

ABSTRACT

Fumigation, a form of chemical treatment method, has been widely used to address the problem of biodegradation of fiber-based museum natural textiles. However, the use of toxic chemicals presents not only occupational health hazards, but also challenges in terms of legal restrictions regarding environmental release and waste disposal. Methods that eliminate toxic pollutant release while offering low resource (energy and water) requirements and faster and effective treatment are desirable. This study investigated gamma irradiation as an alternative fungal decontamination method for undyed and naturally-dyed cotton fabrics. An established assessment tool was used to rank the two processes based on specific hazard characteristics, including occupational health and environmental hazards. The effectiveness of gamma irradiation was then evaluated, as well as its performance in terms of protecting the desirable physical qualities of the material, such as breaking strength and color. Fumigation with para-dichlorobenzene was assigned a higher hazard score of 8.1, compared to gamma irradiation, which only scored 5. This proves that irradiation is a more desirable method in terms of the identified hazard characteristics. For the technical assessment, fabric samples inoculated with *Aspergillus niger* were irradiated at increasing doses of gamma radiation from a Co-60 source to determine its radiation sensitivity. The decimal reduction values (D10) for undyed and dyed samples were determined to be 0.21 kilo Gray (kGy) and 0.20 kGy, respectively. D10 is the value, which is sufficient to inactivate 90% of the total count initially obtained. The minimum dose required to decontaminate the textile material with 99.99% efficiency (6-log reduction) are 1.26 kGy (undyed) and 1.20 kGy (dyed). To determine the effects of gamma radiation to strength and color properties, fabric samples were irradiated at doses 0.1 to 25 kGy then subjected to breaking strength and elongation tests and color measurement tests. Physical property testing reveals that cotton fabrics of similar composition and construction as the one used in the study do not undergo significant degradation up to 10 kGy radiation dose. This may be regarded as the maximum dose of irradiation, which is well above the minimum dose required to effectively decontaminate the textile material from *A. niger*. Gamma irradiation with cobalt-60 is an effective decontamination method for cotton fabrics that may be used for museum applications as an alternative to fumigation with para-dichlorobenzene.