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EFFECT OF DEW RETTING OF DIFFERENT HARVESTING PERIODS ON THE HEMP FIBERS QUALITY

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ABSTRACT

This work assesses the impact of dew-retting duration (up to 9 weeks) on hemp fibers properties (color, chemical composition, mechanical performance, volatile organic compounds (VOCs) emissions). Different harvesting periods were compared (beginning and end of flowering and seed periods). Results show a change of color, an evolution in chemical composition with a decrease in the pectins and hemicellulose contents, an increase in cellulose contents, different behaviors in mechanical properties and evolution in VOCs nature and amounts. The retting duration differs as more than 9 weeks are required for fibers sampled during flowering while only 3 weeks are needed for fibers in seed period.

INTRODUCTION

Hemp fibers are increasingly used as reinforcements in polymeric materials (forming biocomposites) due to their challenging performances (low-density, renewability, good specific mechanical properties and biodegradability) compared to conventional fibers such as glass fibers. The hemp fibers are issued from the upstream processing termed retting. This treatment allows a subsequent fiber separation from the plant stems by a partial pectin degradation by microorganisms (Ribeiro et al. 2015). This operation is currently very empirically carried out in the fields, so that a large variability in the fibers quality (mechanical properties, color, morphology, chemical composition...) is resulting. This variability hinders the biocomposites introduction in some competitive industries such as automotive. Furthermore, if controlled, dew retting could be favorable to good properties of hemp fibers.

The mechanical performance of natural fiber depends on the chemical composition and fiber diameter (Duval et al. 2011) which are linked to the harvesting period and the retting duration. For this reason, dew-retting of hemp fibers obtained from different harvesting periods (beginning, end of flowering and seed maturity) were performed to understand the variation of mechanical properties in relation to chemical composition, color, morphological features and VOCs emissions during growth and dew-retting.

The aim of this present work is then to characterize hemp fibers of each weekly stems sampling during dew-retting. The fibers were characterized using multiple experimental techniques: biochemical (gravimetric) analysis, spectrophotometric measurements (pectins content), thermogravimetric, morphological analysis, mechanical testings and VOCs analysis.

RESULTS AND CONCLUSIONS

Variations in hemp fibers color versus retting time for different harvesting periods (beginning and end of flowering and seed maturity) are shown in Table 1. The color varies between light green for unretted fibers, yellow for low retted fibers and dark grey for highly retted fibers.

Retting time (week)	R0	R1	R2	R3	R4	R5	R6	R7	R9
Beginning of flowering									
End of flowering									
Seed maturity									

Table 1: Color changes of hemp fibers. From unretted fibers on the left to retted fibers on the right

Fibers need 9 weeks to be grey while 3 weeks only are required to obtain the same color in the seed period. This color change could be due to the development of microbial communities at the stems surface. It was given in evidence that the retting degree is linked to the weather conditions that were also recorded.

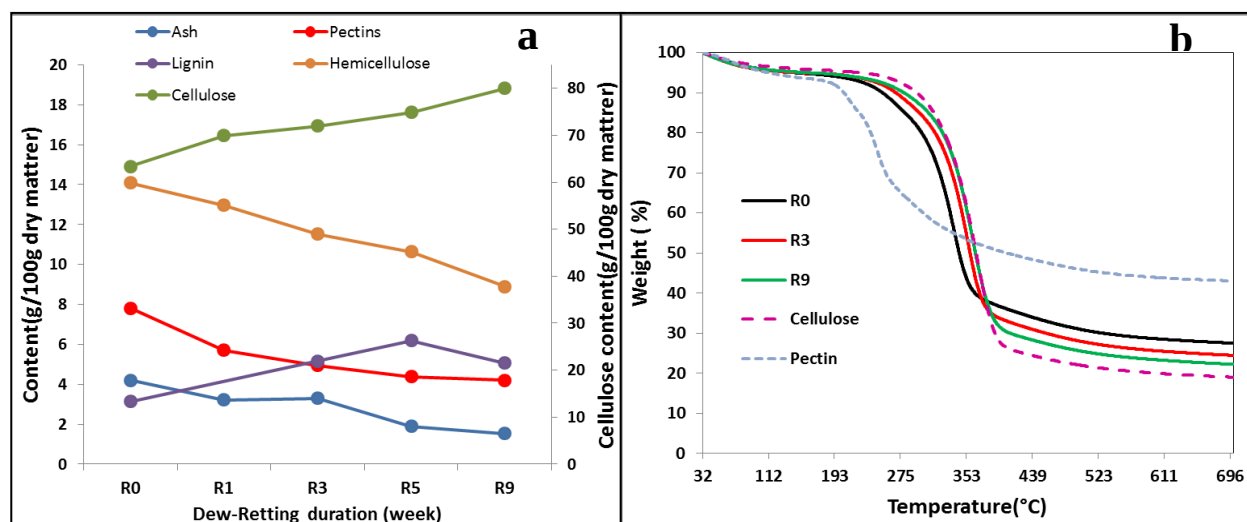


Figure 1 : Evolution of the biochemical content of fibers at the beginning of flowering A) Hemp fibers content variation using solvent extraction. B) Mass loss of hemp fibers content during dew-retting by thermogravimetry.

Figure 2a exhibits the evolution of chemical composition (based on solvent extraction) of hemp fibers cut at the beginning of flowering and retted. The cellulose content increases more than 15% during retting. Pectins, hemicellulose and ash content slightly decrease and then remain stable. Thermogravimetric analysis (Figure 1b) corroborates previous observations. Pectins and hemicellulose are degraded that leads to the increase of cellulose content. This result explains the increase of weight loss at 200-400°C with retting duration.

This study shows that there are differences in color, chemical composition and VOCs emissions of the hemp fibers during retting for flowering period but also in mechanical properties.

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