FLOWER

Flax composites, LOW weight, End of life and Recycling

Deliverable n°3.2.2

TECHNICL REPORT ON FIBRE SELECTION FOR THE MANUFACTURE OF THE REINFORCEMENTS

03/2019

PP LEADER INRA

Interreg

France (Channel Manche) England

EUROPEAN UNION

European Regional Development Fund

Partners

PP Leader: INRA

Partners involved: UBS

Content

❖ Material:

Three different batches of scutched long flax fibres grown in 2017-2018 in Normandy were provided by our partner DEPESTELE, coming from the TEILLAGE VANDECANDELAERE (Figure 1).The first batch (n°7458) is a Bolchoï variety considered of good quality. Batch n°6489 is a Marylin type of lower quality. The last batch (n°2425) is a Drakkar variety which was under-retted.

Figure 1: Optical pictures of the material provided by DEPESTELE

❖ Biochemical analysis:

Biochemical analysis was performed at INRA in order to determine the monosaccharides composition of the different batches using Gas Phase Chromatography (GPC). The results are presented in Figure 2.

The major monosaccharide in the flax batches is glucose, when expressed as the dry matter content. With nearly 75% of the Dry matter, and nearly 80% of the total monosaccharides, glucose from the three batches seems slightly under represented in the batch 6489 "Meagre". The glucose is often consider as the cellulose content of the bast fibres, like the flax ones. The flax batches 7458 and 2425 are not significantly different in monosaccharides content, even if slightly upper values in arabinose and xylose could be highlighted in the under-retted flax batche (2425).

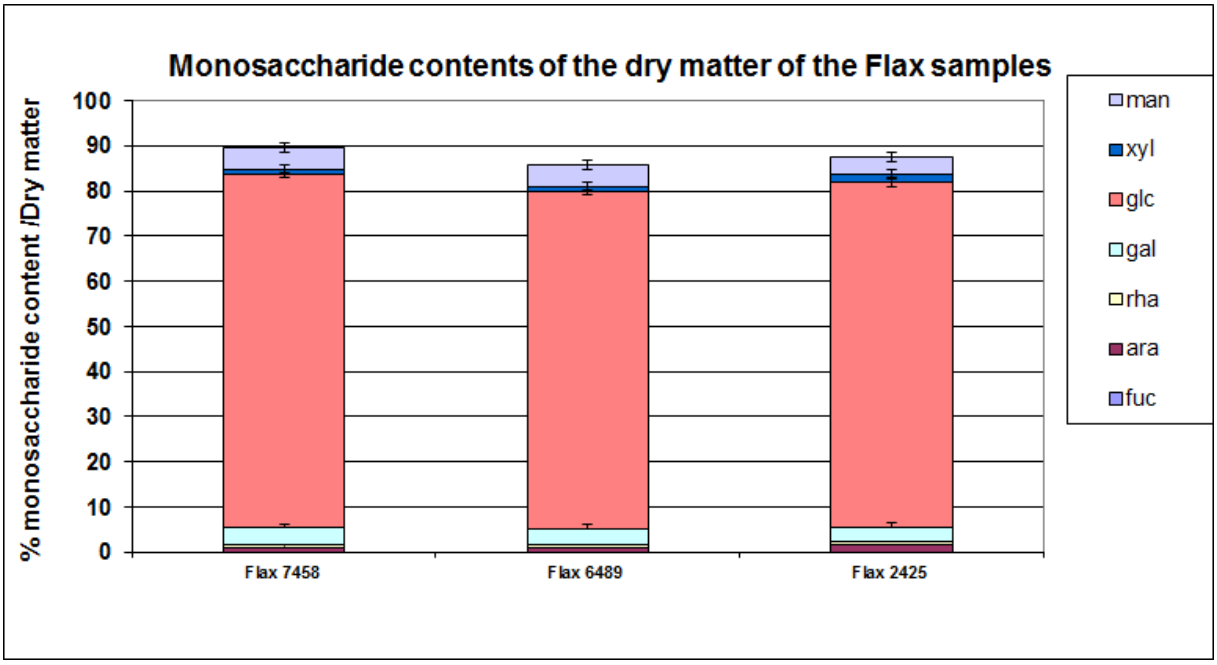

Figure 2: Monosaccharide contents of the different flax batches

❖ Mechanical characterization

Tensile testing of unitary fibres was conducted at UBS - Lorient on a MTS tensile testing machine with a load cell of 2N, following the standard AFNOR NFT 25-704.
Characteristics stress-strain curves of the three different batches are presented in Figure 3. The average (σ) and standard deviation (sd) of the diameters, Young's modulus, strains at break and strengths are summarized in Table 1. The "meagre" batch (n°6489) presented a significantly lower Young's modulus, strength and strain at break. No differences were observed between the high quality (n°7458) and under-retted (n°2425) flax. Our assumption is that under-retting impacts predominantly the middle lamella, which is removed at the scale of the unitary fibre. A study at the bundle scale could therefore be of interest to investigate the impact of under-retting.

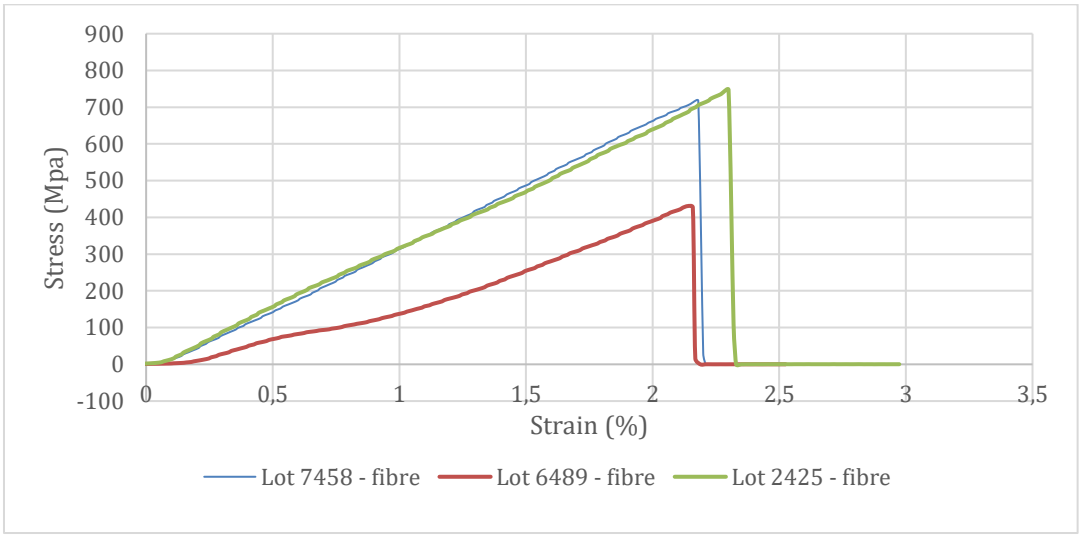

Figure 3: Stress-strain curves of the three different batches

Table 1: Mechanical properties of the unitary fibres of the three different batches

Batch	Number of samples		Diameter	E fibres	Strain at break	Strength
			µm	Gpa	%	Mpa
N°7458 (High quality)	27	σ	16.2	41.1	1.96	671
		Sd	2.77	10.97	1.18	255
N°6489 (Low quality)	41	σ	23.4	37.2	1.68	495
		Sd	4.32	8.86	0.72	226
N°2425 (Under-retted)	11	σ	18.2	40.4	2.1	671
		sd	3.03	17.24	0.53	301

σ is the average value ; sd is the standard deviation.

- Electron Microscopy for Imaging

Cross-sectional observations of several bundles of each batch were performed using Scanning Electron Microscopy (SEM) in a low vacuum mode. The samples were included in an acrylic resin and cut in slices of 1.5 µm in thickness. An important variability in terms of fibre geometry was observed among the same batch and no differences could be raised between the batches.

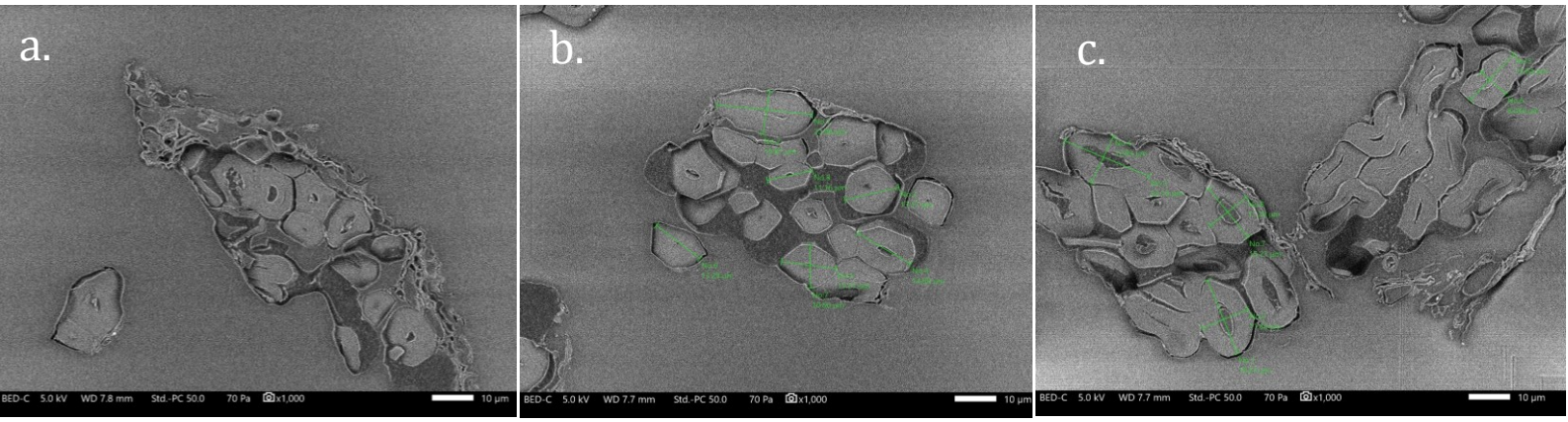

Figure 4: Cross-sectional observations of batches n°7458 (a), n°6489 (b) and n°2425 (c)

- Fineness:

The fineness of the different batches was assessed by morphological analysis using Qicpic equipment. The fibres were cut in a few mm long particules and dispersed in water. The

geometry of millions of particules was analysed, leading to statistical results summarized in

Figure 5. In agreement with the diameter observations made by optical microscopy before tensile testing (Table 1), the diameter of the batch n°6489 (lower quality) is superior to the other batches at a cumulative distribution of 50%. Further investigations will be conducted to explain the origin of the diameter difference.

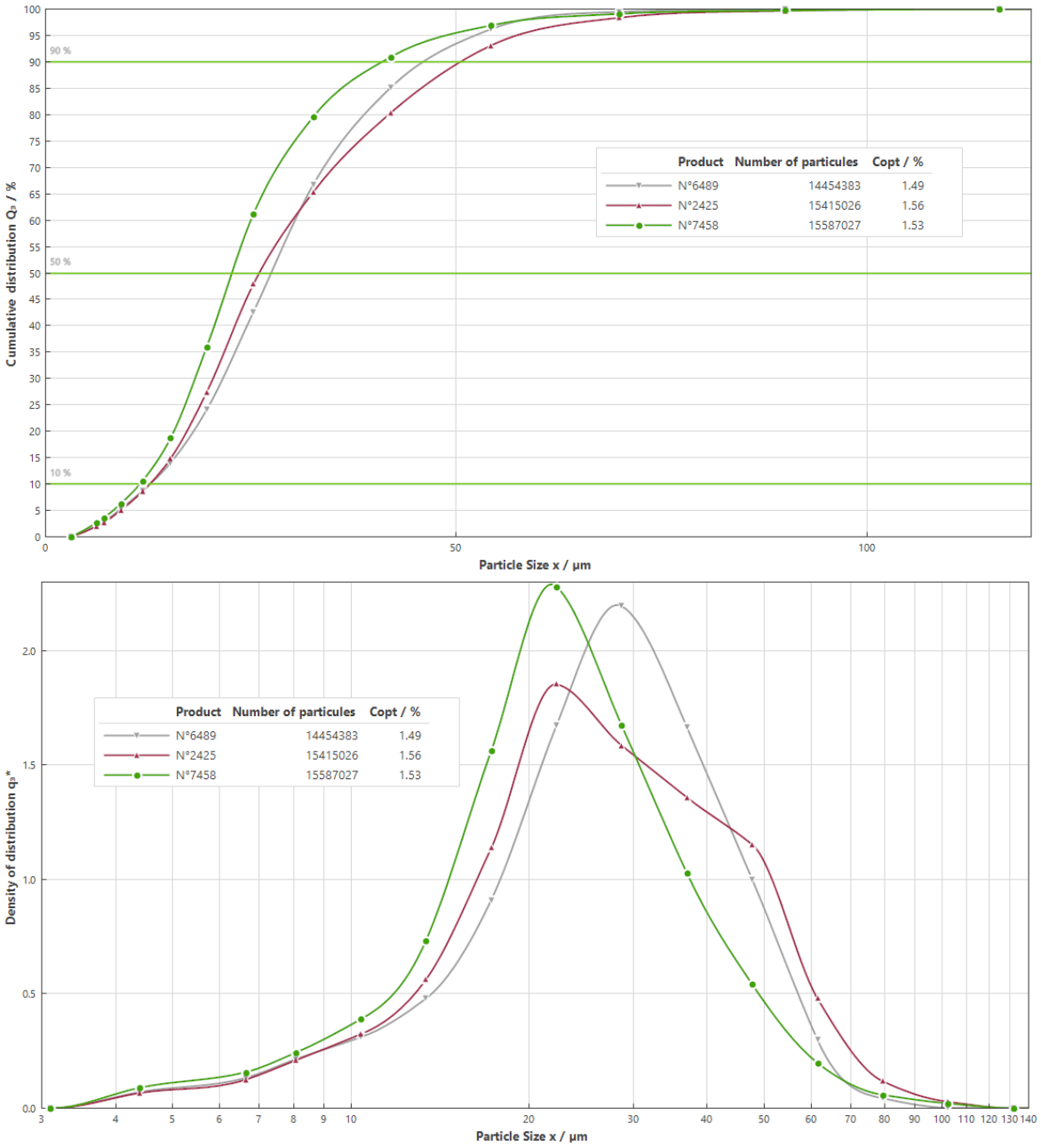

Figure 5: Cumulative distribution (upper) and density of distribution (lower) of the diameters of the fibres

NEXT STEPS

- Quantification of the defects present in the different batches
- Investigations of the mechanical properties at the bundle scale
- Assessment of the rupture behaviour