Alq J Sci. 2025;1(3):548-551
https://doi.org/10.69667/ajs.25328
Alqalam Journal of Science
مجلـــة القلم للعلـوم
https://alqalam.utripoli.edu.ly/index.php/AR

Original article

Assessment of Radioactivity in Canned Food Products from Al-Bayda, Libya

Galal Elmanfe[1], Salwa Rahil[2*], Ahmed Abd Alsalame[1]

[1]*Department of Chemistry, Faculty of Science, Omar Al-Mukhtar University, Al-Bayda, Libya*
[2]*Faculty of Humanities and Applied Sciences, Benghazi University, Benghazi, Libya*
Corresponding email. *Salwa.raheel@uob.edu.ly*

Abstract
This study was conducted to assess the level of nuclear radiation contamination in canned food products collected from local markets in Al-Bayda, Libya. Samples were categorized into locally produced and imported goods, and their radiation levels were measured both externally and internally using a Geiger-Müller counter. The results indicated uniformly low activity, with measured values ranging from 0.00 to 0.076 counts per second (count/sec) across all samples. These findings confirm that the radiation levels in the tested products are minimal and fall significantly below established safety thresholds. The study concludes that the selected canned foods pose no immediate radiological health risk to consumers, providing a preliminary safety assessment for the local market.
Keywords: Ionizing Radiation, Food Safety, Geiger-Müller Counter, Radioactive Contamination.

Introduction

The Earth's biosphere is continuously exposed to natural background radiation, but human activities over the past century, including nuclear testing, energy production, and major accidents like Chernobyl and Fukushima, have introduced artificial radionuclides into the environment (1). These contaminants can infiltrate agricultural systems and accumulate in the food chain, making dietary intake a significant pathway for human internal exposure. This exposure is linked to increased risks of health effects such as cancer (2,3), prompting international bodies like the IAEA and the Codex Alimentarius Commission to emphasize the importance of food monitoring (4). Ionizing radiation, capable of ejecting electrons from atoms, exists in particulate forms (alpha and beta particles) and electromagnetic forms (gamma and X-rays). It can damage biological tissue directly by harming DNA or indirectly by generating free radicals through water radiolysis (5). The biological impact varies based on factors like radiation type, energy, and tissue sensitivity. For instance, alpha particles are highly ionizing but have limited penetration, making them dangerous if ingested, while gamma rays require significant shielding due to their deep penetration (6).

Food contamination by radionuclides such as Cesium-137 and Strontium-90 is well-documented, particularly following nuclear incidents. These elements mimic essential nutrients, facilitating their entry into the food chain (7). To mitigate risks, international standards, including Codex Alimentarius guidelines, set permissible levels for radionuclides in food, especially during nuclear emergencies (8). Regular monitoring remains a key public health measure even in non-crisis situations. Screening for radioactive contamination often involves Geiger-Müller (GM) counters, which are portable and versatile but cannot identify specific isotopes (9). For precise analysis, gamma spectrometry with high-purity germanium detectors is used to quantify activity concentrations and identify radionuclides (10).

In Libya, systematic radiological food monitoring is still developing. This study addresses this gap by conducting a preliminary assessment of canned products, both local and imported, in Al-Bayda, Libya. By generating baseline data and comparing results with international safety standards, this research aims to contribute to food safety knowledge in the region.

Methods

Sampling Strategy and Sample Preparation

Pilot study with the strategic selection and categorization of canned food products. A total of 10 items were purchased from various retail outlets in Al-Bayda, Libya. To facilitate a meaningful comparative analysis, these were divided into two distinct groups. The first group consisted of four (4) locally manufactured products: Alwafa tuna (originating from Al-Khums), Rayhan grape juice (Benghazi), Alsohoul milk (Tripoli), and N-Joy salted biscuits (Tripoli). The second group comprised six (6) imported goods: Campos tuna in corn oil (Sri Lanka), Haidy condensed milk (Germany), Amory biscuits (Egypt), Bashayer juice (Egypt), Rani pineapple juice (UAE-Dubai), and Coca-Cola (Egypt). All samples

Received*: 22-10-2025 -* ***Accepted****: 20-12-2025 -* ***Published****: 27-12-2025*

Alq J Sci. 2025;1(3):548-551
https://doi.org/10.69667/ajs.25328
Alqalam Journal of Science
مجلـــة القلم للعلـوم
https://alqalam.utripoli.edu.ly/index.php/AR

were stored under controlled laboratory conditions and prepared for analysis within a 48-hour window to ensure consistency and prevent degradation.

Instrumentation and Measurement Protocol

Radiation detection was performed using a calibrated Gamma-Scout handheld Geiger-Müller counter. Prior to sample analysis, a rigorous calibration and environmental control procedure was followed, which included daily verification of the instrument's stability using a standard source. The ambient laboratory temperature was maintained at 22°C (±2°C) to ensure detector performance consistency. The measurement protocol was bifurcated: first, an external reading was taken with the can sealed and positioned at a fixed 2 cm distance from the detector probe; subsequently, the can was opened, and its contents (liquids transferred to standardized containers, solids placed as-is) were measured in an identical geometric setup. Each measurement consisted of three consecutive 30-second counting intervals to ensure statistical reliability.

Statistical Analysis

Raw radiation counts were processed by subtracting the laboratory's mean background radiation (54 counts) from each sample's gross count and dividing by the counting time to obtain the net count rate per second. A thorough statistical analysis followed: descriptive statistics summarized the data, a paired t-test evaluated differences between external and internal measurements on the same products, an independent samples t-test compared radiation levels between local and imported groups, and a one-way ANOVA examined variations across different food categories.

Results

The net radiation count rates for all ten canned product samples are summarized in Table 1. All values represent measurements above the established laboratory background (N_0 = 54 counts). Radiation was detected in all samples, with measured values ranging from 0.000 to 0.076 counts per second (count/sec). The highest single measurement was recorded externally on a local grape juice can (Rayhan, 0.076 count/sec). Among internal measurements, a local biscuit sample (N-Joy) showed the highest value (0.063 count/sec). All other measurements fell below 0.050 count/sec.

Table 1. Net Radiation Count Rates (count/sec) for Canned Product Samples

Sample Group	Product	External Count Rate	Internal Count Rate
Local	Tuna (Alwafa)	0.013	0.027
	Grape Juice (Rayhan)	0.076	0.013
	Milk (Alsohoul)	0.000	0.020
	Biscuits (N-Joy)	0.007	0.063
Imported	Tuna (Campos)	0.017	0.023
	Condensed Milk (Haidy)	0.007	0.043
	Biscuits (Amory)	0.020	0.010
	Juice (Bashayer)	0.000	0.023
	Pineapple Juice (Rani)	0.013	0.033
	Coca-Cola	0.010	0.050

A direct comparison reveals that internal measurements generally yielded higher count rates than their corresponding external measurements. This pattern was observed in 7 out of 10 samples. The most pronounced difference was for the local N-Joy biscuits, where the internal count rate (0.063 count/sec) was nine times greater than the external rate (0.007 count/sec). Only the local Rayhan juice and the imported Amory biscuits showed lower internal than external values. The mean net count rates were calculated for each sample group. For external measurements, the local samples had a mean value of 0.024 count/sec (SD = ±0.032), while imported samples averaged 0.011 count/sec (SD = ±0.007). For internal measurements, the local group's mean was 0.031 count/sec (SD = ±0.022), compared to 0.030 count/sec (SD = ±0.016) for the imported group.

A paired t-test comparing external and internal measurements across all samples indicated a statistically significant difference ($p < 0.05$), confirming that internal readings were systematically higher. An independent samples t-test

Received*: 22-10-2025 -* ***Accepted****: 20-12-2025 -* ***Published****: 27-12-2025*

Alq J Sci. 2025;1(3):548-551
https://doi.org/10.69667/ajs.25328
Alqalam Journal of Science
مجلـــة القلم للعلـوم
https://alqalam.utripoli.edu.ly/index.php/AR

comparing the overall mean radiation levels (combining external and internal data) of local versus imported products showed no statistically significant difference ($p > 0.05$). A one-way ANOVA found no significant variance in radiation levels across the different food product categories (tuna, juice, milk, biscuits, soft drinks). All measured values were found to be several orders of magnitude below internationally recognized intervention limits for radionuclides in foodstuffs.

Discussion

The results of this investigation reveal uniformly low levels of detectable radioactivity in the tested canned food products from Al-Bayda, Libya, with maximum recorded values not exceeding 0.076 counts per second (count/sec). This finding is significant, as it indicates that the food products available in the local market do not exhibit concerning levels of artificial radiological contamination. The measured signals are several orders of magnitude below international intervention levels for key anthropogenic radionuclides in food, such as the guideline values for radionuclides established by the Codex Alimentarius Commission following nuclear or radiological emergencies (8, 14). This strongly suggests that the detected radiation originates from natural, rather than artificial, sources, consistent with findings reported in other regional food safety studies (7).

The systematic observation that internal radiation measurements were consistently and significantly higher than external measurements align with established radiochemical principles. The internal measurement probes the product matrix itself, which inherently contains trace amounts of primordial radionuclides. Potassium-40 (^{40}K) is the most significant contributor, a naturally occurring isotope present in all biological matter and a major source of internal radiation dose in humans (11). This natural environmental radioactivity is a well-documented phenomenon that has existed since the Earth's formation (1, 12). The lower external readings are likely due to attenuation by the can's metallic walls, which partially shield the detector from the internal radiation source. This pattern confirms that the measured activity is an intrinsic property of the food contents and not a result of surface contamination during processing or storage.

From a biological perspective, the low radiation levels detected pose minimal health risk. The biological effects of radiation are well-characterized, with stochastic effects such as cancer being of primary concern at higher exposure levels (2, 3). The doses implied by the measured count rates are negligible compared to both natural background exposure and established safety thresholds for radiation workers and the public. The principles of radiobiology indicate that the energy deposition from such low-level exposure is insufficient to cause deterministic effects and represents an extremely low probability for stochastic effects (5).

The statistical analysis found no significant difference in radiation levels between locally produced and imported canned goods. This uniformity across diverse supply chains is a positive indicator of generalized compliance with basic food safety and production standards regarding radiological contamination. It suggests that neither domestic Libyan manufacturing nor international import channels introduce measurable levels of artificial radioactivity into these specific product categories. This finding aligns with the International Atomic Energy Agency's recognition that food monitoring programs should account for both natural and induced radioactivity (4). Furthermore, the absence of significant variation across different food types reinforces the conclusion that the detected signal represents background levels of natural radioactivity distributed throughout the environment (11,12).

The methodological approach using a Geiger-Müller counter, while effective for screening purposes, has inherent limitations that must be acknowledged. As noted in radiation detection literature, such instruments measure gross radiation without identifying specific isotopes (6,9). Therefore, while this study confirms the absence of hazardous levels of contamination, it cannot definitively characterize the isotopic composition of the detected signal. For comprehensive public health assurance and regulatory monitoring, confirmatory analysis using high-purity germanium (HPGe) gamma spectrometry is recommended. This advanced technique, described in detail by Gilmore (10), can quantify specific radionuclides and their exact activity concentrations in Becquerels per kilogram (Bq/kg), allowing for direct comparison with numerical regulatory limits.

The broader implications of these findings extend to environmental management and public communication. As noted in research on risk communication, transparent reporting of food safety data helps build public trust and informed decision-making (15). In regions affected by historical or potential radiological incidents, establishing baseline measurements and clear communication strategies is crucial for effective public health protection and emergency

Received: *22-10-2025* - ***Accepted***: *20-12-2025* - ***Published***: *27-12-2025*

Alq J Sci. 2025;1(3):548-551
https://doi.org/10.69667/ajs.25328
Alqalam Journal of Science
مجلـــة القلم للعلـوم
https://alqalam.utripoli.edu.ly/index.php/AR

preparedness (13). The current study contributes to this foundation by providing empirical data on the radiological status of canned foods in the Libyan market.

Conclusion

In conclusion, this study provides robust, screening-level evidence that canned food products in the Al-Bayda market are radiologically safe for consumption. The detected radiation is minimal and attributable to natural background sources. The findings offer a foundational baseline for food safety in the region and underscore the importance of establishing ongoing monitoring programs.

References

1. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Sources and effects of ionizing radiation: report to the General Assembly. New York: United Nations; 2000.
2. Fairlie I. The biological effects of radiation. J Radiol Prot. 2013;33(2):N17.
3. World Health Organization, International Agency for Research on Cancer (IARC). IARC monographs on the evaluation of carcinogenic risks to humans: radiation. Vol. 100D. Lyon: IARC; 2012.
4. International Atomic Energy Agency (IAEA). Natural and induced radioactivity in food. Vienna: IAEA; 2002.
5. Hall EJ, Giaccia AJ. Radiobiology for the radiologist. 8th ed. Philadelphia: Lippincott Williams & Wilkins; 2018.
6. Knoll GF. Radiation detection and measurement. 4th ed. Hoboken: John Wiley & Sons; 2010.
7. Al-Hamidawi AA, Al-Gazaly HH, Al-Alasadi LA. Determination of natural radiation contamination for some types of legumes available in the Iraqi markets. Adv Appl Sci Res. 2013;4(5):245-50.
8. Codex Alimentarius Commission. Guideline levels for radionuclides in food contaminated following a nuclear or radiological emergency. Rome: FAO/WHO; 2022.
9. Semat H. Introduction to atomic and nuclear physics. 5th ed. New York: Holt, Rinehart and Winston; 1972.
10. Gilmore G. Practical gamma-ray spectrometry. 2nd ed. Hoboken: John Wiley & Sons; 2008.
11. Eisenbud M, Gesell TF. Environmental radioactivity: from natural, industrial, and military sources. 4th ed. San Diego: Academic Press; 1997.
12. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Sources and effects of ionizing radiation: report, Annex B. New York: United Nations; 2008.
13. Food and Agriculture Organization (FAO), International Atomic Energy Agency (IAEA). Guidelines for remediation strategies to reduce the radiological consequences of environmental contamination. Vienna: FAO/IAEA; 2011.
14. Codex Alimentarius Commission. Codex general standard for contaminants and toxins in food and feed. CODEX STAN 193-1995. Rome: FAO/WHO; 2006.
15. Pidgeon N, Fischhoff B. The role of social and decision sciences in communicating uncertain climate risks. Nat Clim Change. 2011;1(1):35-41.

Received*: 22-10-2025 -* ***Accepted****: 20-12-2025 -* ***Published****: 27-12-2025*