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Degradation of Chlorinated Organic and Pyrethroid Pesticides Induced by Gamma Irradiation in Cultural Heritage

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Background of the study:

The presence of pesticides in cultural heritage items poses health risks to museum workers and others who come into direct contact with contaminated objects. Mitigation measures are necessary, and in this context, ionizing radiation emerges as a promising technique for application to cultural heritage, as previous studies have demonstrated its potential for degrading organic pesticides in soil, food, aqueous waste, and other substrates. This presentation aims to explore the application of gamma radiation for the degradation of DDT, lindane, hexachlorobenzene, and permethrin, pesticides historically used for the preservation of cultural heritage objects.

Methodology:

A Cobalt-60 gamma-ray source was used for irradiation experiments at IPEN's Multipurpose Cobalt-60 Irradiator facility at the Radiation Technology Center (CTER) of the Nuclear and Energy Research Institute, IPEN-CNEN/SP. Standard pesticide solutions at 1, 5, and 10 ppm concentrations were irradiated with doses of 0, 1, 3, 6, 10, 25, 50, and 100 kGy. Pesticide concentrations were analyzed before and after irradiation using GC-MS, and to validate the analytical method, parameters including selectivity/specificity, linearity/working range, limit of detection (LOD), limit of quantification (LOQ), precision, and accuracy were evaluated.

Results:

The results indicated that 25 kGy doses degraded DDT by 93.07%-98.25%, lindane by 58.25%-78.45%, hexachlorobenzene by 27.56%-83.26%, and permethrin by 31.51%-71.42%. Increasing the absorbed doses resulted in greater degradation of the target pesticides.

Conclusion:

The pesticides selected for this research are persistent and were significantly reduced by ionizing radiation processing. Future studies are needed to determine if degradation efficiency remains in samples simulating museum objects and if different substrates can influence pesticide degradation results. The application of ionizing radiation on cultural heritage items must be conducted within limits to avoid undesirable side effects. Therefore, future investigations should consider whether absorbed doses capable of degrading pesticides in solutions are safe for application on cultural heritage items.