Gamma radiation effect on early synthetic dyes

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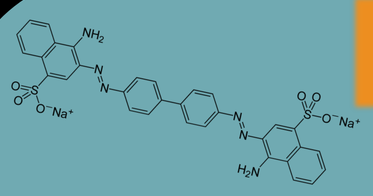
BACKGROUND

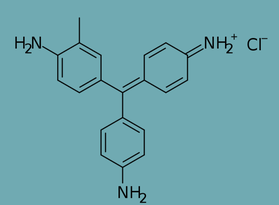
Cultural Heritage's textile objects are constantly under the action of microorganisms, insects, climatic or physical factors. These assaults can determine dyes discoloration and textile degradation which would definitely alter the object preservation and affect its mission as historical witness. Gamma irradiation's fungicide and bactericide effect is known and used for a very long time, being an exceptional disinfection method with very few drawbacks. Its efficiency and efficacy designates it for Cultural Heritage objects, but its application is limited to a maximum dose and dose rate effect on some biopolymers. Concerning the effect of ionizing radiation on dyed textiles, until recently, there was almost no data in literature, references being limited to the mechanical properties of irradiated textiles [1].

GOALS

If the effect of gamma radiation on natural dyes has already been studied and presented at DHA39, the present survey takes into account the investigation of potential changes in early synthetic dyes caused by irradiation and describes its effect on different dyed textiles' experimental models, prepared according to traditional recipes. Such an approach comes as a necessity when considering the demands for gamma irradiation disinfection of 19th-20th c. traditional textiles received by at IFIN-HH, IRASM Facility and the use of early synthetic dyes in these objects. Gamma irradiation experiments were carried out at about 2 kGy/h, having as target doses values from 10 to 25 kGy. Analysis was performed using reversed phase liquid chromatography with UV-Vis detection (RPLC–DAD), followed by a chemometric approach effectuated in order to have a better comprehension of the eventual changes induced by gamma irradiation decontamination processes on dyed historical textiles. Understanding the necessary and maximum degree of gamma sterilization, by identifying and characterizing irradiated synthetic dyes, will provide significant information on a suitable disinfection operation.

SAMPLES & IRRADIATION

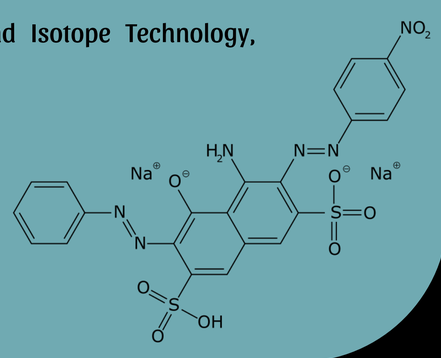




- Powder early synthetic dyes standards: alizarin yellow GG; oramge II sodium salt; congo red; basic fuchsin; naphtol blue black

- 28 early synthetic dyes on wool support -> acid hydrolysis classical extraction (on-going study)

  - Absorbed doses: 10, 15, 20 and 25 kGy; dose rate: 2.1 kGy/h (± 2,4 %)
  - Irradiator: GC-5000 (Board of Radiation and Isotope Technology, India), Co-60 source, cylindrical geometry
    Dosimetric system: ECB C 8485



METHODS

Equipment and experimental parameters:

RPLC-DAD: High-performance liquid chromatograph system from Agilent (USA), type 1260 INFINITY II with a UV-Vis detector (DAD)

Column: Zorbax C18 (150 mm; 4.6 mm i.d.; 5 µm) @ 40 °C

Mobile phase: solvent A: 0.2% (v/v) formic acid aqueous solution; solvent B: 0.2% (v/v) methanol/acetonitrile 1:1 (v/v)

Flow: 0.8 mL/min

Injected volume: 5 µL

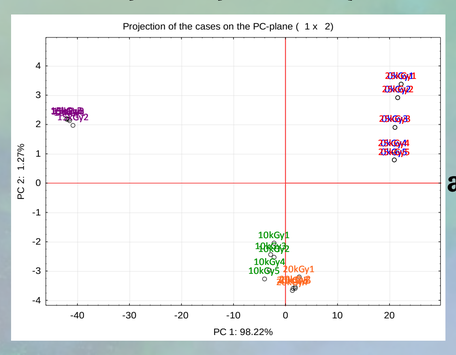
Detector: DAD → λ: 255, 275, 295, 420 and 490 nm

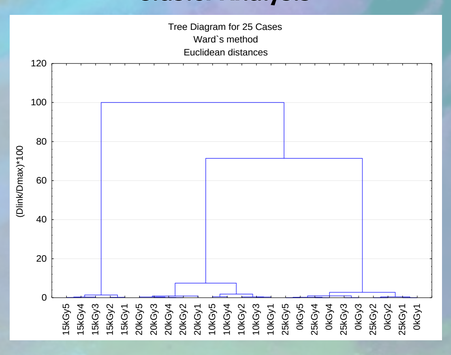
RESULTS AND DISCUSSION

Principal Component Analysis

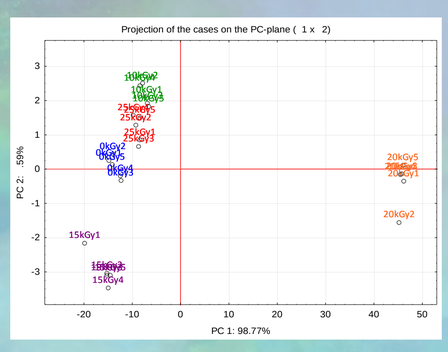
Cluster Analysis

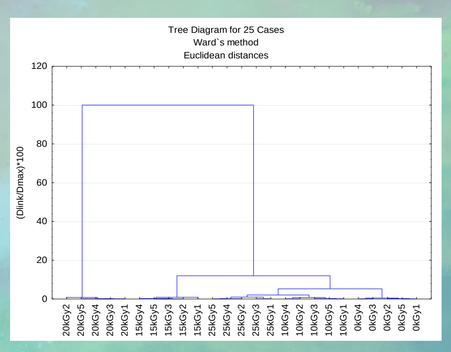
alizarin yellow GG



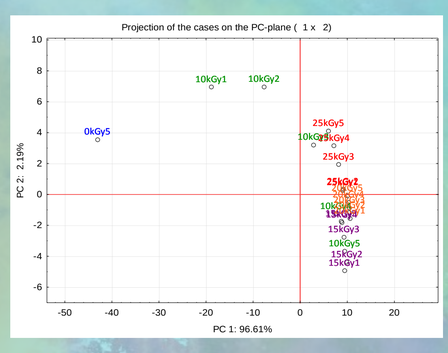


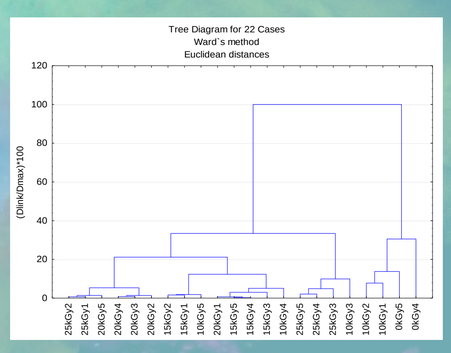
orange II sodium salt



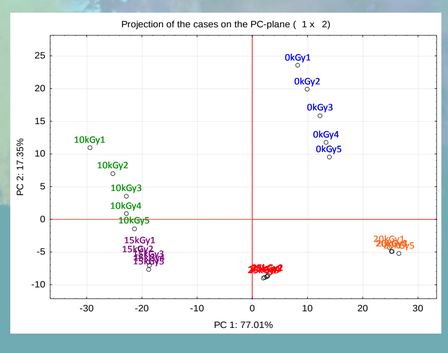


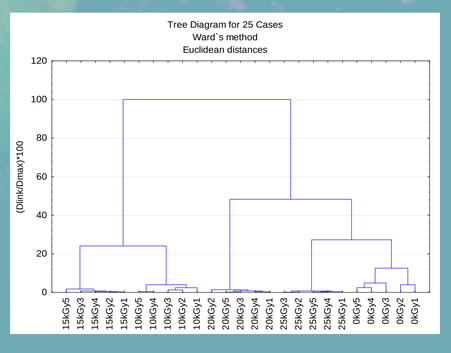
congo red



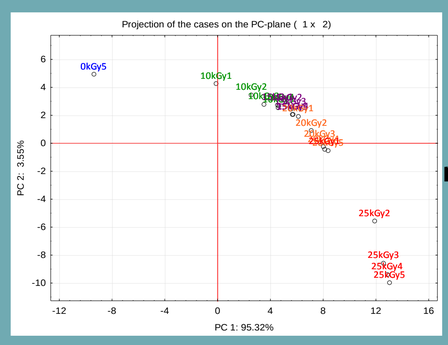


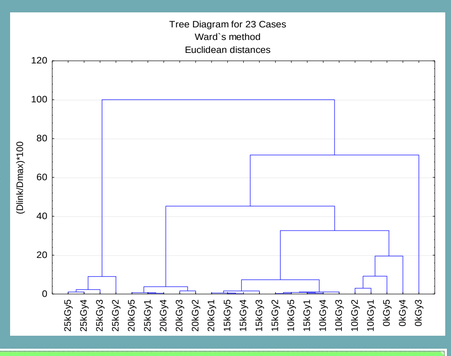
basic fuchsin



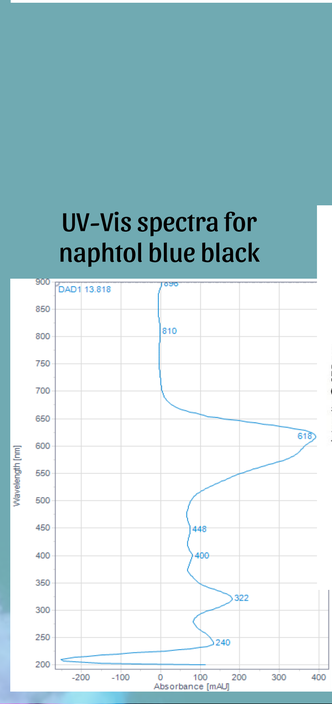


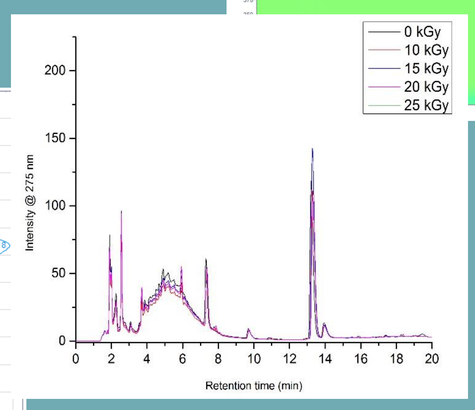
naphtol blue black

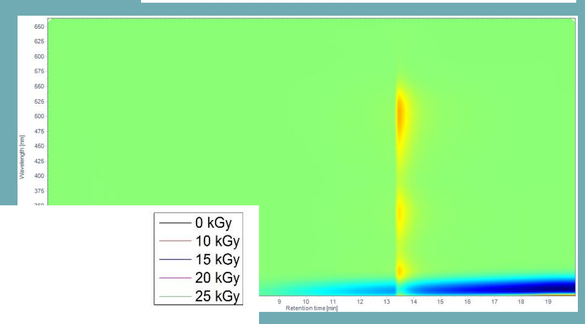




UV-Vis spectra for naphtol blue black







Isoabsorbance plot for congo red

HPLC-DAD chromatograms for alizarin yellow before and after irradiation at different absorbed doses

CONCLUSIONS

Liquid chromatography data and statistical analysis pointed out that before and after irradiation at the 5 absorbed doses, for the tested early synthetic dyes, there is no significant variation proportional to the irradiation dose, proving gamma irradiation is a suitable disinfection method for Cultural Heritage dyed textiles. The only one that showed a dose dependence behavior is naphtol blue black, therefore, a lower irradiation dose is recommended.

References: [1] W. Machnowski, B. Gutarowska, J. Perkowski, H. Wrzosek, *Text. Res. J.*, 2012, 83, 44-55

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