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Poster *1 slides*

γ- RADIATION EFFECTS ON PROPERTIES OF CELLULOSE PULPS

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Introduction

γ-radiation has been used to sterilize packages for food or health products. It is also used to clean documents or arts attacked by fungi. It is known that γ-radiation can affect paper properties in such products [1] as consequence of cellulose damage [2,3].

The well-knowing of the effects of γ-radiation on cellulose is important for the correct application of this technology. On this way, the aim of this study is evaluate and compare the effects of three γ-radiation dose on properties of five different bleached cellulose pulps.

Experimental Section

Table 1. Samples

Test	Method	Sample				
		Cotton 1	Cotton 2	Eucalyptus 1	Eucalyptus 2	Pinus
Degree of polymerization	ABNT NBR IEC 60450:2009	686 (17)	1382 (42)	708 (7)	1073 (21)	833 (2)
Alpha Beta Gamma cellulose	ABNT 14032:2015	-x- -x- -x-	-x- -x- -x-	92.8 (0.1) 5.7 (0.1) 1.5 (0.2)	92.2 (0.1) 5.8 (0.3) 1.9 (0.3)	86.0 (0.1) 7.3 (0.1) 6.7 (0.1)
Ash (525 °C)	ABNT NBR 13999:2003	0.08 ± 0.03	0.07 ± 0.02	0.29 ± 0.01	0.48 ± 0.01	0.28 ± 0.02
Acetone soluble-matter	ABNT NBR 14578:2000	0.06 ± 0.02	0.03 ± 0.05	0.05 ± 0.04	0.01 ± 0.01	0.04 ± 0.06

Table 2. Irradiation and test methods

Test	Method
Irradiation	- Source: ^{60}Co - Irradiation rate: 1.2 kGy/h - Radiation dose: 10 kGy, 25 kGy, 50 kGy
Index of crystallinity (Ic) (X-Ray diffraction) $Ic = \frac{\sum A_{crystallinity}}{\sum A_{total}}$	- Sample: paper sheet 70 g/m² - Kα do cobre (1.54 Å), 40 kV, 20 mA, angular speed: 2°/min, slit: 1° - Four Voigt curves [4]: (101, 10$\bar{1}$, 002) and amorphous - Grams/AI 8.00 (Thermo Electron Co.)
Water retention value (WRV)	ABNT NBR ISO 23714:2008
Thermogravimetric analysis	- Temperature: 25 °C to 900 °C - Temperature rate: 10 °C/min - Nitrogen flux: 30 mL/min; - TA Instruments, model Q50.
Infrared spectroscopy (FTIR)	- Thermo Fisher Scientific, model Nicolet iS10 - Spectral range (4000 – 400) cm^{-1} - Resolution 4 cm^{-1} - Scans 32

Results

- The five cellulose pulps had no visual changes with the three radiation dose.
- The viscosimetric molecular weight (M_n) of cellulose pulps (**Figure 1**) show a exponential decrease with the dose radiation.
- The loss of M_n (initial M_n – M_n (50 kGy)) has a linear dependence on initial M_n (**Figure 2**), i.e., higher the initial M_n more affected by γ-radiation is the pulp.

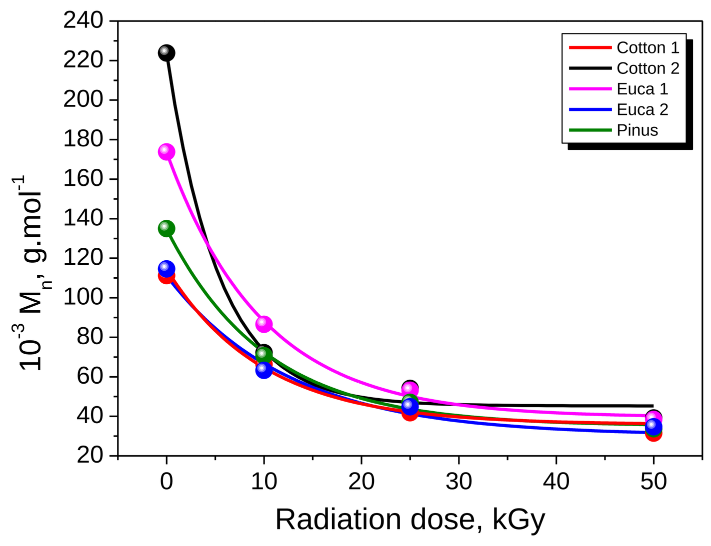

Figure 1. Molecular weight (M_n) x radiation dose

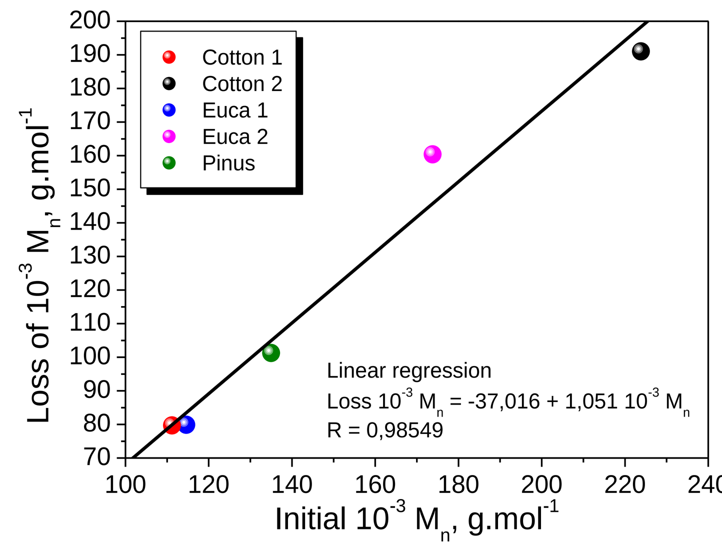

Figure 2. Loss of M_n x initial M_n

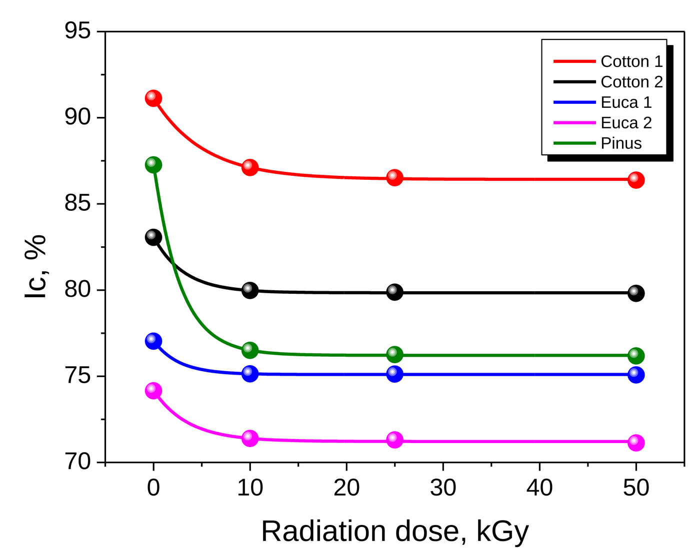

Figure 3. Index of crystallinity (Ic) x radiation dose

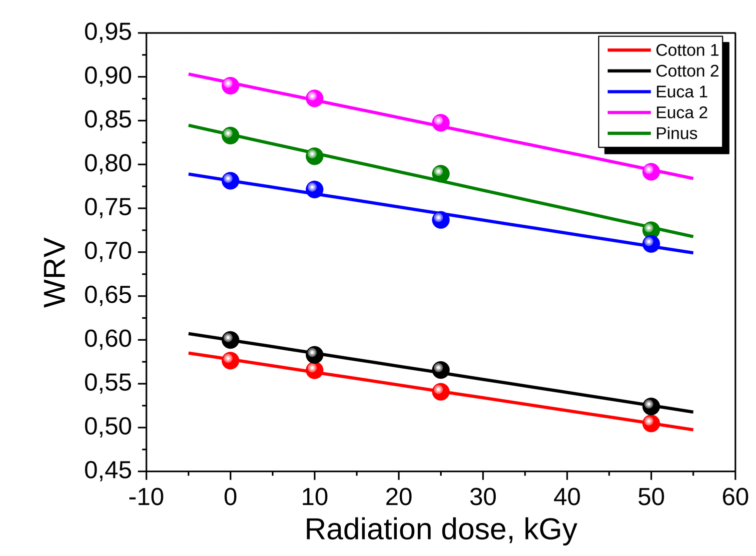

Figure 4. Water retention value (WRV) x radiation dose

- The index of crystallinity (Ic) of five cellulose pulps is affected by γ-radiation even at low radiation dose (**Figure 3**). The exponential decay is in agreement with the Khan et al. results [5].
- The water retention value (WRV) of five cellulose pulps have a linear dependence on radiation dose (**Figure 4**).
- The Pinus cellulose pulp had Ic and WRV most affected by γ-radiation, probably due to its higher β-cellulose and γ-cellulose content (**Table 1**).

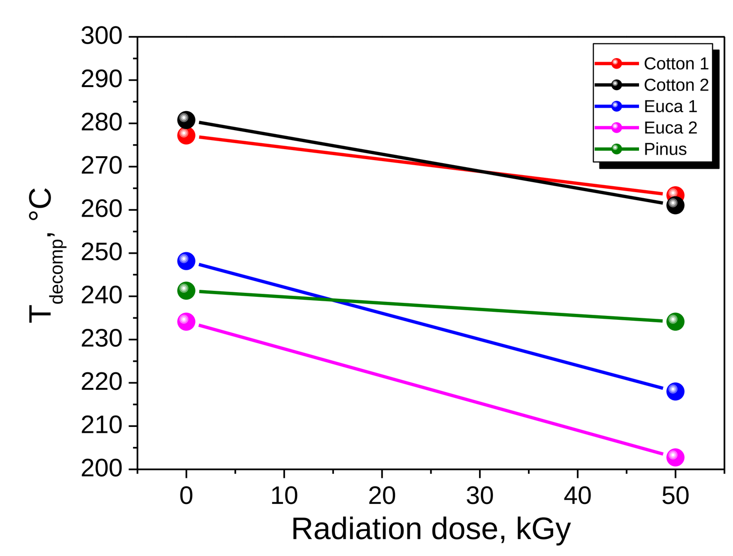

Figure 5. Temperature of decomposition x radiation dose

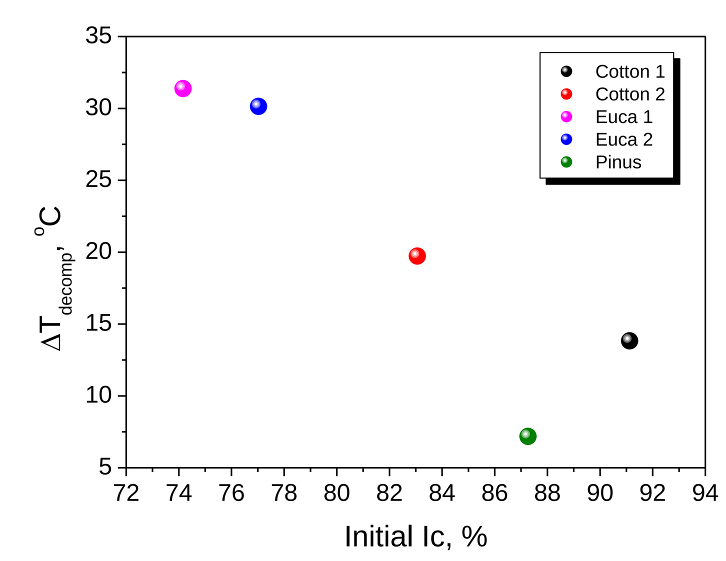

Figure 6. Variation of temperature of decomposition x initial index of crystallinity

- The temperature of decomposition decrease after irradiation with 50 kGy (**Figure 5**). Eucalyptus pulps are the most affected and Pinus pulp is the less affected.
- **Figure 6** shows that the variation of T_{decomp} has a dependence on initial index of crystallinity.
- FTIR spectra of cellulose pulps before and after irradiation with 50 kGy do not show significant differences, indicating few modification on chemical structure of the polymer.

Conclusions

γ-radiation can affect bleached cellulose pulps even when low doses of radiation are employed. The initial composition of the cellulose pulp influences the effects of radiation, the higher the beta cellulose content and sensitive gamma radiation and pulp. Results of index of crystallinity and WRV suggest that degradation occurs, preferentially, in the amorphous phase since both decrease with increasing of radiation dose.

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