



# Latest results and overview

Work Package 5: Utilisation of kenaf for  
industrial products and energy.

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# Content

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- Overview
  - fibre decortication (separation)
  - fibre quality
  - insulation mats
  - kenaf core absorbers
  - kenaf fibre/PP composites
- Extra tests of kenaf mats under high humidity
- SEM pictures of kenaf

# Market and techno-economic feasibility study

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- Separation only worthwhile if both fractions can be sold.
- Application of separated kenaf bast fibre in insulation.
- Application of kenaf core as absorber.

# Affected kenaf stems

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Unaffected FAIR project



Affected BIOKENAF  
project



# Fibre decortication

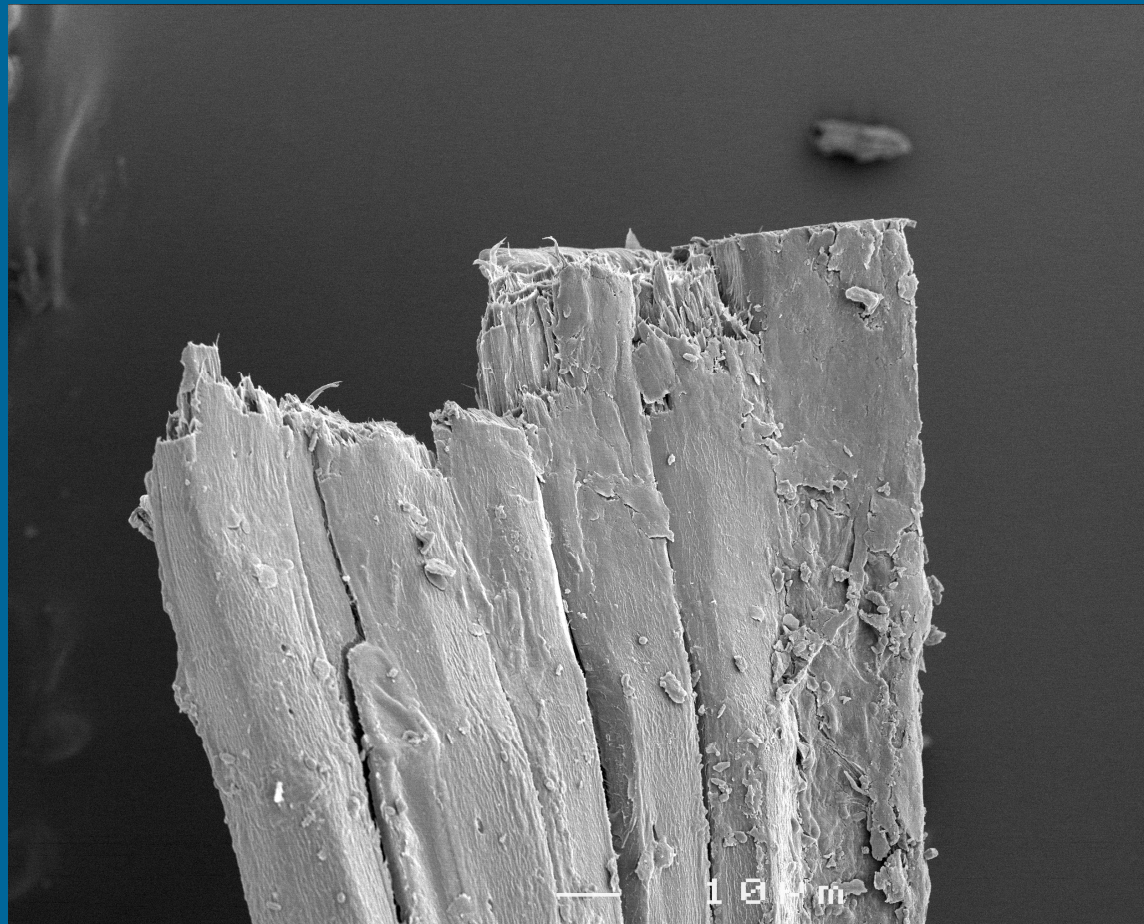
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- Easy Separation no extra retting necessary
- Still 11% of core particles present in the fibre fraction

# Tensile fracture of a kenaf fibres

Material	Tensile strength (MPa)	St.dev	n
<i>Kenaf</i>			
FAIR retted	556 – 682		
FAIR green decorticated	276 - 435		
→ CETA fibres	343 - 486		
Uni Catania fibres	425	41	3
Uni Nova fibres	374	69	3
Uni Nova fibres retted	462	88	5
Flax	500-880		
Hemp	400-750		
Jute	351-468		
Sisal	650		

# Tensile fracture of a kenaf fibre bundle



# Insulation mats

## Coefficient of thermal conductivity

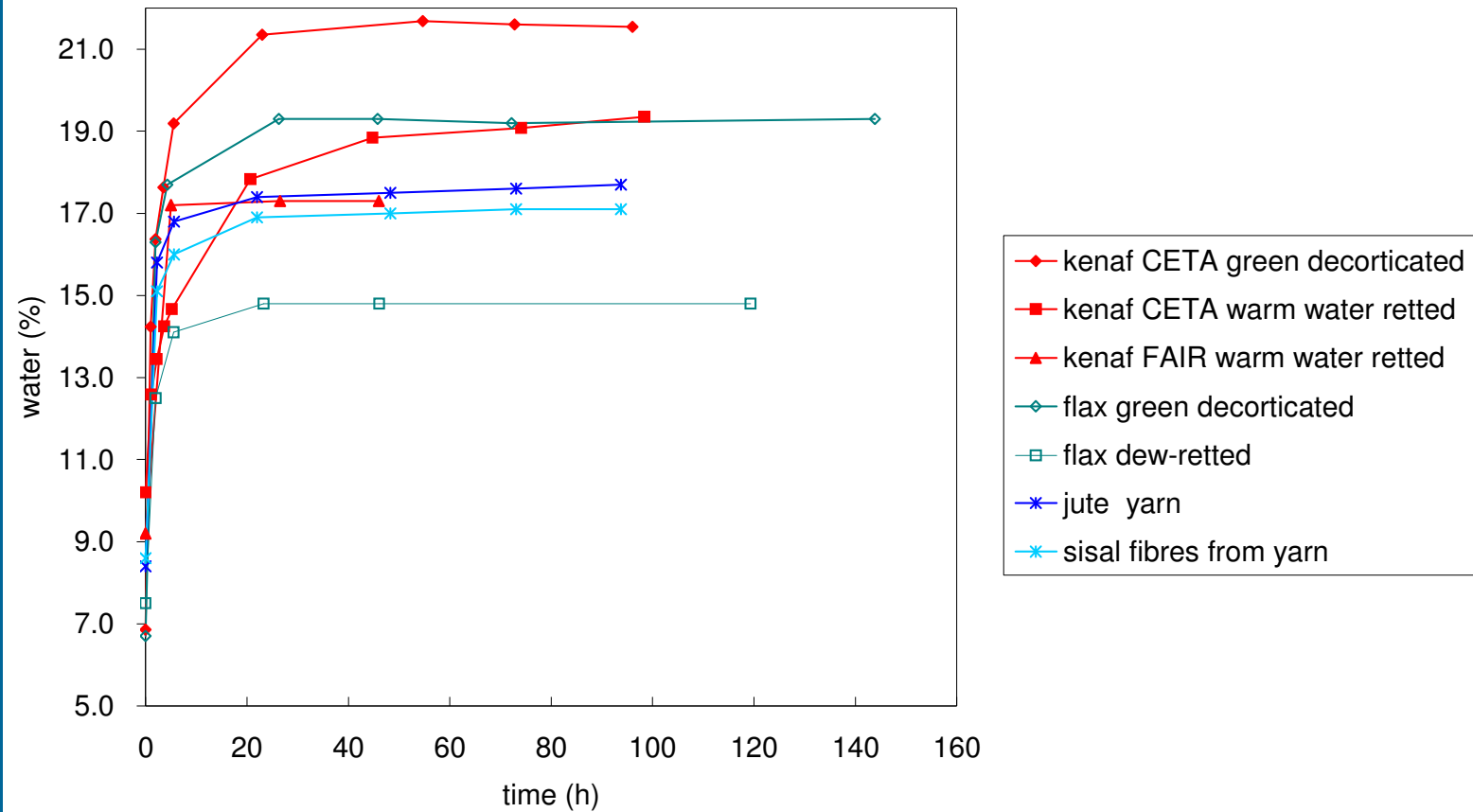
Sample	Company	Thermal conductivity [W.m <sup>-1</sup> .K <sup>-1</sup> ]	Remarks
Kenaf	KEFI	0.043	Biokenaf measurements NEN-EN 12667
ISOVLAS PL	ISOVLAS	0.041	Biokenaf measurements NEN-EN 12667
ISOLKENAF	KEFI	0.039	Info website ISO 8302/91
Spouwplaat 433	ROCKWOOL	0.036	Info website NEN-EN 12667
Sonepanel	ISOVER	0.038	Info website

# Insulation mats

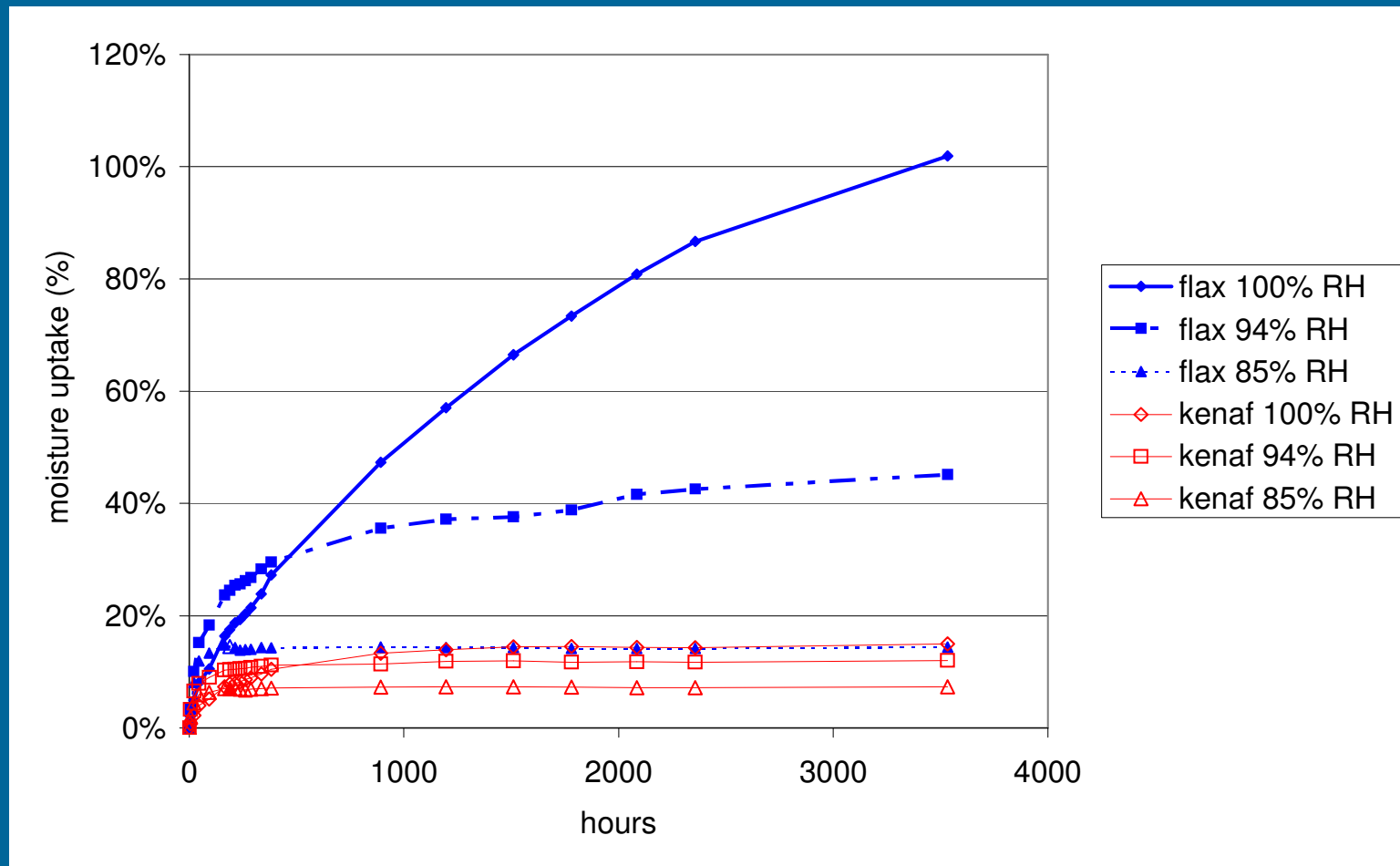
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- Kenaf mats showed 10-15% lower than given values for mineral mats
- With less core particles left in the fibres lower values comparable to the measured flax mats are expected.

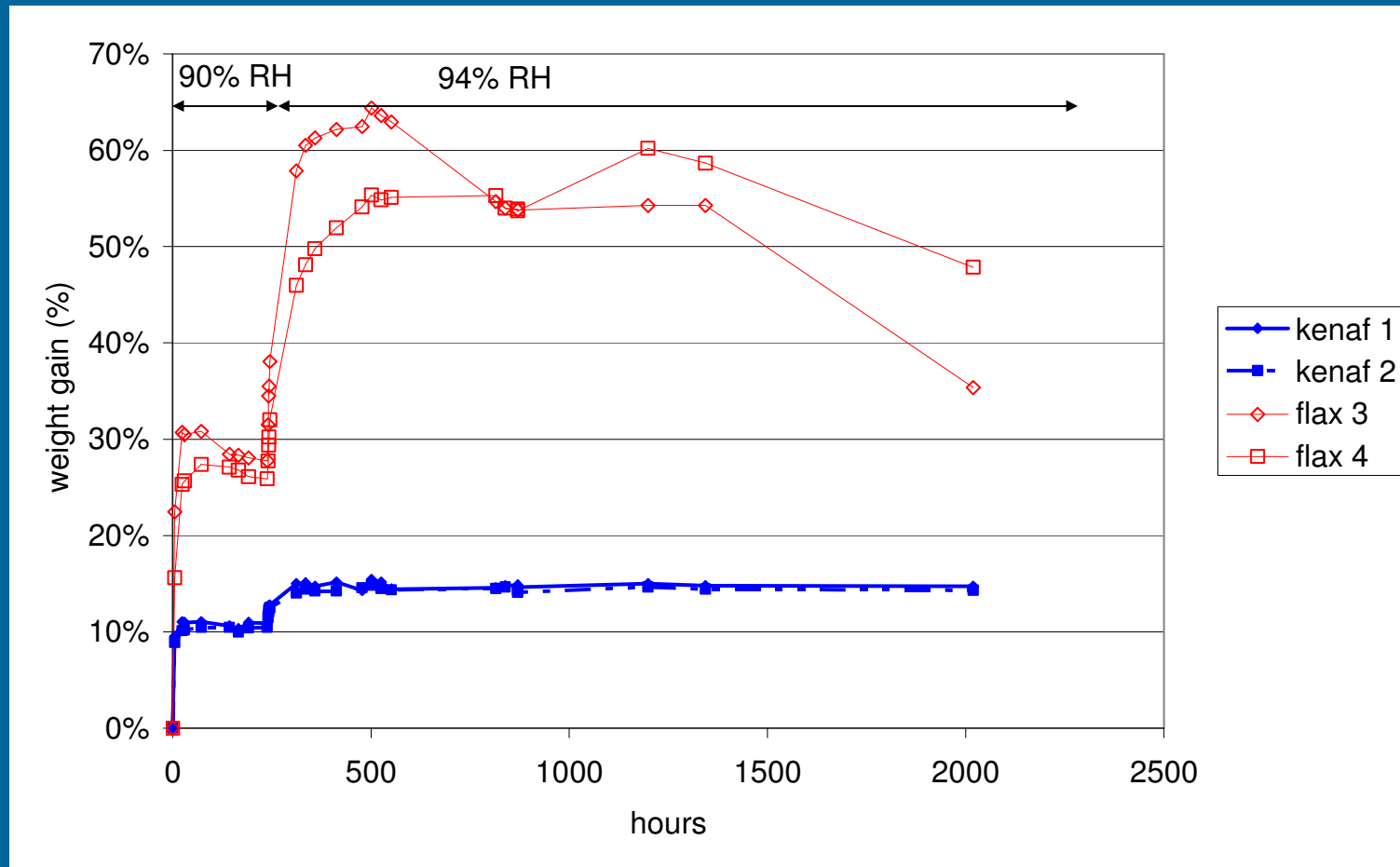
# Moisture absorption of natural fibres



# Moisture uptake of insulation mats under semi- aerobic conditions

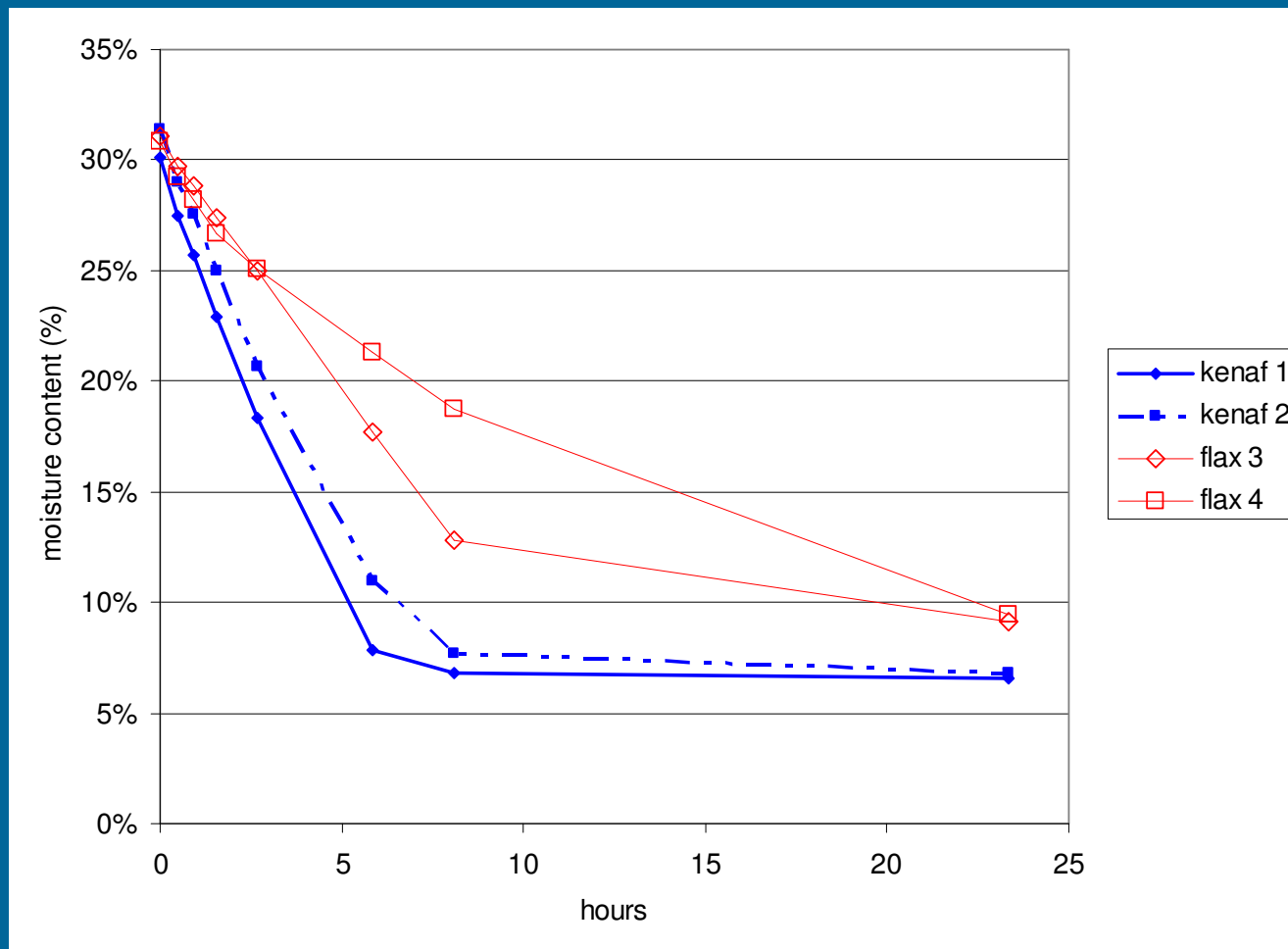


# Moisture absorption insulation mats under aerobic humid conditions

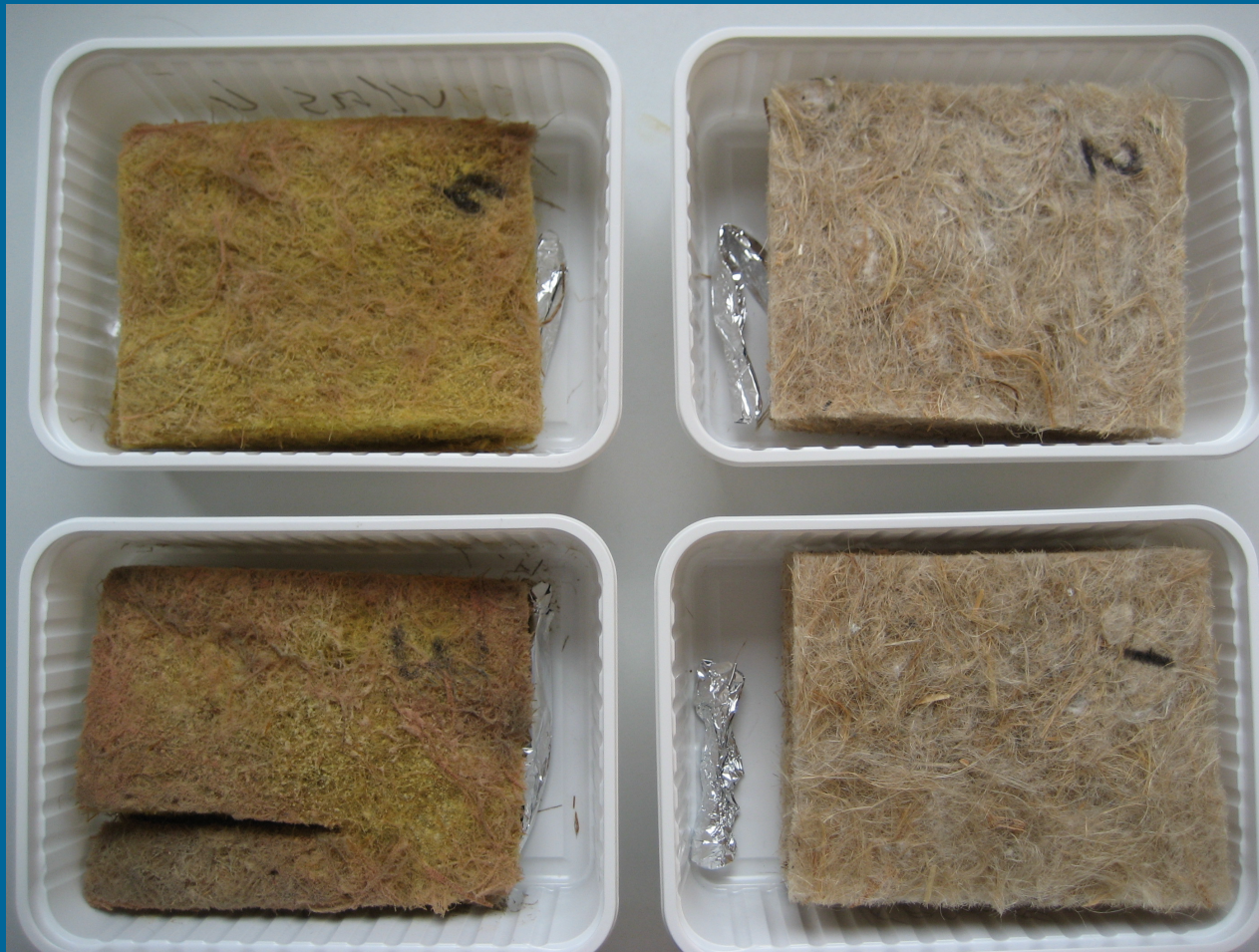




# Moisture desorption of locally wetted insulation mats at 23 °C and 30% Relative Humidity



# Moisture absorption insulation mats under aerobic humid conditions



# Moisture absorption of fibre mats

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- Kenaf mats show no visible microbial degradation at 94% RH and 23 °C and have a low moisture uptake.
- Flax mats with fire retardants show high water uptake in humid air and microbial degradation.
- After wetting kenaf mats show faster evaporation than flax mats with fire retardants.

# Moisture absorption of fibre mats

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- Use of fire retardants with kenaf mats will also increase moisture uptake.
- Good ventilation is a prerequisite

# Conclusions - fibres

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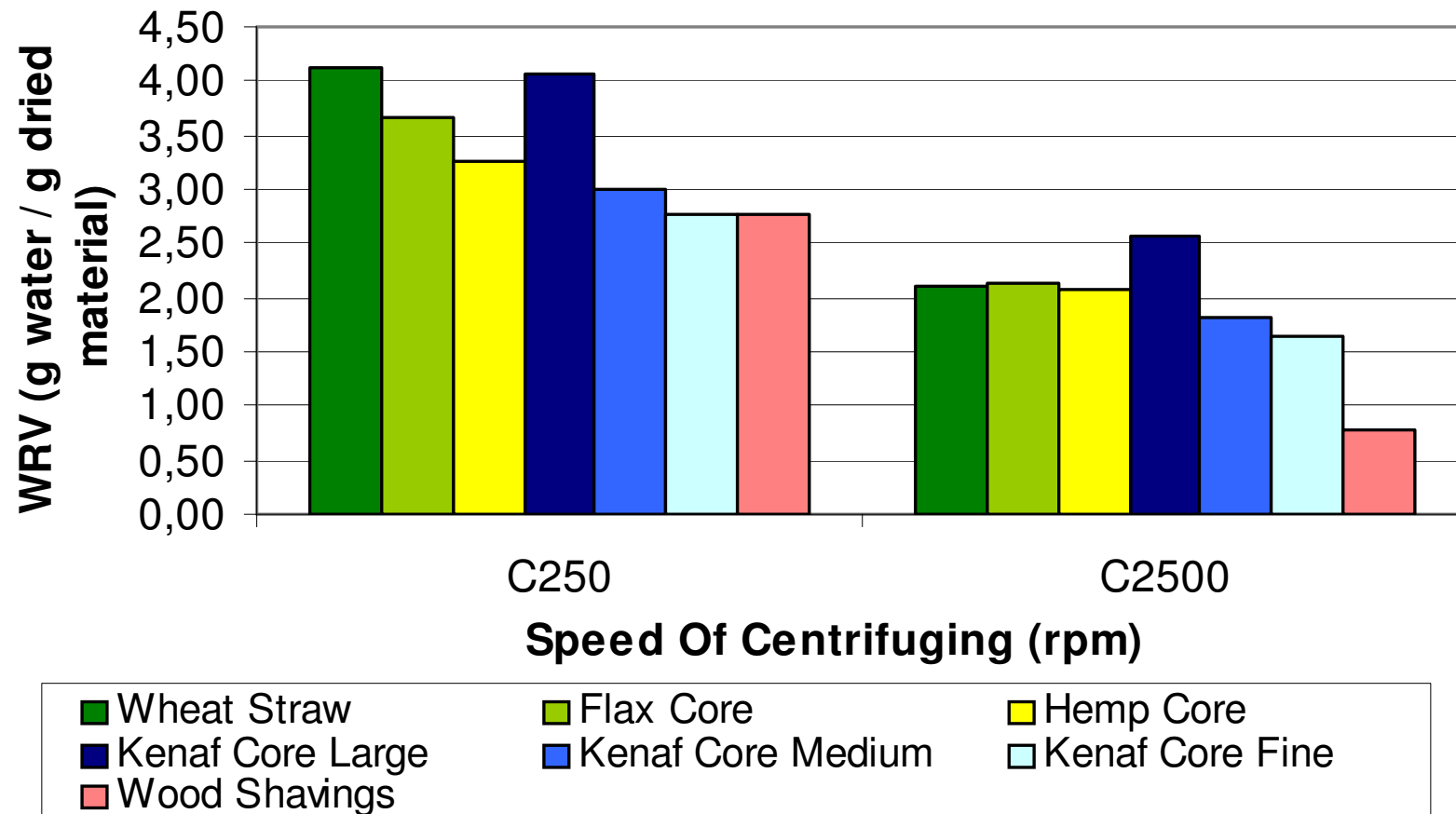
- Easy fibre extraction
- weakened fibres - 60% of maximum
- Weakened fibres can be used insulation mats

# Fibre Quality

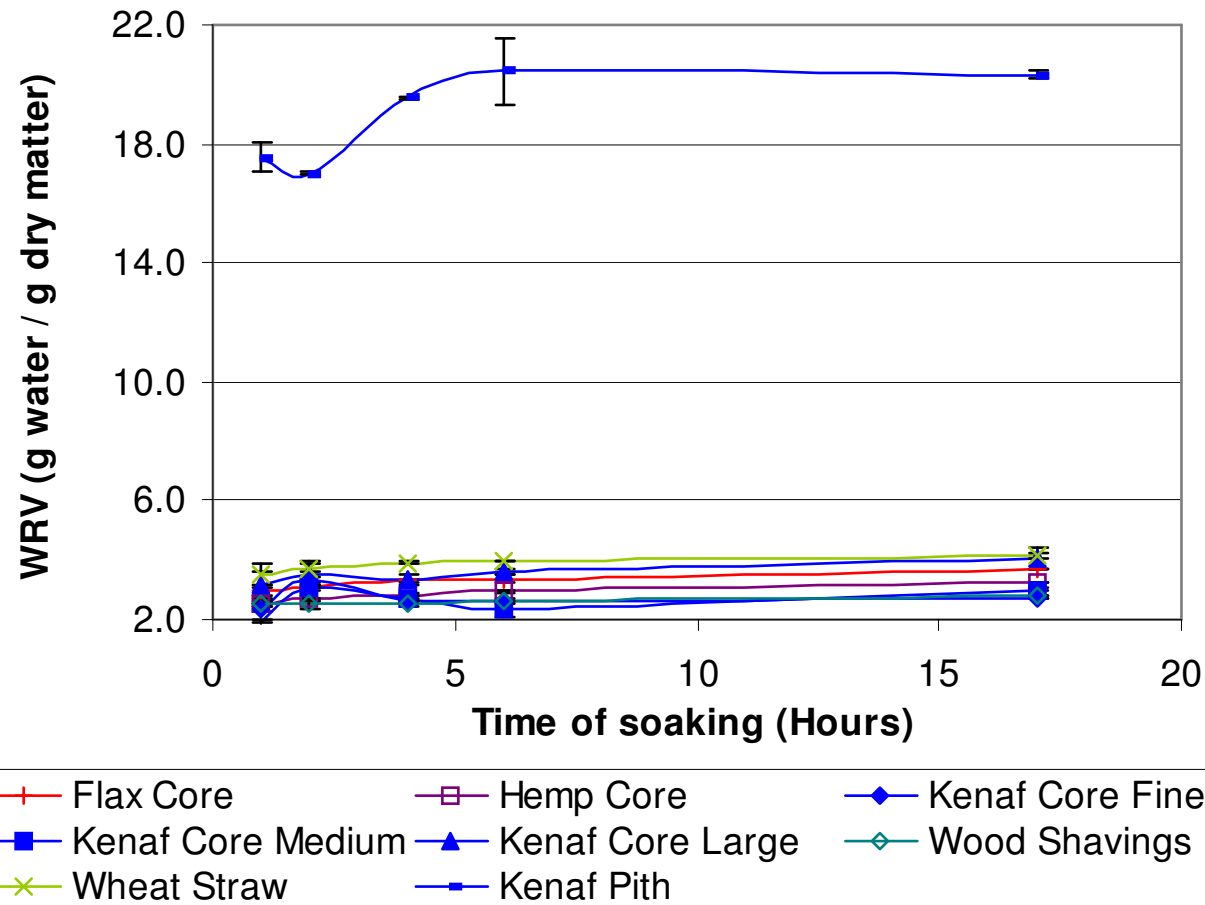
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- To ensure sustainable kenaf fibre business
- a broader range of possible applications must be developed by improving the quality of the fibres.
- Higher quality fibres might be achieved by studying and developing new retting and extraction processes.

# Water retention of animal bedding materials

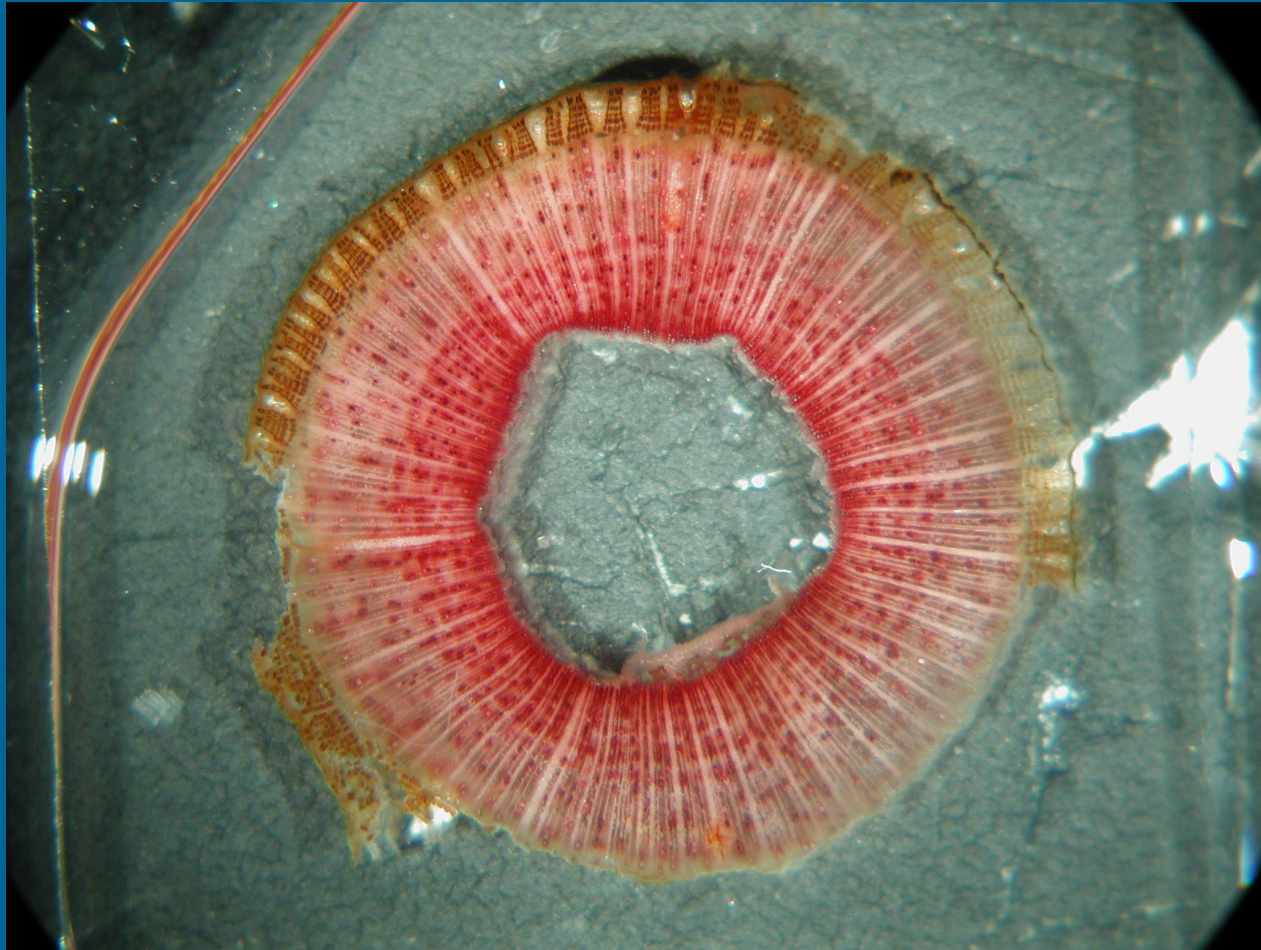


# Water retention kenaf pith

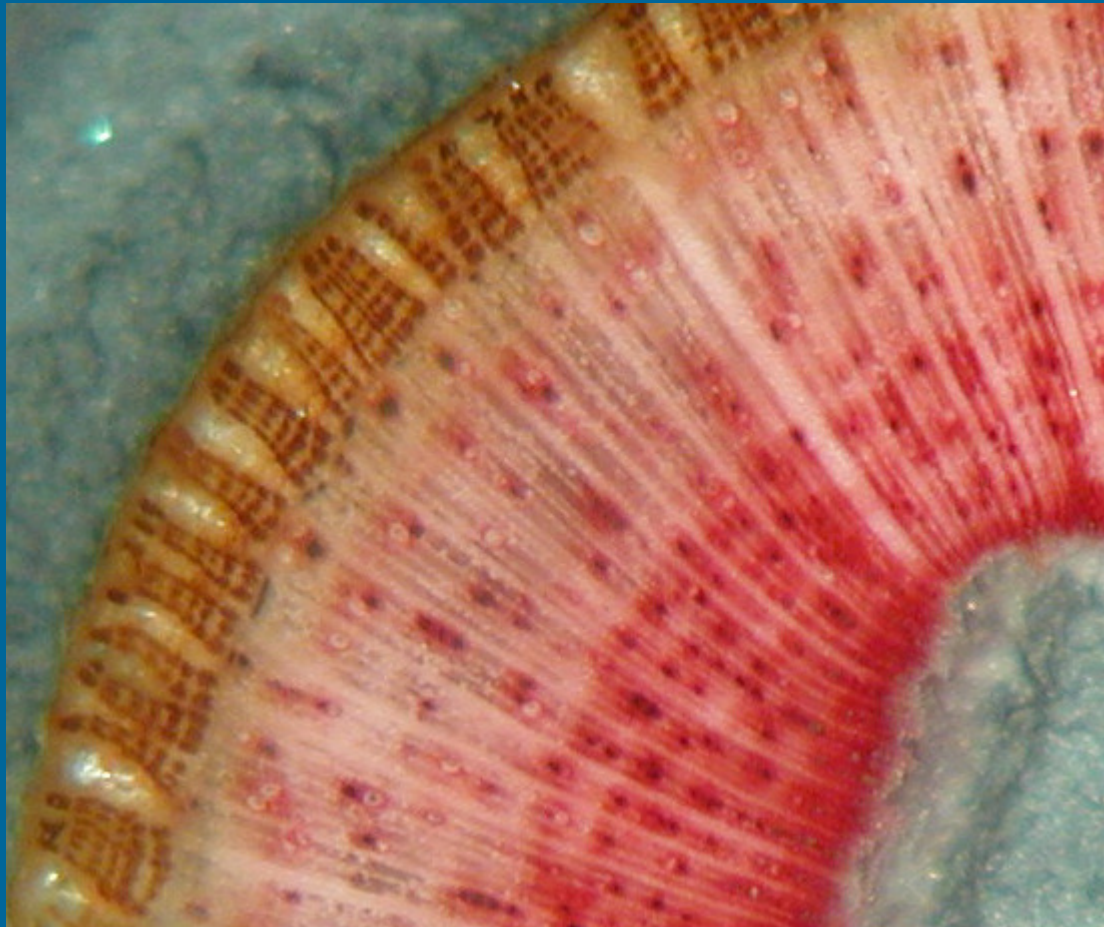




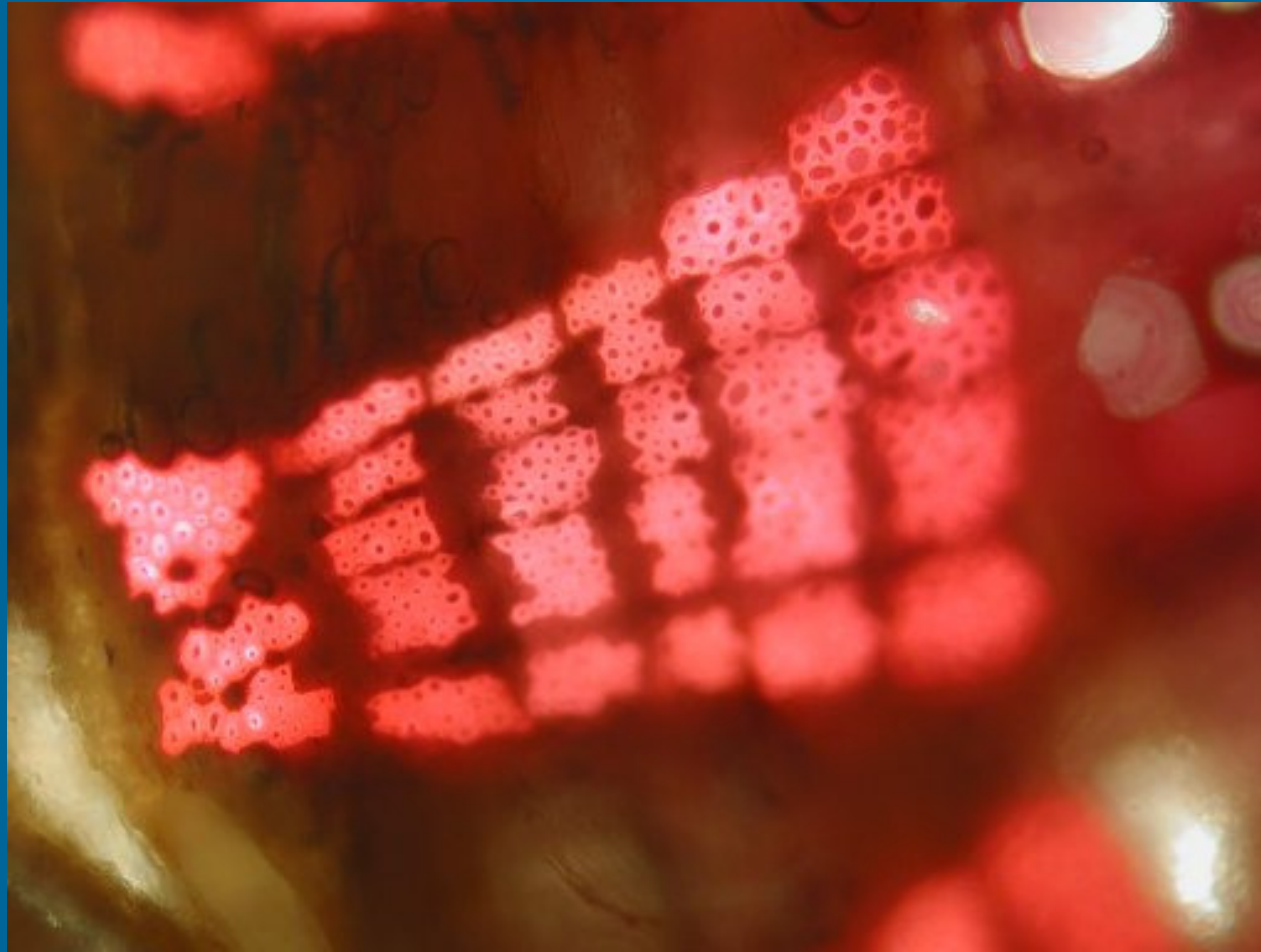
# Structure of kenaf stem (Everglades 41)



# Structure of kenaf stem (Everglades 41)



# Bast structure of kenaf (Everglades 41)





# Transverse section of a Kenaf core particle

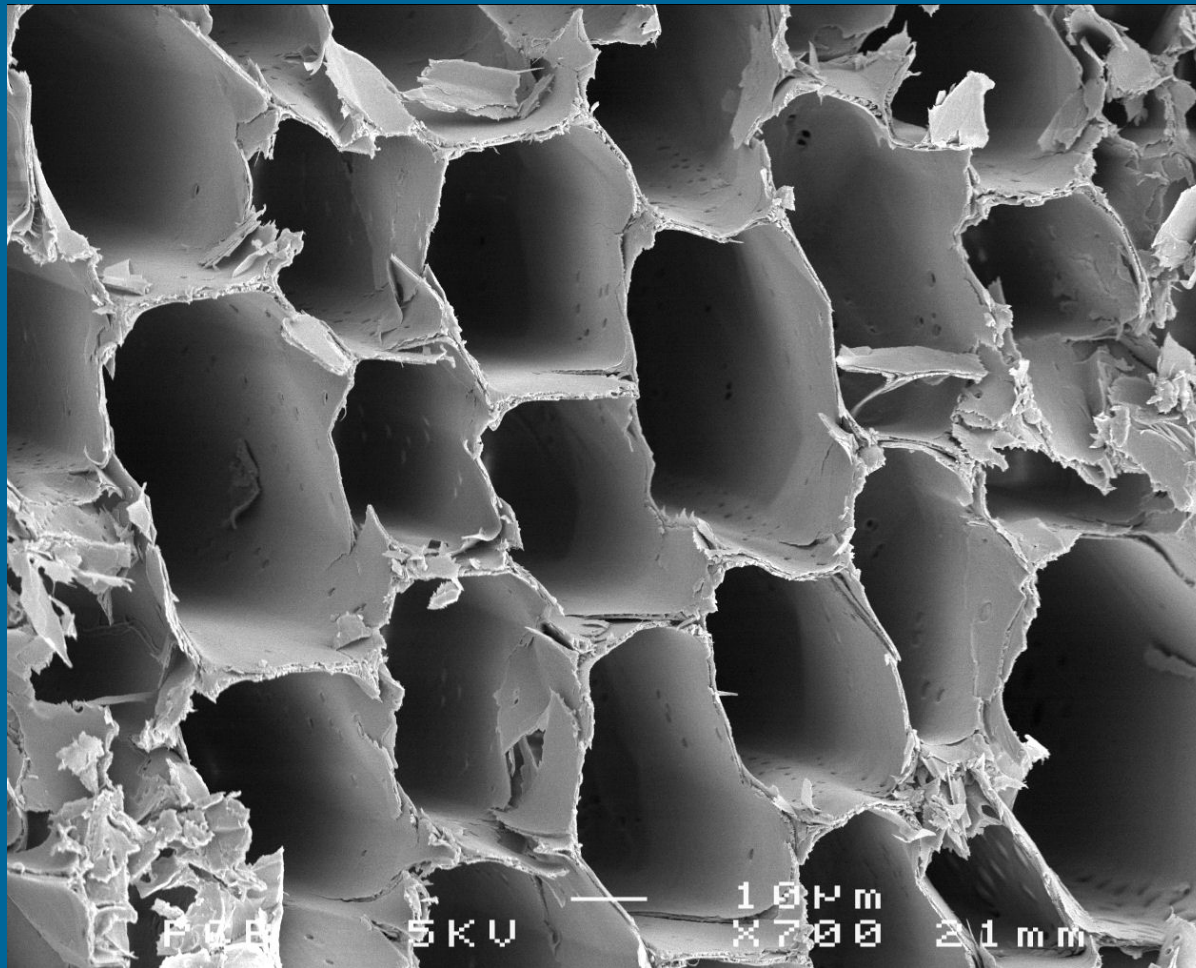


# Transverse section of a Kenaf core particle

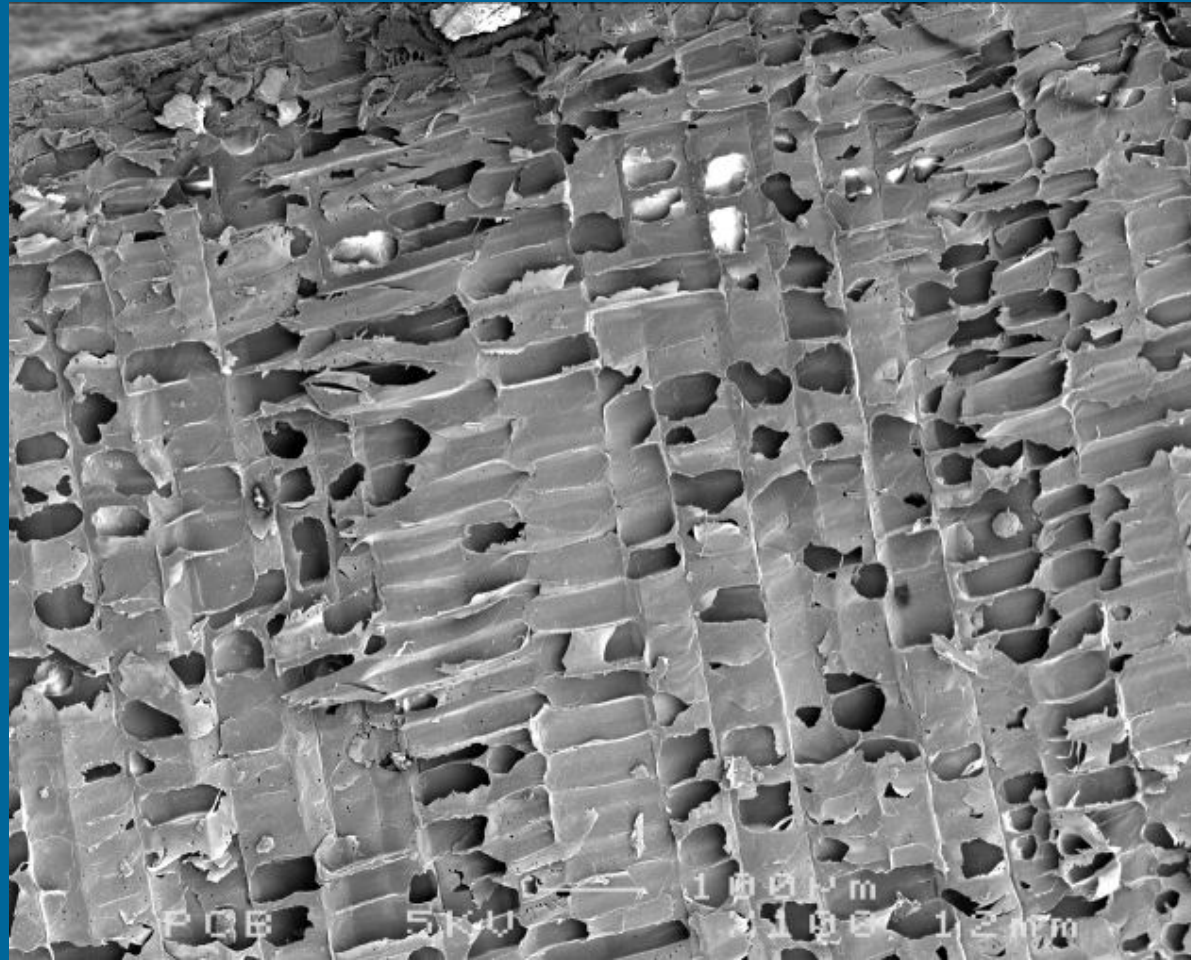




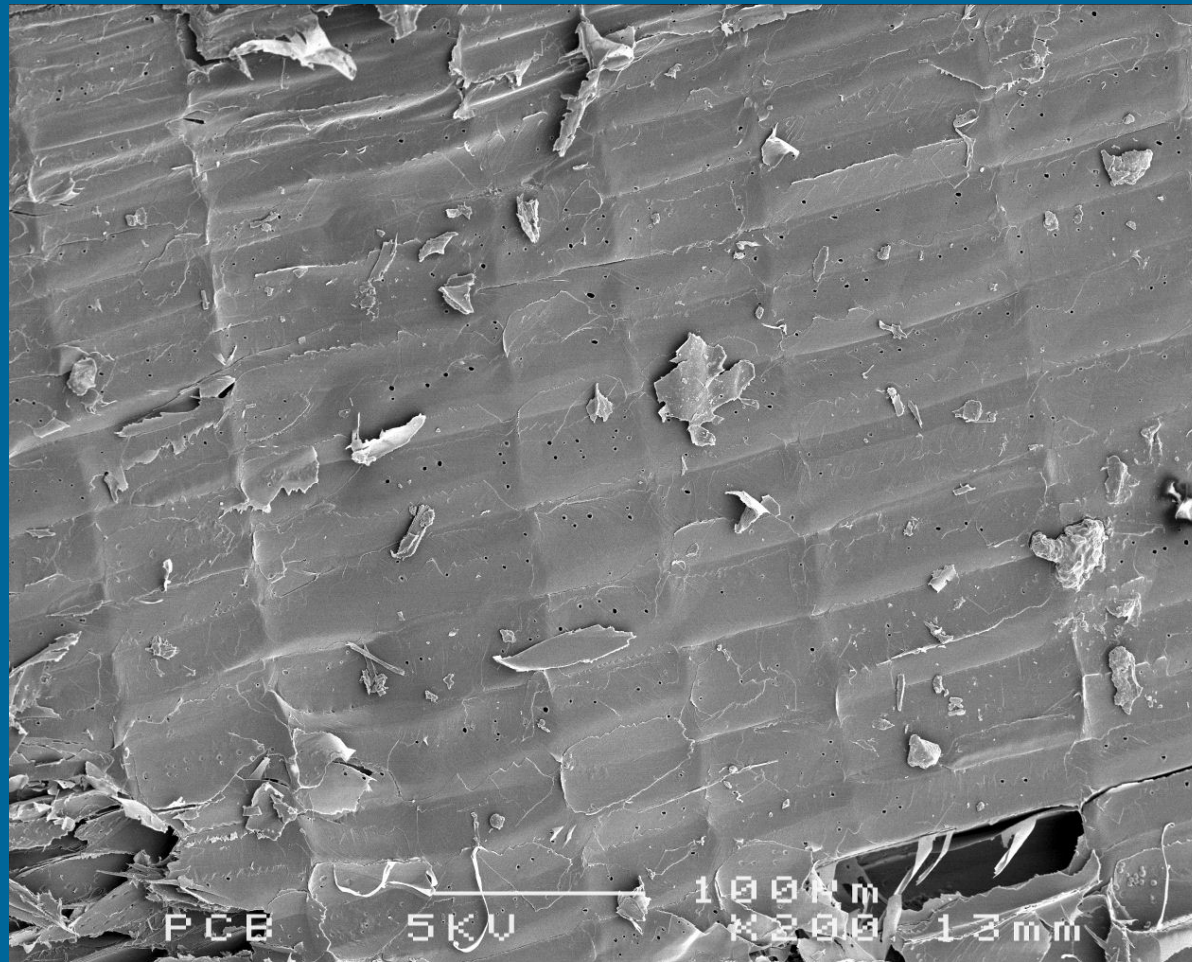
# Transverse section of a Kenaf core particle



# Parenchymatic tissue in Kenaf core particles

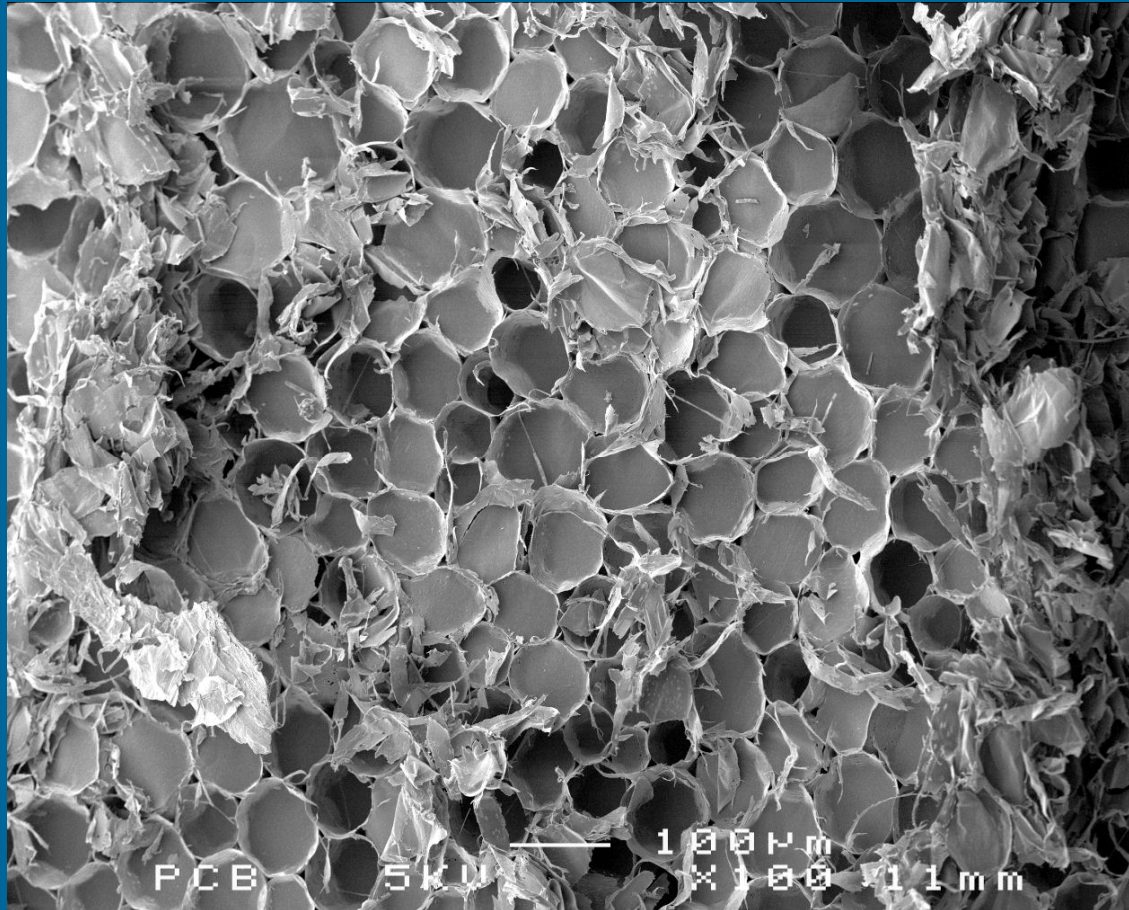


# Parenchymatic tissue in Kenaf core particles

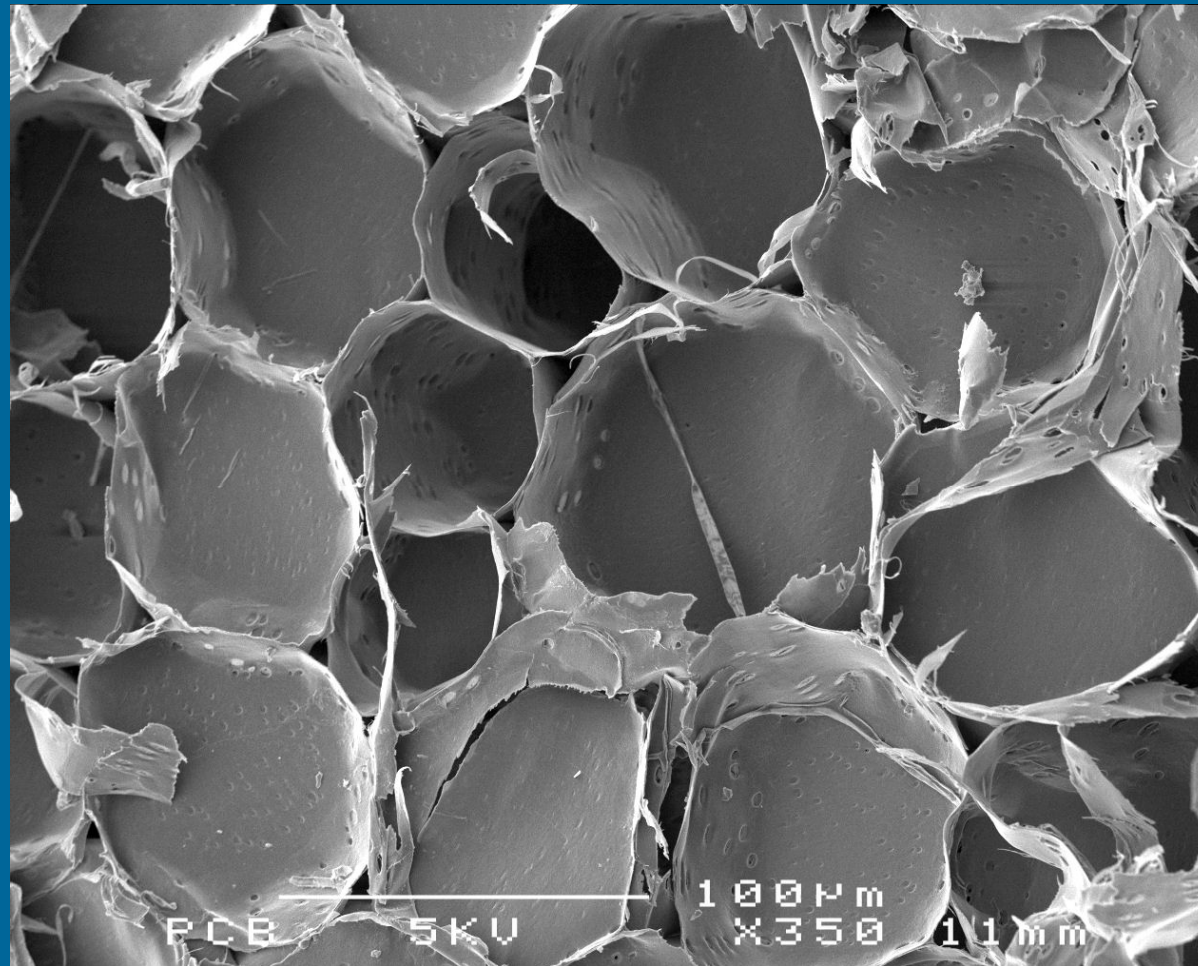




# Pith cells



# Pith cells

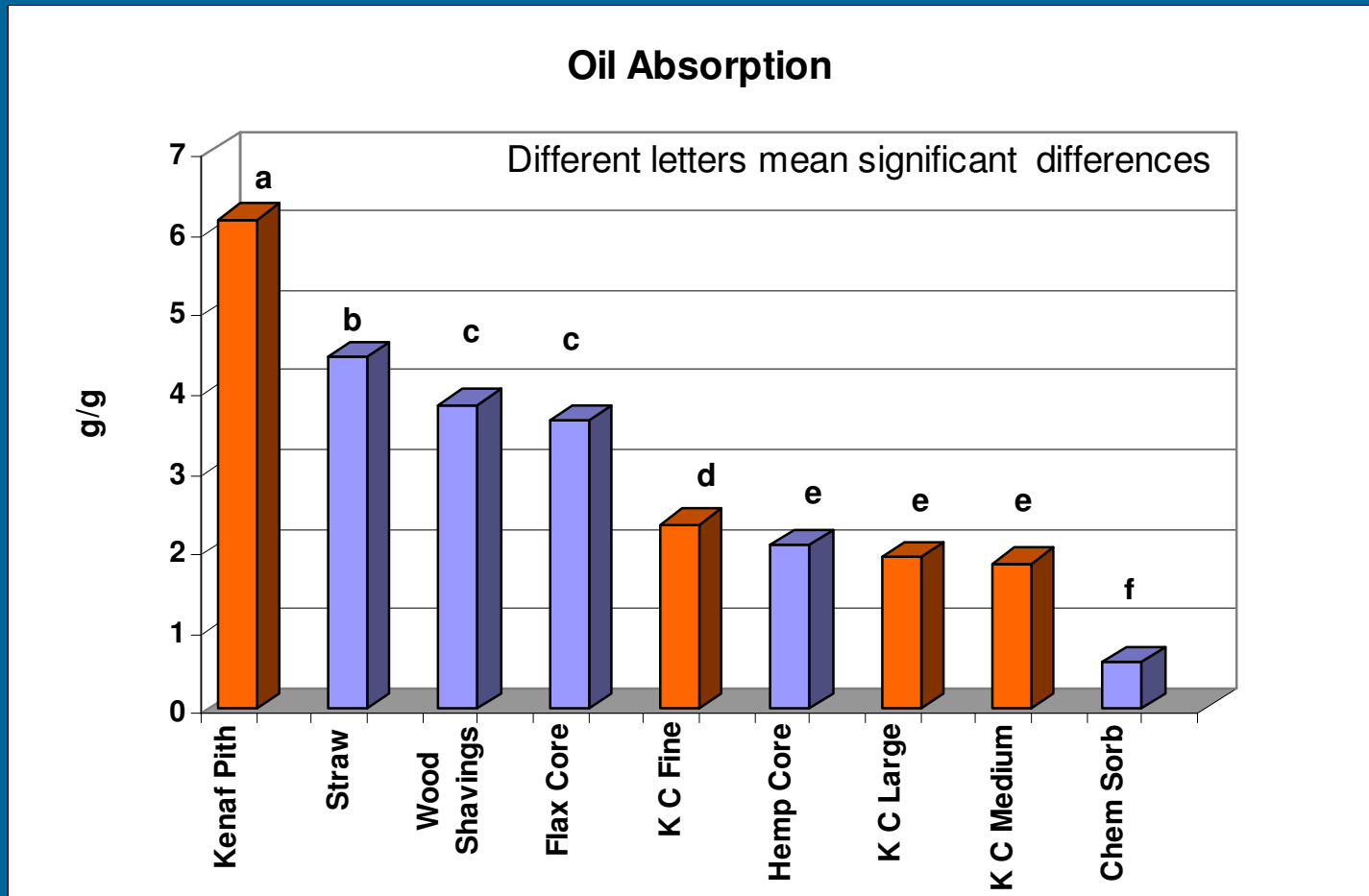


# Conclusions - water absorption kenaf core

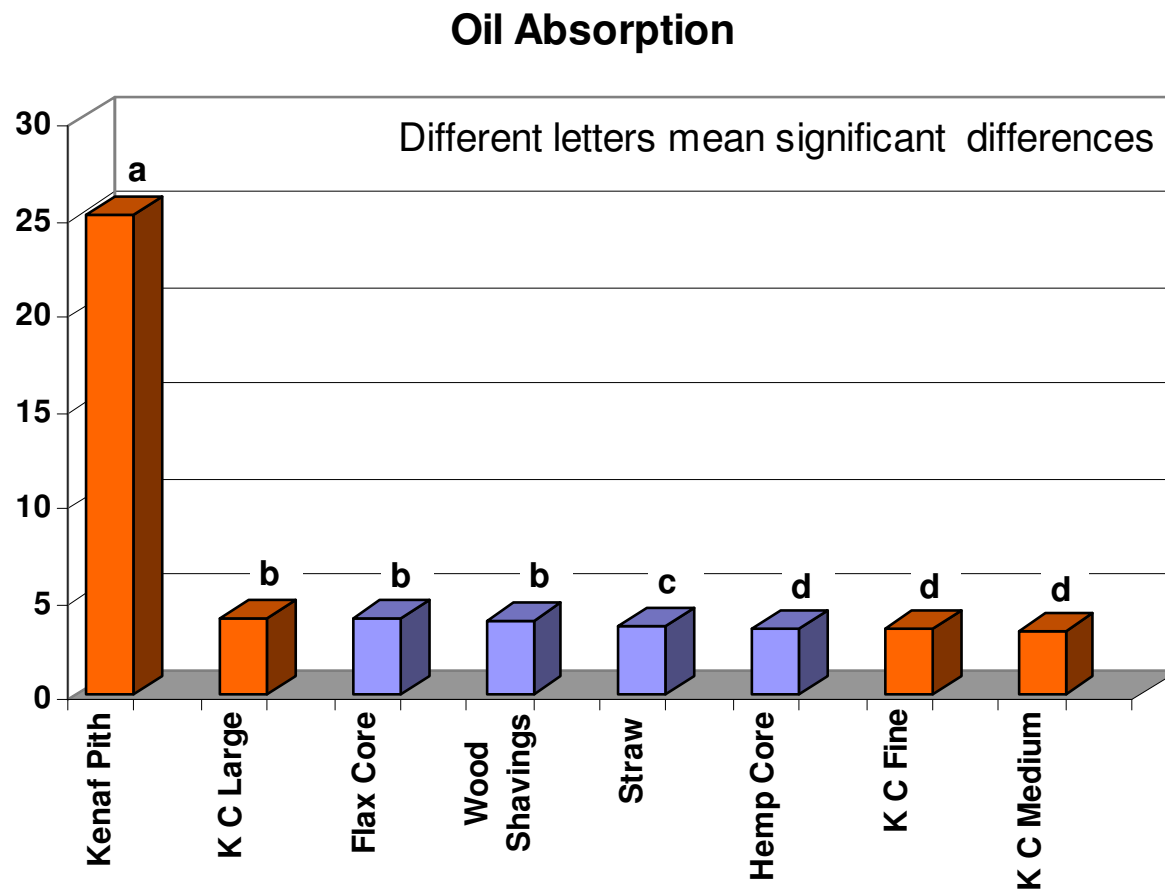
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- Large core fraction is the best water absorber of all the tested materials.
- Kenaf core medium and fine absorb
  - somewhat less than wheat straw and core of hemp and flax
  - more than wood shavings
- Kenaf pith is a very good absorber.

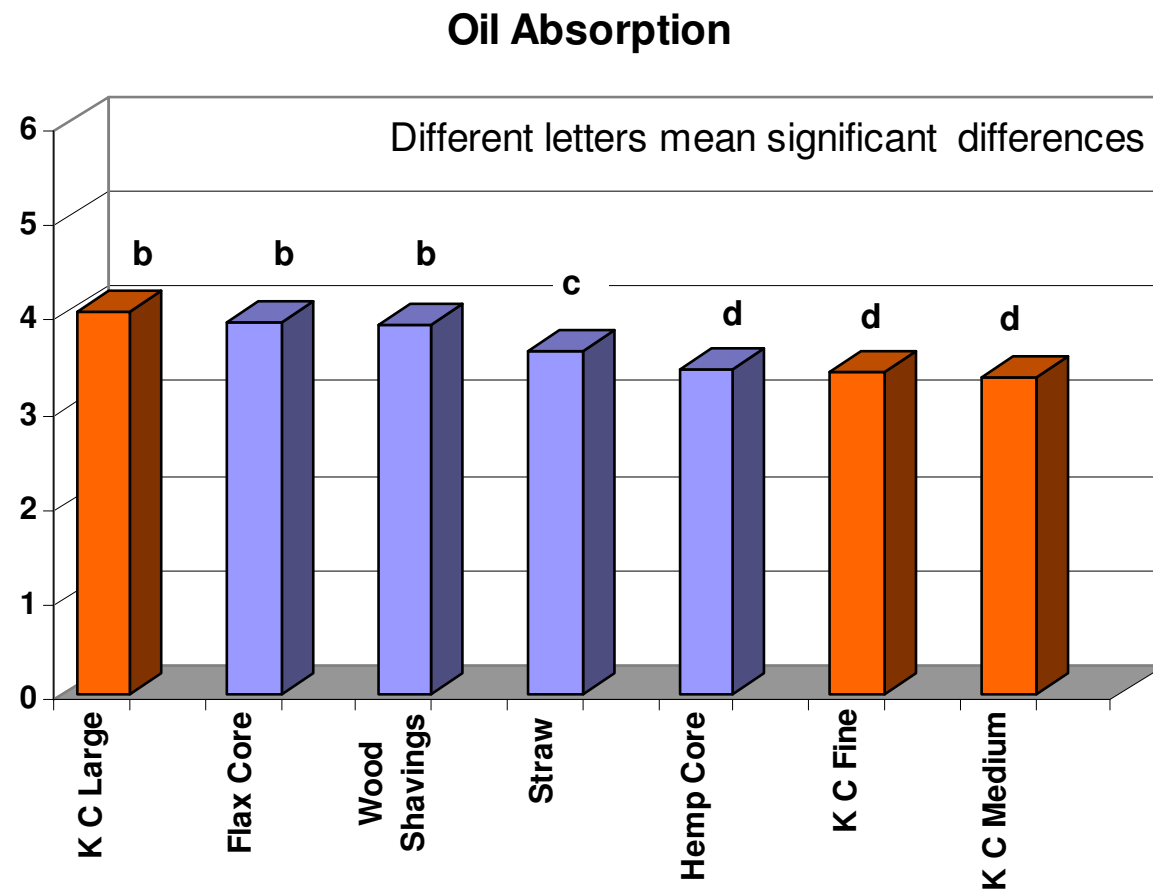
# Oil absorption kenaf core and other materials



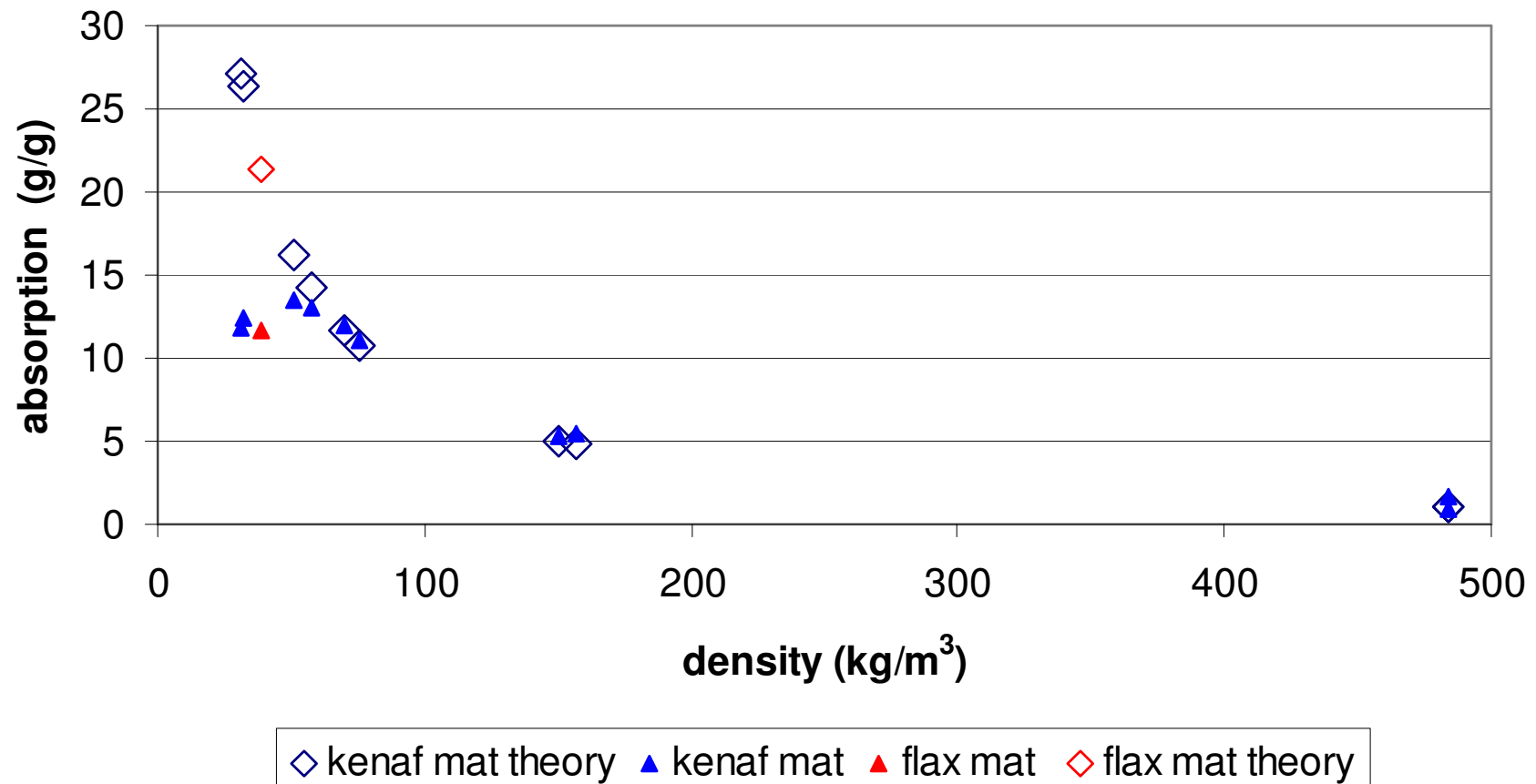
# Oil absorption of milled kenaf core and milled other materials



# Oil absorption of milled kenaf core and milled other materials



# Oil absorption of kenaf fibre mats (K.E.F.I.)



# Conclusions – oil absorption

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- Kenaf core as received shows low level of oil. The level is comparable to that found by Ghalambor
- Kenaf core is not a better oil absorber than the other tested organic materials
- Extra milling increases the oil absorption capacity

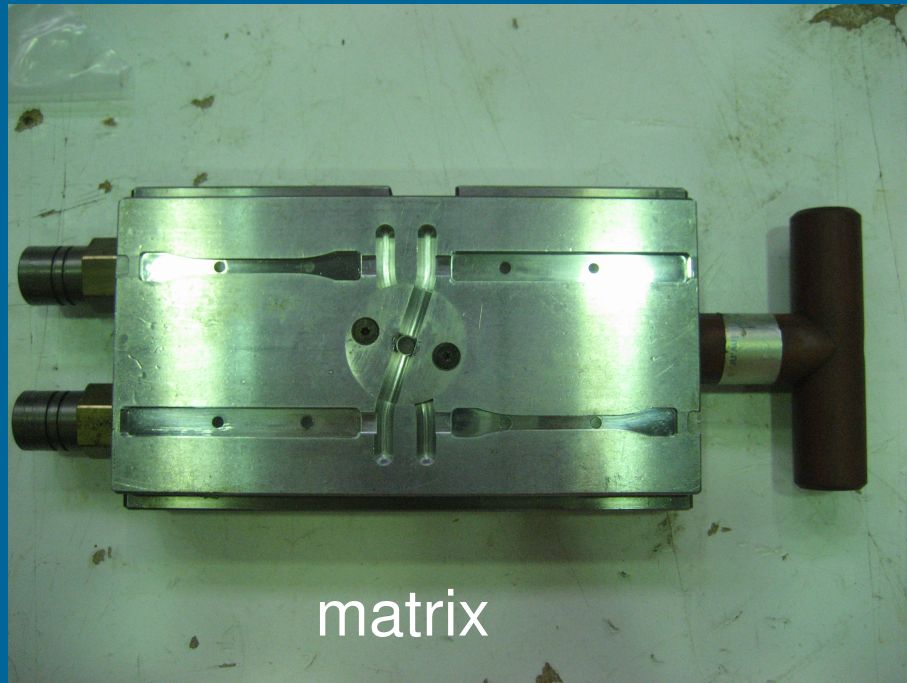


# Conclusions – oil absorption

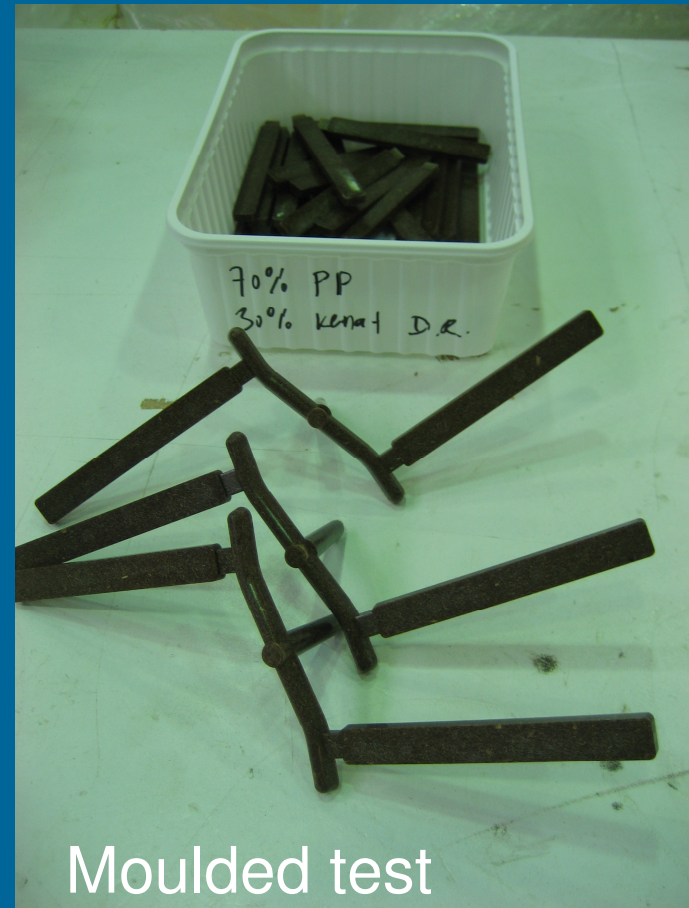
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- Kenaf pith absorbs 200% more oil than kenaf core
- Milled kenaf core absorbs 500% more oil than not milled kenaf core. This is comparable to the ratio found by Ghalambor
- Kenaf /polyester mats show high absorption capacity for oil. They can be pressed out and re-used at least six times without losing their

# Producing Kenaf-Polypropylene composite



matrix



Moulded test  
pieces

# Strength properties of kenaf fibres/ PP compounds

Material	Flexural Modulus [GPa]	Flexural Strength [MPa]	Strain [%]	Charpy impact [kJ/m2]
CETA	3.3 (0.2)	53 (1)	3.6 (0.1)	12 (1)
CETA +MAPP	3.2 (0.1)	71 (1)	4.1 (0.1)	12 (2)
UniNova +MAPP*	3.1 (0.2)	70 (1)	4.2 (0.1)	13 (2)

\*warm water retted

# Strength properties of kenaf fibres/ PP compounds

Material	Flexural Modulus [GPa]	Flexural Strength [MPa]	Strain [%]	Charpy impact [kJ/ m2]
CETA*	3.3	53	3.6	12
CETA + MAPP	3.2	71	4.1	12
UniNova + MAPP	3.1	70	4.2	13
FAIR unretted	4.0	53	3.1	11
FAIR retted	4.1	55	3.2	12
Jute	3.2	69	4.8	18
Hemp	2.7 - 3	59 - 67	4.8 – 5.3	13 - 19

\*fibres produced by CETA and extracted by KEFI

# Conclusions Kenaf/PP compounding

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- The tested kenaf fibres can compete with other natural fibres on flexural strength properties, but not on impact strength.
- Retted kenaf fibres harvested in autumn did not give stronger composites than CETA/KEFI fibres
- Quality of the fibres in relation to harvest time and extraction method must be further investigated

# Conclusions - general

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- Technically numerous application are possible.
- Competitiveness with other materials or quality aspects limits the number of applications.
- Higher quality fibres might be achieved by studying and developing new retting and extraction processes.

