

# Date palm rachis as a source of cellulose fibres for papermaking applications



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## Objective

Important quantities of date palm rachis accumulated every year in Tunisia. The rational valorisation of these available renewable resources fits very well with the recent sustainable approach, established nowadays. This work aims at ascertaining the chemical composition of this agricultural residue and testing the cooking conditions leading to pulp production for papermaking. The resulting pulps were then refined using a PFI mill refiner at 0, 500, 1500 and 3000 revolutions. The disintegrated and refined pulps were then screened through a sieve of 0.15 mm mesh size and used to produce conventional handsheets. The resulting samples were fully characterised in terms of physical properties, according to commonly used standards. The physical properties of the prepared materials were close to those displayed by other common papermaking furnishes. The obtained pulps and papers combine good drainability with excellent mechanical properties. Thus, date palm rachis can be considered as potential source of fibres for papermaking application.

## Current work

### Introduction

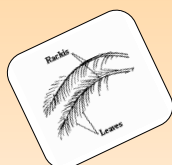
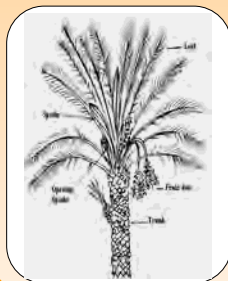
In recent years, pulp production has continuously increased, mainly because of a drastic increase of paper consumption in emerging countries. In this context, many research works devoted to the study of new raw materials leading to the preparation of cellulosic fibres have been reported, particularly those dealing with various agricultural crops and residues.

Date palm rachis is one of the most cultivated plants in Tunisia with more than 4 millions palms occupying about 32 thousands ha, as reported from the Tunisian Ministry of Agriculture statistics. This culture produces a huge amount of date palm rachis, which is left to biodegrade and to fertilise the agricultural lands.

### Material & Methods

#### Chemical composition of date palm rachis

The chemical composition of date palm rachis was established in terms of the amount of extractive substances in different liquids (1% sodium hydroxide and ethanol-toluene), ashes, Klason lignin, holocellulose and  $\alpha$ -cellulose, using the standard methods, as listed in Table 1.



Figures of date palm tree and rachis

### Pulping conditions

The pulping of date palm rachis was carried out according to a procedure derived from that described by Khristova et al.(2005)



- Total alkali charge: 20 g of NaOH to 100 g of raw material (o.d)
- Liquor to solid ratio: 10
- Anthraquinone concentrations (w/w with respect to o.d. material): 0.1%
- Cooking time at constant temperature: 120 min
- T= 165°C

### Paper properties

ISO 5269-2 standard



The pulp was refined in a PFI mill refiner according to

ISO 5264-2:2002 standards



SR - ISO 5267-1 standard

## Results & Discussion

Table 1. Chemical composition of date palm rachis

	Content (%)	Standard
Ethanol - toluene solubility	6.30	T 204 cm-07
Klason lignin	27.2	T 222 om -06
Ash	5.0	T 211 om-07
Holocellulose	74.8	Wise et al., 1946
$\alpha$ -cellulose	45.0	T 203 cm-99
Hot water solubility	8.10	T 207 cm-08
1% sodium hydroxide solubility	20.8	T 212 om-07
Cold water solubility	5.0	T 207 cm-08

Table 2. Screening yield, drainability and WRV for refined pulps.

PFI revolutions	Screening yield (%)	<sup>1</sup> Drainability (°SR)	<sup>2</sup> WRV (g/100g)
0	94	14	138
500	96	20.5	164
1500	99	26.2	175
3000	100	51.5	197

<sup>1</sup> The pulp drainability was evaluated by measuring the Shopper Riegler degree (°SR - ISO 5267-1)

<sup>2</sup> Water Retention Value (WRV) was determined by centrifugation of wet samples of pulp, during 15 min at 3000g.

### Evolution of the burst and tear indexes, as a function of the Shopper Riegler degree

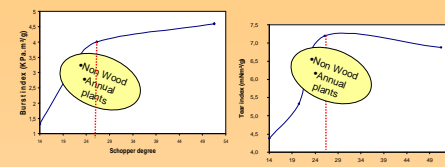


Table 3. Mechanical properties of date palm rachis based papers

PFI revolutions	0	500	1500	3000
Shopper degree (°SR)	14	20.5	26.2	51.5
Elongation (%)	1.09	1.84	2.79	3.07
Breaking Length (km)	3.13	5.87	6.92	7.81
Young modulus (GPa)	2.5	3.6	4.4	5.3
Zero-Span breaking length (dry)(km)	13.4	13.8	14.2	14.6
Zero-Span breaking length (wet) (km)	10.8	11.1	11.2	11.3
Internal bond strength (J/m <sup>2</sup> )	94.5	305	566	1010
Short-Span Compression Test (kN/m)	1.32	1.55	1.84	2.26

• Drainability remains point good until 1500 PFI revolutions.

• Date palm rachis based papers are characterised by very good physical properties.

• Increasing refining level improves all the properties.

• Zero-span breaking length values reveal that intrinsic strength of the fibres is high.

## Conclusion & Perspectives

This study shows that:

- Date palm rachis contains enough polysaccharides to justify its cooking.
- The obtained pulps showed promising properties, both in terms of paper quality and papermaking process (drainability).
- Date palms rachis can be considered as a possible alternative source of cellulosic fibres for papermaking.

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