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Gamma Radiation for Preservation: A Novel Approach to Disinfect VHS Tapes in Historical Archives

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1. Introduction

Preserving historical artifacts, such as VHS tapes, in archival collections poses unique challenges, especially when faced with environmental conditions that foster mold contamination. The inadequate control of temperature and relative humidity can lead to the growth of mold, threatening the integrity of these valuable cultural assets [1,2]. This study explores the application of gamma radiation treatment as an effective method for the disinfection of VHS tapes contaminated with mold in historical archives.

In particular, we focus on the utilization of gamma radiation at the Nuclear and Energy Research Institute (IPEN), São Paulo, Brazil. The Multipurpose Gamma Irradiation Facility at IPEN has been at the forefront of employing gamma radiation for the decontamination of historical and cultural artifacts [3,4]. The research investigates the efficacy of gamma radiation in eradicating mold from VHS tapes while preserving their structural and informational integrity. This study contributes to the broader understanding of innovative preservation techniques, addressing the unique challenges posed by environmental factors in the storage of historical materials.

2. Methodology

The gamma radiation treatment utilizing the The Multipurpose Gamma Irradiation Facility at IPEN, São Paulo, Brazil, involved exposing mold-contaminated VHS tapes to a standard dose of 10 kGy, a commonly accepted level for the disinfection of cultural heritage materials. The irradiation process was conducted at a controlled rate of 5 $kGy.h^{-1}$ to ensure an effective treatment.

Pre- and post-irradiation, the mechanical properties of the VHS tapes were evaluated through tensile testing to assess their resistance. Tensile tests were performed using a Universal Testing Machine (Instron 5567), measuring parameters according to ASTM D 882 [5]. This analysis aimed to determine the impact of gamma radiation on the structural integrity of the VHS tapes, providing insights into the material's mechanical behavior after the disinfection process.

In addition to the mechanical analysis, the evaluation extended to the visual aspects of the VHS tapes. Images of the tapes were captured both before and after gamma radiation exposure. A comprehensive visual inspection included an assessment of mold growth, discoloration, and any other visible alterations in the tape's surface. Special attention was given to preserving the information encoded on the tapes and ensuring that the visual quality remained intact.

The combination of visual evaluation and mechanical analysis provided a holistic understanding of the impact of gamma radiation on the VHS tapes. The assessment of images served as a qualitative measure to complement the quantitative data obtained from the mechanical tests, offering insights into the overall preservation and appearance of the historical materials after the disinfection process. The comparison of pre- and post-irradiation images aided in determining the efficacy of gamma radiation in preserving both the structural and visual integrity of the VHS tapes in historical archives.

3. Results and Discussion

The tensile testing results provide valuable insights into the mechanical properties of the VHS tapes, both before and after gamma radiation exposure. Prior to irradiation, tensile tests were conducted on non-irradiated (control) and biodeteriorated sample, exhibiting mold contamination, to establish baseline values for comparison with the irradiated counterparts. The data obtained from these initial tests serves as reference values for assessing the impact of gamma radiation on the mechanical integrity of the VHS tapes.

Table 1 presents the key parameters derived from the tensile tests, including tensile strength and elongation at break, for control, biodeteriorated and irradiated samples. The comparison of these values enables a comprehensive evaluation of the alterations induced by gamma radiation on the material's mechanical performance.

Table I: Tensile test data for VHS tape control and gamma irradiated (10 kGy) sample.

Sample	Tensile strength (MPa)	Tensile strain (%)
control	121.96	103.96
biotedeteriorated	64.46	131.38
10 kGy	88.20	136.96

The introduction of a biodeteriorated sample, without irradiation treatment, enriches our understanding of the impact of gamma irradiation in compare to a mold contaminated and uncontaminated VHS tapes. In comparison to the control, the biodeteriorated sample displayed a significant reduction in tensile strength, a consequence of mold-induced structural weakening. However, the 10 kGy gamma-irradiated sample exhibited a notable increase in tensile strength, indicating the efficacy of gamma radiation in mitigating the adverse effects of mold and reinforcing the material.

Moreover, the biodeteriorated sample showed higher tensile strain, reflecting increased deformability before failure due to compromised structural integrity from mold presence. The 10 kGy gamma-irradiated sample

demonstrated further improvement in tensile strain, suggesting enhanced flexibility without compromising overall strength. These findings underscore gamma radiation's potential as a dual-function method, effectively disinfecting mold-contaminated VHS tapes while positively influencing their mechanical properties.

This mechanical enhancement aligns with visual inspection results, where no observable alterations in the appearance of VHS tapes post-gamma irradiation were noted. The combined mechanical and visual analyses contribute to the overall discussion, supporting gamma radiation as a viable preservation strategy for historical artifacts.

In addition to mechanical analysis, a visual inspection involved capturing images of the VHS tape before and after the gamma radiation treatment. Notably, no discernible differences were observed between pre- and post-treatment images, indicating the absence of visual alterations resulting from secondary effects of irradiation.

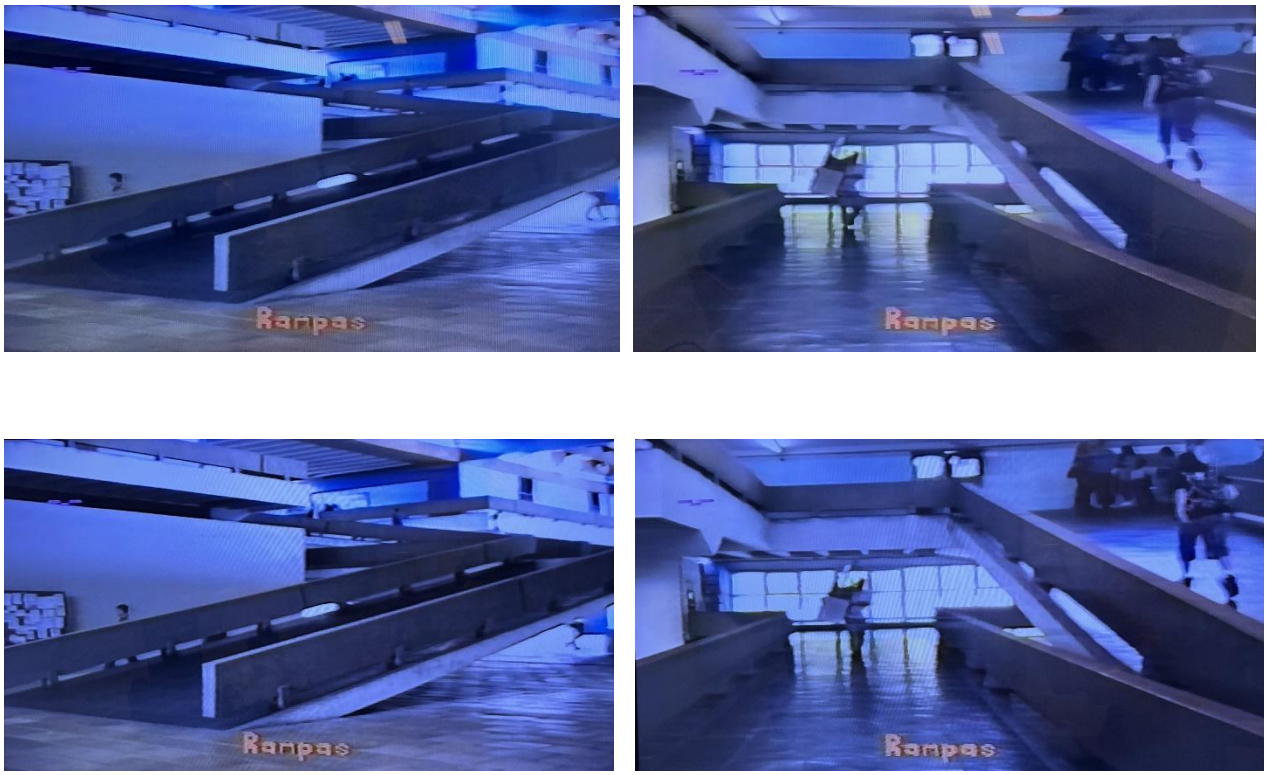

Figure 1: VHS images before (above) and after (below) gamma irradiation treatment.

The lack of observable changes in the visual appearance of the VHS tape underscores the non-destructive nature of the gamma radiation treatment in terms of preserving the tapes' external characteristics. This finding further supports the viability of gamma radiation as an effective disinfection method for mold-contaminated artifacts, as it minimizes potential aesthetic and structural damage.

The integration of mechanical and visual assessments enhances the comprehensiveness of our study, affirming the overall efficacy of gamma radiation in preserving both the mechanical and visual integrity of historical VHS tapes. These combined results contribute valuable insights to the ongoing discourse on innovative

strategies for the preservation of cultural heritage materials.

4. Conclusions

In conclusion, our investigation into the application of gamma radiation for the disinfection of mold-contaminated VHS tapes in historical archives has yielded promising outcomes. the tensile test results, particularly with the inclusion of the biodeteriorated sample, reinforce the positive outcomes of gamma irradiation in both disinfection and mechanical reinforcement. This dual benefit positions gamma radiation as a promising preservation technique for mold-contaminated cultural heritage materials. Future research should delve into specific mechanisms underlying these effects, further refining gamma radiation protocols for optimal outcomes in cultural heritage preservation.

The absence of discernible alterations in the visual appearance of the VHS tape post-treatment underscores the non-destructive nature of gamma radiation. This finding aligns with the preservation of both mechanical and visual integrity, affirming gamma radiation as an effective method for disinfecting mold-contaminated artifacts without inducing adverse secondary effects.

Our study contributes to the evolving field of cultural heritage preservation, highlighting the potential of gamma radiation to safeguard historical materials. The comprehensive analysis of mechanical and visual aspects provides a robust foundation for future preservation strategies.

Looking forward, continued research should delve into refining gamma radiation applications, exploring adaptability to diverse cultural artifacts, and addressing potential long-term effects. Collaborative efforts between preservation experts, scientists, and archivists remain essential for advancing holistic approaches to safeguarding our historical heritage.

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