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cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST FP1205
Innovative applications of regenerated wood cellulose fibres

Towards lignonanofibers competitive production from the technical and economical point of view

H. Oliver-Ortega, M. Delgado-Aguilar, Q. Tarrés, N. Pellicer and P. Mutjé

Cellulosic material Properties and industrial potential
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Outline

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Industrial wastes as raw material to CNF production

Paper production requires large amounts of cellulosic fiber, whereas the world's forested lands and croplands have a finite capacity to supply such resources [...]. The industry can be expected to view recycling as a central part of its activities. Basis weights of various paper-based products can be expected to decrease over the coming decades, and more of the fiber content will be replaced with fillers such as calcium carbonate. Such trends will place intense demands upon chemical-based strategies to enhance bonding [...] reducing the amount of new forest resources.

M. A. Hubbe, 2014

Hubbe, M. A. (2014). *BioResources*, *9*(1), 1634-1763.

Industrial wastes as raw material to CNF production

- Pine sawdust has been used as a raw material for CNF production. However, usually a pretreatment like TEMPO oxidation was performed.

- The TEMPO oxidation pretreatment is expensive

Cost (€/kg)	T5	T10	T15
Chemicals	1,63	2,37	3,11
Energy	2,88	1,19	0,73
Total	4,51	3,56	3,84

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Industrial wastes as raw material to CNF production

The objective is the production of CNF of pine sawdust with low cost and good mechanical performance

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Lignocellulosic nanofibres mechanically produced

Mechanical CNF

Pine Sawdust
- Industrial waste

Milling
- 1mm
- Chemical compostion of pine sawdust

Digestion
- 25% NaOH , 180°C, 90min
- 0,1% Anthraquinone

Mechanical defibration
- Sprout Waldron
- Morphologic analysis

Bleaching
- 8% NaClO, 70°C
- 3 different times: 0min (P1), 30min (P2) and 60min (P3)
- Chemical composition

LCNF production
- Mazuko grinder
- LCNF characterization

Performance test
- Virgin fibres and brown line paper
- °SR and Breaking length

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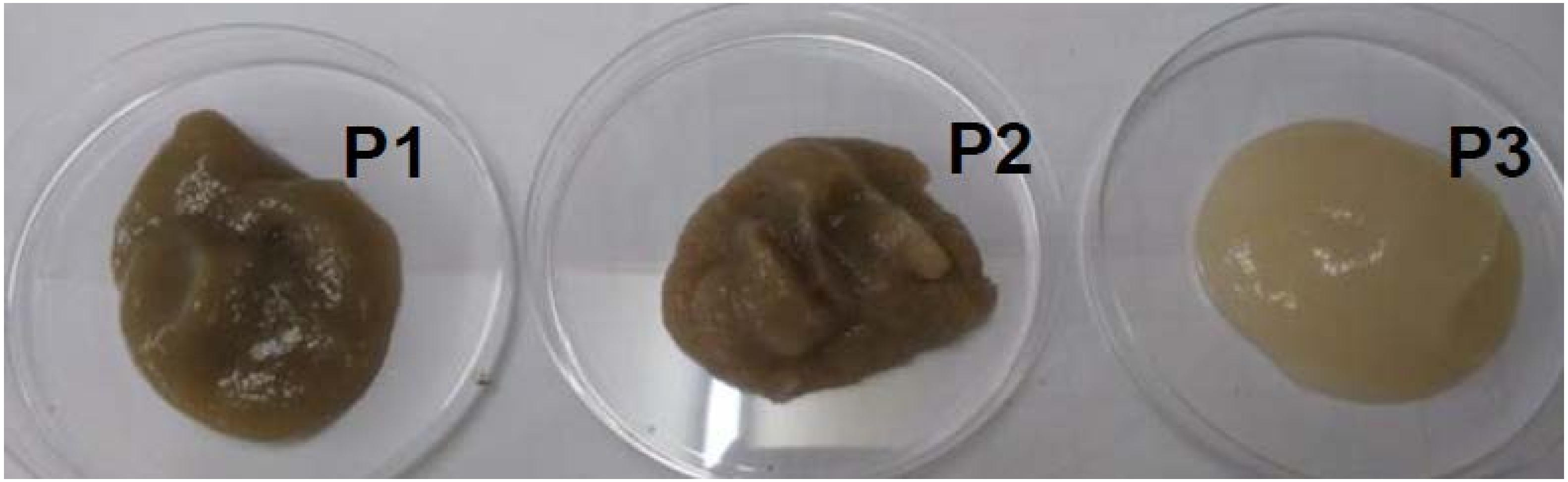
Chemical composition

Sample	Kappa Number	Extractives (%)	Lignin (%)	Hemicellulose (%)	Cellulose (%)
Pine Sawdust	88	2.04	30.60	12.3	55.06
P1	25	0.80	14.67	5.89	78.64
P2	17	0.57	6.58	5.47	87.11
P3	14	0.37	4.67	4.55	90.4

LCNF characterization



Sample	Kappa Number	Yield of nanofibrillation (%)	Cationic demand (µeq/g)	Carboxyl content (µeq/g)	Specific surface (m^2/g)	Estimated diameter (nm)
P1	25	17,71	180,87	46,44	65,5	40
P2	17	19,46	185,27	46,44	67,6	39
P3	14	18,17	188,82	46,44	69,3	38

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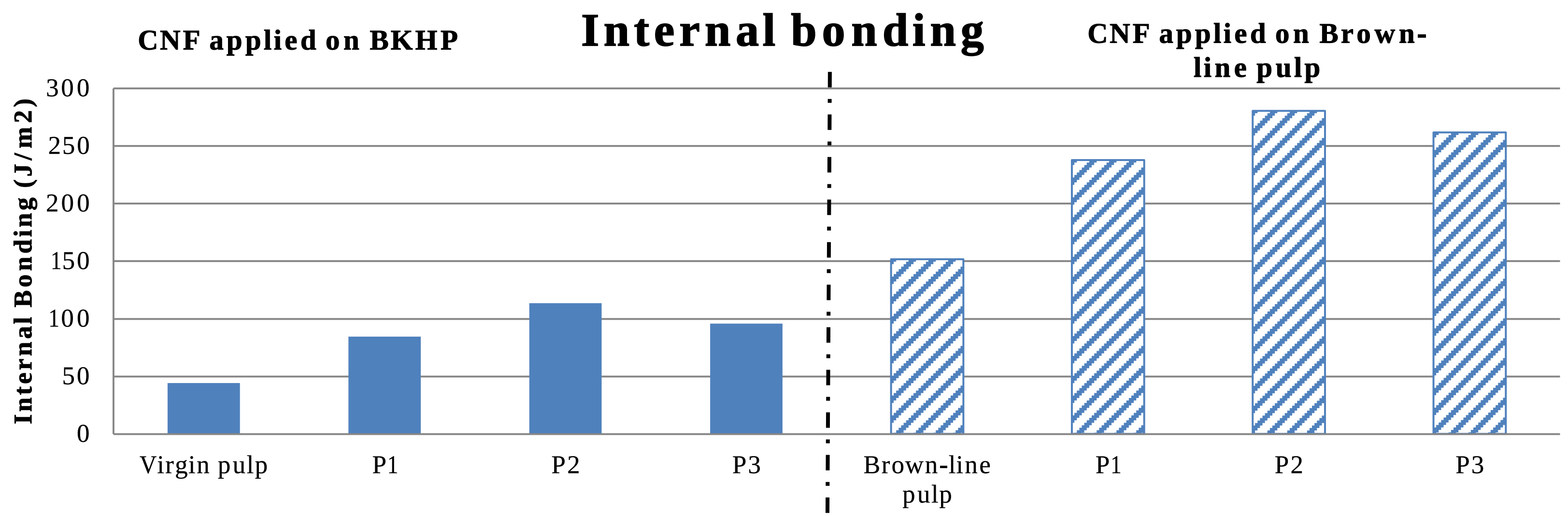
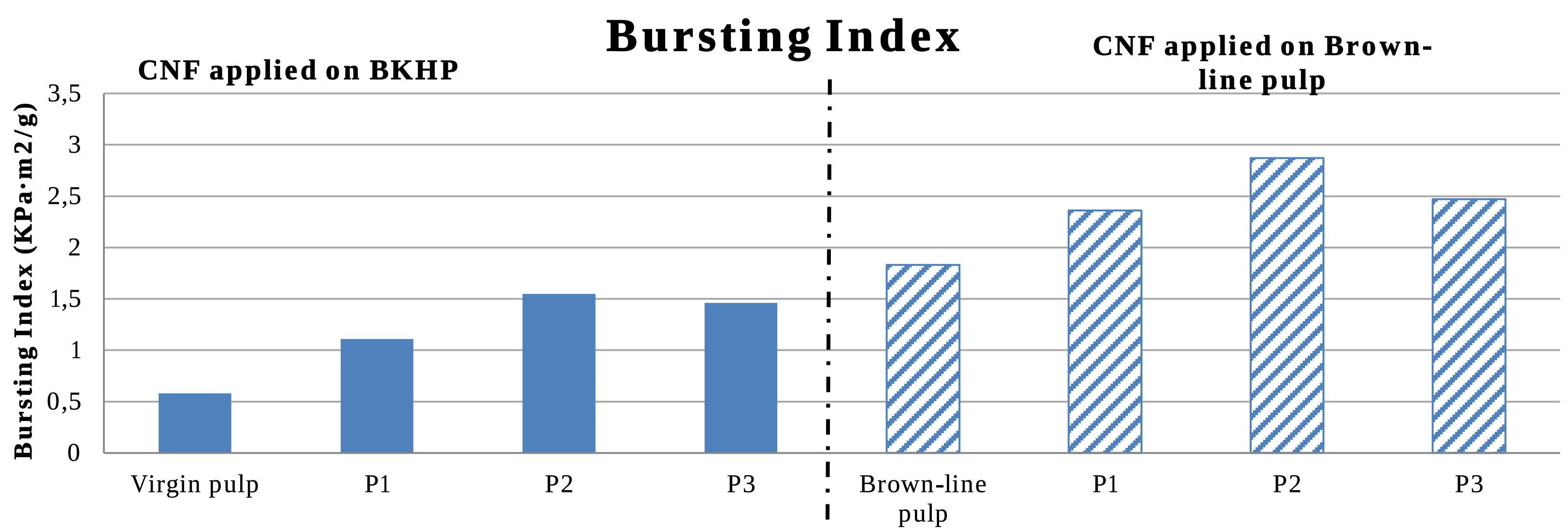
Mechanical Performance

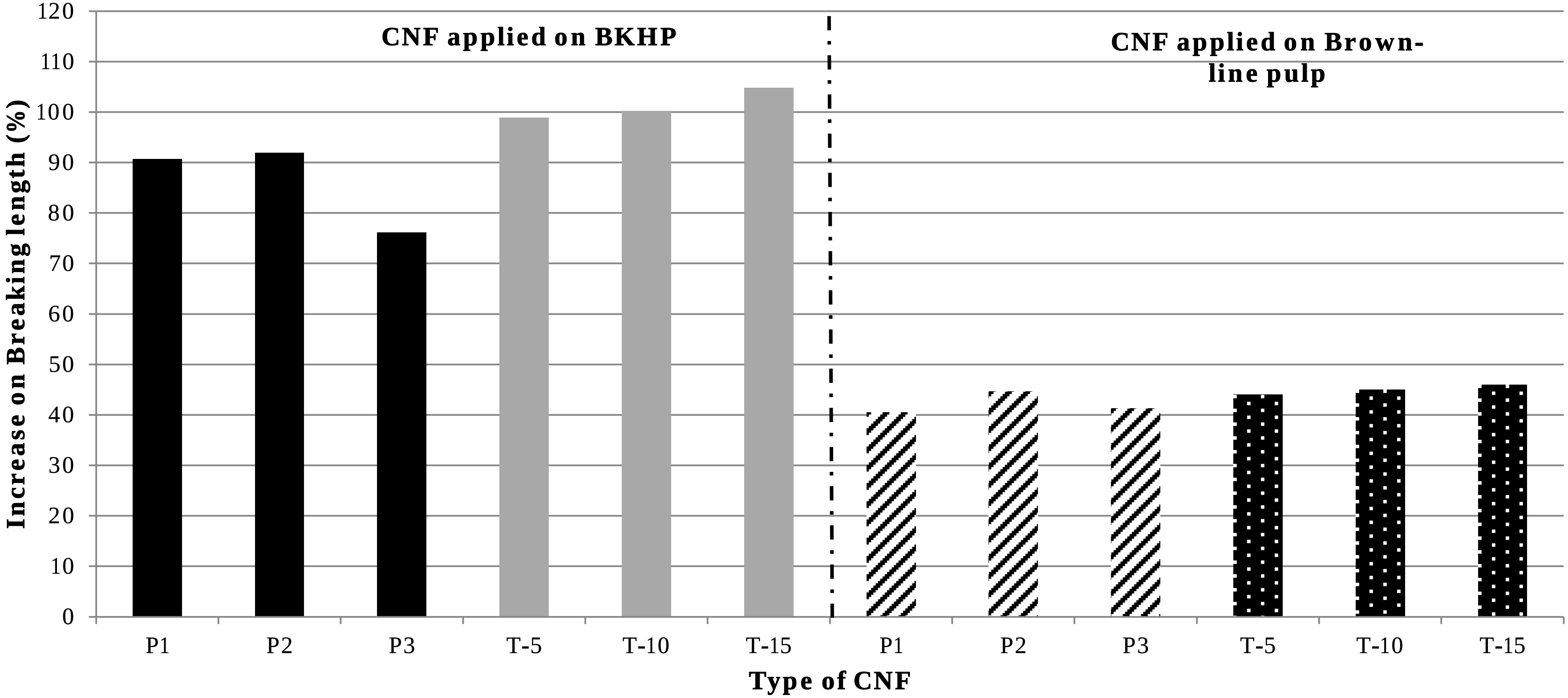
Pulp suspension	LCNF	°SR	Breaking Length (m)	ΔBreaking length (%)	Internal Bonding (J/m2)	Bursting index (Kpa·m2/g)
Virgin pulp	-	18	1701	-	44,4	0,58
	P1 (KN 25)	23	3244	90,71	84,6	1,11
	P2 (KN 17)	25	3265	91,94	113,6	1,55
	P3 (KN 14)	24	2997	76,19	95,8	1,46
Brown-line pulp	-	35	3338	-	151,6	1,83
	P1 (KN 25)	41	4690	40,50	237,7	2,36
	P2 (KN 17)	44	4828	44,63	280,4	2,87
	P3 (KN14)	45	4715	41,25	261,7	2,47

Mechanical Performance





Mechanical CNF Performance



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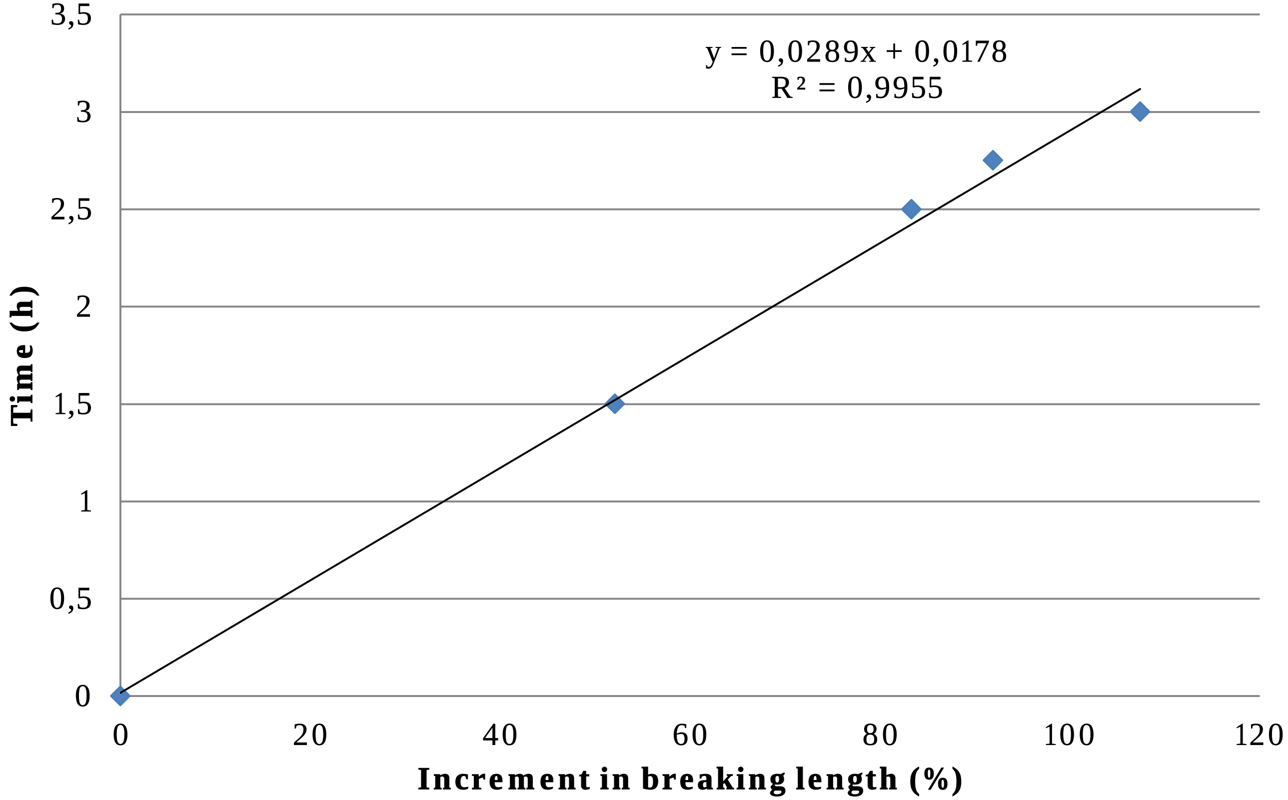
Mechanical CNF Performance

Pulp suspension	LCNF	ºSR
Virgin pulp	-	18
	P1	23
	P2	25
	P3	24
Brown-line pulp	-	35
	P1	41
	P2	44
	P3	45

Pulp suspension	LCNF	ºSR
Virgin pulp	-	18
	T5	27
	T10	29
	T15	29
Brown-line pulp	-	35
	T5	52
	T10	53
	T15	54

Mazuko time



Price: 2,21 kW·h/ kg

Production cost:

0,18€ /kg of LCNF for 2,75h

0,20€/ kg of LCNF for 3h

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CONCLUSIONS

- Mechanical LCNF with different lignin contents were produced and applied in Virgin pulp and Brown-line pulp satisfactory

- The CNF characterizartion shown a lineal increase of the surface and a decresion of the CNF diameter when lignin content decreases. However, the maximum nanofibrillation yield was obtained with a 6% of lignin (KN 17)

- The higher mechanical performance was obtained with P2 CNF (KN 17).

- To obtain the same perfomance than TEMPO oxidazed CNF, 15min more are required in the Mazuko grinder, increasing the price 0,02€/kg.

Future challenges

- Use of termomechanical treatment instead to a chemical treatment to reduce the cost and waste for the LCNF production.

- Use of enzymatic hydrolysis pretreatment to facilitate the mechanical desestructuration

Thanks you for your kindly attention!

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