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Radiological health risk assessment of powdered and liquid milk in South Africa: A study on activity concentration levels of ^{226}Ra , ^{238}U , ^{232}Th , ^{40}K and ^{137}Cs

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Our natural environment is endowed with natural radioisotopes to which humans are exposed through the ingestion of foodstuffs with consequent health implications. In this study, an assessment of the radioactivity levels in powdered and liquid milk available in South Africa was conducted to evaluate their associated radiological health risks. Both natural radioactivity sources such as ^{226}Ra , ^{238}U , ^{232}Th and ^{40}K , as well as artificial radionuclides like ^{137}Cs , were analyzed using gamma-ray spectroscopy. A total of twenty-eight frequently consumed milk samples were collected from the groceries stores in South Africa and measured using a high-purity Germanium detector. The results revealed varying levels of radioactivity in the milk products, with mean values of 29.940 ± 3.571 Bq/kg for ^{238}U , 33.803 ± 4.655 Bq/kg for ^{226}Ra , 29.508 ± 5.245 Bq/kg for ^{232}Th and 573.553 ± 103.273 Bq/kg for ^{40}K , for powdered milk. Liquid milk showed mean concentrations of 7.252 ± 1.215 Bq/L for ^{238}U , 10.332 ± 0.731 Bq/L for ^{226}Ra , 11.169 ± 1.137 Bq/L for ^{232}Th and 137.072 ± 57.982 Bq/L for ^{40}K . Artificial radionuclide ^{137}Cs was not detected in the milk samples. The mean value of ^{40}K for powdered milk exceeds guideline limit set by UNSCEAR for foodstuff. The mean annual effective dose was calculated to be $2.546 \times 10^{-4} \pm 0.189 \times 10^{-4}$ mSv/y while the lifetime cancer risk was found to be $8.276 \times 10^{-5} \pm 6.170 \times 10^{-5}$. The estimated mean values of radiological health risks of the milk samples are within the tolerable limit set by UNSCEAR and other global regulatory bodies. However, infants are at high risk by consuming up to 15 kg/year of powdered milk due to high radiation doses to vital organs of the range 1.659 ± 0.190 to 2.957 ± 0.339 mSv/y, but half the quantity is recommended. The findings of this study are comparable with those reported in the literature and provide valuable insights into the radioactivity levels in milk products in South Africa and their potential implications for human health. It shows that there is no significant radiological health impact due to the consumption of milk. However, continuous monitoring and further research on heavy metal contents are recommended to ensure the safety of milk consumption by the populace.

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