and aerosols upon impact. The dust in the aerosols spontaneously ignites, producing uranium oxide. The majority of the oxide dust produced remains within the tank that is impacted. DU particles escape rapidly due to metal density and do not disperse easily (6). DU ammunition can penetrate thick armor plates, releasing DU particles inside and outside the vehicle. The particles formed from DU quickly settle and are difficult to re-suspend due to their high uranium density (8, 9, 10). Penetrators from DU impact soft ground such as sand or clay and may stay intact while penetrating for 500 millimeters to some meters into the soil. Over time, they undergo slow oxidation and dissolution within the soil. Soil conditions influence the rate at which DU fragments dissolve. DU penetrators that are deposited near the surface are expected to dissolve completely within 35 years (11).

Existing Levels of Uranium in The Environment

Uranium is a heavy metal found in various chemical forms on all ground, crags, seawater, and oceans. Water and food that we consume also contain it. On average, humans ingest about 90 micrograms of uranium through normal consumption of food, water, and air (5). Typical concentrations of DU in common foods, such as bread and fresh vegetables, were approximately half as low (2 µg/kg) Uranium concentrations in rice and meat ranged from 0.1 to 0.2 g/kg (6). Around the world, concentrations of U-238 in milk products vary from 0.1 mBq/kg to 17 mBq/kg, while in meat products, the range is from 1 mBq/kg to 20 mBq/kg. On the other hand, concentrations of U-235 are over 20 times lower (7). On average, people ingest 1.3 micrograms of U per day, equal to 0.033 Becquerel, resulting in an annual receive of 11.6 Bq. Individuals inhale approximately 0.6 µg (15 mBq) per year. They may also receive an amount of approximately 120 µSv yearly from consuming and breathing in decay products of U, like Radium-226 and its offspring within the water, Radon-222 in homes, and Polonium-210 in cigarette smoke (7).

Ingestion of Depleted Uranium by Food Animals

The uranium ingested by livestock through herbs and ground is rapidly eliminated by urine and feces (7). Animals raised domestically are less exposed to contaminated feed by sourcing from outside affected areas. Animals are likely to have greater exposure than humans because of their limited and less varied diet. While browsing, herbivores may ingest large amounts of soil, making them vulnerable to DU particles in soil and vegetation (1). It is estimated that cattle ingest approximately 500 grams of soil per day. Data on sheep's soil intake is limited, but it is estimated to be around 60g per body weight. Goats are selective grazers and typically concentrate on the tops of grass leaves, so soil ingestion is usually negligible (5). Uranium compounds ingested orally are poorly absorbed into the bloodstream, with only a small percentage, even for soluble forms, being absorbed at 2% (12).

What is the Impact of Uranium Depletion on Animal Food?

Domestic animals may come into contact with DU through the same routes as humans. Studies on the gastrointestinal tract uptake factors in animals have shown variations depending on the amount of uranium administered, the animal's age, and dietary stressors such as iron deficiency and fasting (5). Like other heavy metals, uranium is not absorbed efficiently from the intestinal lumen (14). In experiments, it has been discovered that young animals absorb more uranium into their blood than adult animals when fed uranium (2). Over 90% of ingested uranium is quickly excreted in urine after passing through the GI tract to the bloodstream (15). No adverse health effects have been associated with ingested DU in human or animal studies. Researchers have not found any evidence connecting ingested uranium compounds to human cancer. Similarly, there were no animal studies conducted that showed any evidence of cancer being induced orally (16). The uranium content in cattle grazing near the Rocky Flats Plant in Colorado may reflect contamination from this source, as it was slightly higher than in other cattle (17). Concentrations of uranium in muscle from cattle exposed to elevated levels of forage (440 µg/kg) were like those in the control group. These results suggest that uranium is not concentrated in cattle muscle (1,17).

Residues of Depleted Uranium

The exact amount of DU ammo used in the 2003 conflict remains uncertain, with estimates ranging from 170 to 1700 tons, according to various studies. The UK Ministry of Defence reported using less than 1 ton of DU ammunition in the 1991 Gulf Warfare and about 1.9 tons in the 2003 Iraq conflict. The USA has not provided UNEP with DU target coordinates for the 1991 or 2003 conflict (18). US forces fired the vast majority of the estimated 300,000 depleted uranium rounds during the 2003 Iraq warfare. US forces fired around 782,414 depleted uranium rounds during the 1991 conflict (19). The first Gulf War of 1991 saw the firing of at least 300 metric tons of depleted uranium. Coalition forces used 1000-2000 tons of depleted uranium in the 3-week conflict of the Second Gulf War in 2003 (20). Considering the radiological profile of natural and depleted uranium, it is unlikely to pose any radiological health hazards. DU exposure could not be detected or is very low in soldiers and residents in areas with military use of DU (21).

This report concludes that the population at the four studied locations in southern Iraq does not face a radiological risk due to radiation doses from depleted uranium. The annual radiation doses from DU residues are constantly below 100 µSv/a and pose little radiological concern to a few individuals (18). Based on estimates, the radiation doses are lower than what people typically receive from natural radiation sources in the environment (which is an average of 2.4 mSv/a worldwide). Furthermore, the doses are below the recommended limits for public exposure (1 mSv/a) set by international standards. Additionally, the doses do not exceed the action level of 10 mSv/a outlined in the IAEA Safety Standard for Remediation of Areas Contaminated by Past Activities and Accidents (22).

During the investigation, four areas of interest were explored in Al Basrah. The first area, located in the northeast quadrant (UTM coordinates 767050 E, 374750 N), showed an ambient dose rate ranging from 0.10 to 0.25 Sv/h when measured 1 meter above ground. Similarly, this area did not exhibit any depleted uranium residues. The second area, located in the north-east quadrant (UTM coordinates 771150 E, 3374750 N), lies south of the city center. The ambient dose rate, measured 1 meter above ground, ranged from 0.06 to 0.25 Sv/h.No residues of depleted uranium, such as penetrators or fragments, were discovered in this location. In addition, the southeast quadrant (UTM coordinates 771150 E, 3372150 N) had an ambient dose rate range of 0.09-0.226 µSv/h at a height of 1 meter above ground. No depleted uranium (DU) residues, such as penetrators or fragments, were discovered in this area. Similarly, the fourth location in the southwest quadrant (UTM coordinates 767050 E, 3372150 N) had an ambient dose rate range of 0.09-0.31 µSv/h at a height of 1 meter above ground and no DU residues were found there either (18). The town of Al Zubayr is situated in the south-west of the city. Roads, buildings, and open areas encompass industrial, commercial, and residential areas. DU residues (penetrators, fragments) were found near or on several tank parts investigated during the 2nd Mission, Al-Zubair military equipment Figure (1) (UTM coordinates 4771263 E, 3038117 N) hit by DU munitions, with an ambient dose rate of about 0.10 Sv/h at 1 m above ground (22). The meat, milk, and water obtained from contaminated areas were not contaminated with Ra 226. Therefore, the food chain was not affected by DU contamination (23). Cattle and sheep can ingest contaminated soil, potentially transferring it into the food chain. However, animals have a lower transfer factor compared to plants (24).

Figure (1): A scrap yard full of debris potentially contaminated by depleted uranium is located near Al-Zubair (2004) .

Conflicts of interest

The authors declare that there is no conflict of interest.

Conclusion

Gulf War missions conducted in Basra in 1991 and 2003 found no widespread contamination of the soil or ground surface. However, some localized contaminations were identified where the use of DU had been reported. The most contamination was found in military equipment and between 10-20 cm directly below the ground penetrator. We found no evidence of DU contamination in water, meat, or milk. We did not find any contaminated water, possibly due to the desert area's limited groundwater sources.

References

1. Bleise, A., Danesi, P. R., & Burkart, W. (2003). Properties, use and health effects of depleted uranium (DU): a general overview. *Journal of environmental radioactivity*, *64*(2-3), 93-112.
2. Eidson, A. F., & Mewhinney, J. A. (1983). In vitro dissolution of respirable aerosols of industrial uranium and plutonium mixed-oxide nuclear fuels. *Health physics, 45*(6), 1023-1037.
3. De Laeter, J. R., Böhlke, J. K., De Bievre, P., Hidaka, H., Peiser, H. S., Rosman, K. J. R., & Taylor, P. D. P. (2003). Atomic weights of the elements. Review (2000) (IUPAC Technical

Report). *Pure and applied chemistry, 75*(6), 683-800

4. Cousins, C., Miller, D. L., Bernardi, G., Rehani, M. M., Schofield, P., Vañó, E., ... & Sim, K. H. (2013). ICRP publication 120: radiological protection in cardiology. *Annals of the ICRP, 42*(1), 1-125.
5. Bleise, A., Danesi, P. R., & Burkart, W. (2003). Properties, use and health effects of depleted uranium (DU): a general overview. *Journal of environmental radioactivity, 64*(2-3), 93-112.
6. Fisenne, I. M., Perry, P. M., Decker, K. M., & Keller, H. W. (1987). The daily intake of 234,235,238 U, 228,230,232 Th and 226,228 Ra by New York City residents. *Health Physics, 53(4),* 357-363.
7. Vanmarcke, H. (2002). UNsCEAR 2000: sources of ionizing radiation. *Annalen van de Belgische vereniging voor stralingsbescherming, 27*(2), 41-65.
8. Cheng, Y. S., Kenoyer, J. L., Guilmette, R. A., & Parkhurst, M. A. (2009). Physicochemical characterization of Capstone depleted uranium aerosols II: particle size distributions as a function of time. *Health physics, 96*(3), 266-275.
9. Parkhurst, M. A., & Guilmette, R. A. (2009). Overview of the Capstone depleted uranium study of aerosols from impact with armored vehicles: test setup and aerosol generation, characterization, and application in assessing dose and risk. *Health physics, 96*(3), 207-220.
10. Holmes, T. D., Guilmette, R. A., Cheng, Y. S., Parkhurst, M. A., & Hoover, M. D. (2009). Aerosol sampling system for collection of capstone depleted uranium particles in a high-energy environment. *Health physics, 96*(3), 221-237.
11. McLaughlin, J. P., Vintro, L. L., Smith, K. J., Mitchell, P. I., & Žunić, Z. S. (2003). Actinide analysis of a depleted uranium penetrator from a 1999 target site in southern Serbia. *Journal of environmental radioactivity, 64*(2-3), 155-165.
12. Bleise, A., Danesi, P. R., & Burkart, W. (2003). Properties, use and health effects of depleted uranium (DU): a general overview. *Journal of environmental radioactivity, 64*(2-3), 93-112.
13. Speksnijder, D. C., Jaarsma, A. D. C., Van Der Gugten, A. C., Verheij, T. J., & Wagenaar, J. A. (2015). Determinants associated with veterinary antimicrobial prescribing in farm animals in the Netherlands: a qualitative study. *Zoonoses and public health*, *62*, 39-51.
14. Spencer, H., Osis, D., Fisenne, I. M., Perry, P. M., & Harley, N. H. (1990). Measured intake and excretion patterns of naturally occurring, and calcium in humans. *Radiation research, 124*(1), 90-95.
15. Singh, N. P., Bennett, D. D., Wrenn, M. E., & Saccomanno, G. (1987). Concentrations of alpha-emitting isotopes of U and Th in uranium miners' and millers' tissues. *Health physics*, *53(3), 261-265.*
16. Ismail, K. (2001). A review of the evidence for a "Gulf War Syndrome". *Occupational and environmental medicine, 58*(11), 754-754.
17. Wilkinson, J. M., Hill, J., & Phillips, C. J. C. (2003). The accumulation of potentially-toxic metals by grazing ruminants. *Proceedings of the Nutrition Society*, *62*(2), 267-277.
18. Salama, E., El-Kameesy, S. U., & Elrawi, R. (2019). Depleted uranium assessment and natural radioactivity monitoring in North West of Iraq over a decade since the last Gulf War. *Journal of environmental radioactivity*, *201,* 25-31.

19. Surdyk, S., Itani, M., Al-Lobaidy, M., Kahale, L. A., Farha, A., Dewachi, O., ... & Habib, R. R. (2021). Weaponised uranium and adverse health outcomes in Iraq: a systematic review. *BMJ global health, 6*(2), e004166.

20. Faa, A., Gerosa, C., Fanni, D., Floris, G., Eyken, P. V., Lachowicz, J. I., & Nurchi, V. M. (2018). Depleted uranium and human health. *Current medicinal chemistry, 25*(1), 49-64.

21. Royal Society Working Group on the Health Hazards of Depleted Uranium Munitions. (2002). The health effects of depleted uranium munitions: a summary. *Journal of Radiological Protection, 22*(2), 131.

22. Al-Azzawi, S. (2019). Health Risks related to depleted uranium contamination in Iraq: depleted uranium use in Iraq. *International Journal Of Medical Sciences*, *2(3), 1-8.*

23. Al-Shammari, A. M. (2016). Environmental pollutions associated to conflicts in Iraq and related health problems. *Reviews on environmental health, 31*(2), 245-250.

24. Bem, H., & Bou-Rabee, F. (2004). Environmental and health consequences of depleted uranium use in the 1991 Gulf War. *Environment international, 30*(1), 123-134.

المواد المشعة في محافظة البصرة العراقية ووجود مخلفات اليورانيوم المخصب في المنتجات ذات المصدر الحيوانات مقال مراجعة

عقيل جخيور حسين
فرع الصحة العامة البيطرية، كلية الطب البيطري، جامعة البصرة، العراق

الخلاصة

خام اليورانيوم الموجود طبيعيًا وفير في الطبيعة ويحتوي على عدة نظائر لليورانيوم. جميع نظائر اليورانيوم مشعة. ومع ذلك، يتم استخدام اليورانيوم 235 (U-235) فقط لإنتاج الطاقة النووية والأسلحة النووية. ويتم تركيز اليورانيوم 235، المهم للأسلحة النووية، من خلال تخصيب اليورانيوم. وفي السبعينيات، وبسبب كثافته العالية، بدأت وزارة الدفاع الأمريكية في استخدام اليورانيوم المخصب لصنع الرصاص وقذائف الهاون. يتم ترسب معظم أكسيد اليورانيوم الناتج من الغبار داخل السيارة. ينبعث اليورانيوم المخصب بشكل رئيسي من إشعاع جسيمات ألفا. تفتقر جزيئات ألفا إلى الطاقة الكافية لاختراق الجلد. لا يعتبر التعرض لليورانيوم المخصب خارج الجسم خطراً جسيماً، ولكن تناول أو استنشاق اليورانيوم المخصب يشكل خطراً صحياً جسيماً. يمكن أن يكون للتعرض لجسيمات ألفا تأثير ضار على الخلايا الحية، مما قد يؤدي إلى تلف الكلى. الغبار الذي يتسرب من معدن اليورانيوم لا ينتقل عادةً بعيدًا بسبب كثافته. تظهر عينات البول المأخوذة من الجنود والمدنيين في مناطق ذخيرة اليورانيوم المخصب تعرضاً منخفضاً لليورانيوم المخصب. التربة الملوثة التي تبتلعها الماشية والأغنام يمكن أن تلوث السلسلة الغذائية. ومع ذلك، فإن عامل النقل في الحيوانات منخفض نسبيًا، مقارنة بعامل النقل إلى النباتات.

الكلمات الافتتاحية: اليورانيوم المخصب، البصرة، الزبير، حيوانات الغذاء.