Up-grading agro-wastes from western Africa in biocomposites applications

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CIRAD

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BLP 2025

BIOENERGY FOR LOCAL PRODUCTION

CONFÉRENCE INTERNATIONALE

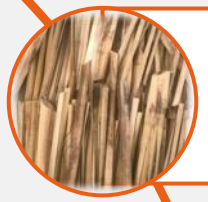
Du 28 au 30 janvier 2025

www.Bio4Africa.eu

This project has recieved funding from the European Unicn's Horizon 2020 research and innovation programme under grant agreement No. 101000762

GENERAL OVERVIEW

QUANTITIES PRODUCED IN AFRICA IN 2020

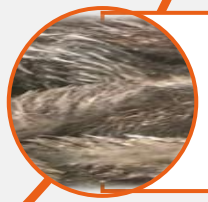


TYPHA → 300,000 to 500,000 tons

MILLET STALKS → 26.31 million tons

RICE HUSK → 8.71 million tons

COCOA PODS → 1.33 million tons



OIL PALM EMPTY FRUIT BUNCH → 23.6 million tons

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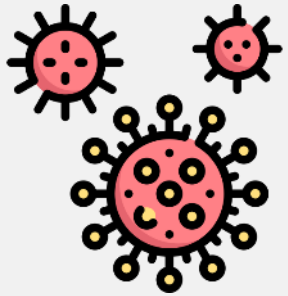
GENERAL OVERVIEW



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MATERIALS AND PARAMETERS

BIOMASS

- TYPHA
- RICE HUSK
- COCOA PODS
- MILLET STALKS
- OIL PALM EMPTY FRUIT BUNCH (OPEFB)

BINDER

- Melamine-Urea-Formaldehyde (MUF)

PANELS

- Application in the housing sector
- Non-load-bearing applications
- Resistant to the tropical climate

PARAMETERS

- BIOMASS
- FIBER/BINDER RATIO
- GRANULOMETRY

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FIBERS PREPARATION

Biomass dried at 80 °C for 24h

Grinding with a sieve of 6 mm

Lignocellulosic fibers

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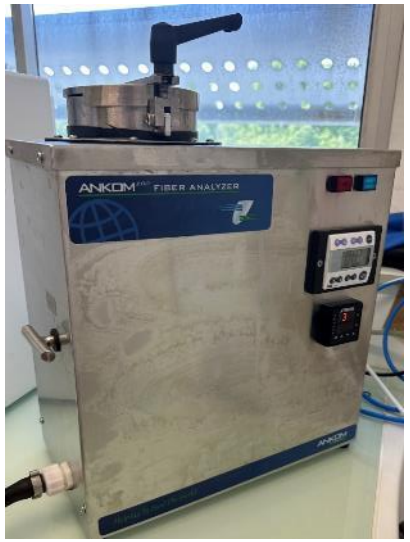
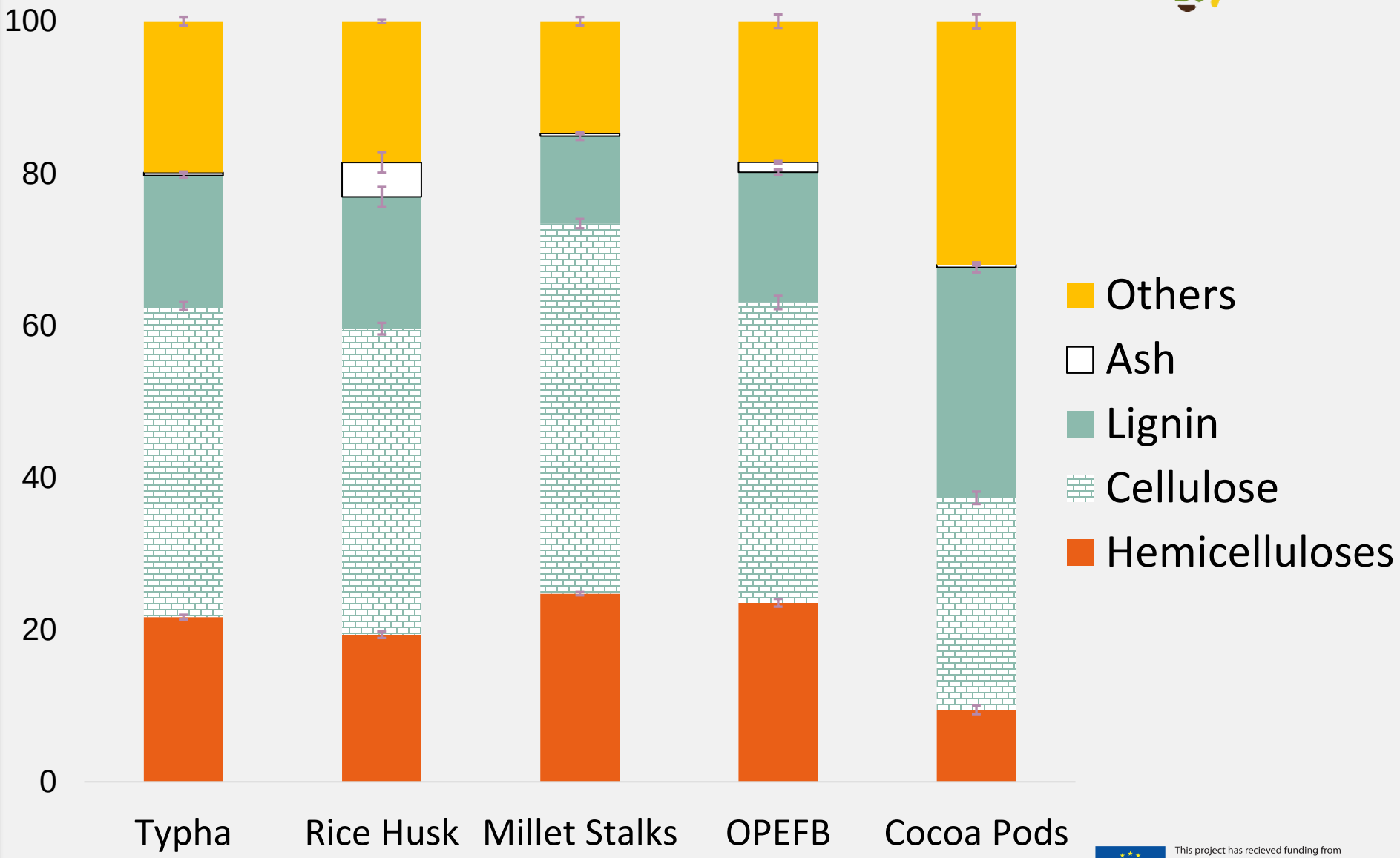
FIBERS CHARACTERIZATION

1

CHEMICAL COMPOSITION





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FIBERS CHARACTERIZATION

1

2 *THERMAL STABILITY*

30 °C to 800 °C
10 °C.min^{-1}
Nitrogen atmosphere

BIOMASS	RESIDUE (%)	DEGRADATION TEMPERATURE (°C)
Cocoa	32.4 ± 1.1	317.2 ± 3.5
Millet	25.9 ± 1.0	316.7 ± 4.1
OPEFB	25.9 ± 1.0	317.7 ± 4.7
Rice	**34.0 ± 1.4**	**347.9 ± 1.5**
Typha	23.8 ± 1.8	333.1 ± 4.1

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FIBERS CHARACTERIZATION

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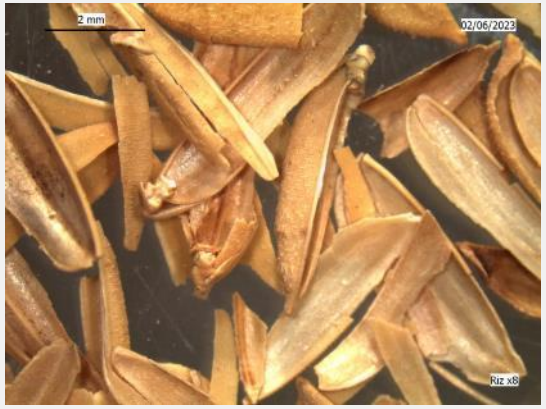
3

SHAPE AND SIZE

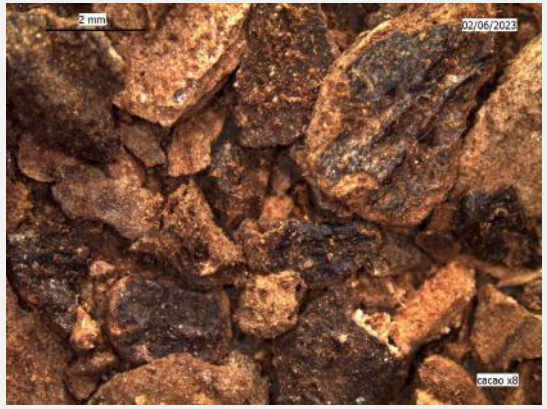
Optical microscope (x8)

OPEFB

RICE HUSK



COCOA PODS



MILLET STALKS

TYPHA

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FIBERS CHARACTERIZATION

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DENSITY

Biomass	Apparent Density (kg/m³)	Real Density (kg/m³)	Porosity (%)
Cocoa	**484.7**	1401.2 ± 8	65.4
Millet	93.6	1229.8 ± 4.5	**92.4**
OPEFB	157.1	1282.9 ± 3.0	87.8
Rice	150.7	1482.9 ± 5.6	89.8
Typha	65.9	1325.9 ± 1.3	**95.0**

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FIBERS CHARACTERIZATION

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DURABILITY TOWARDS TERMITES

Reticulitermes flavipes

27°C, RH > 75%

5 Weeks

Biomass	Termites activity
Rice	**Activity decreases over time, no visible activity after 28 days**
OPEFB	3/5 no activity after 28 days 2/5 active termites
Millet	Termites actives
Typha	2/5 activity decreases after 20 days 3/5 no activity after 20 days
Cocoa	2/5 active termites 2/5 reduced activity after 28 days 1/5 no activity after 28 days
Pine Sapwood Control	The termites were very active during the test period Survival rate > 50%, The screening test is validated

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FIBERS CHARACTERIZATION

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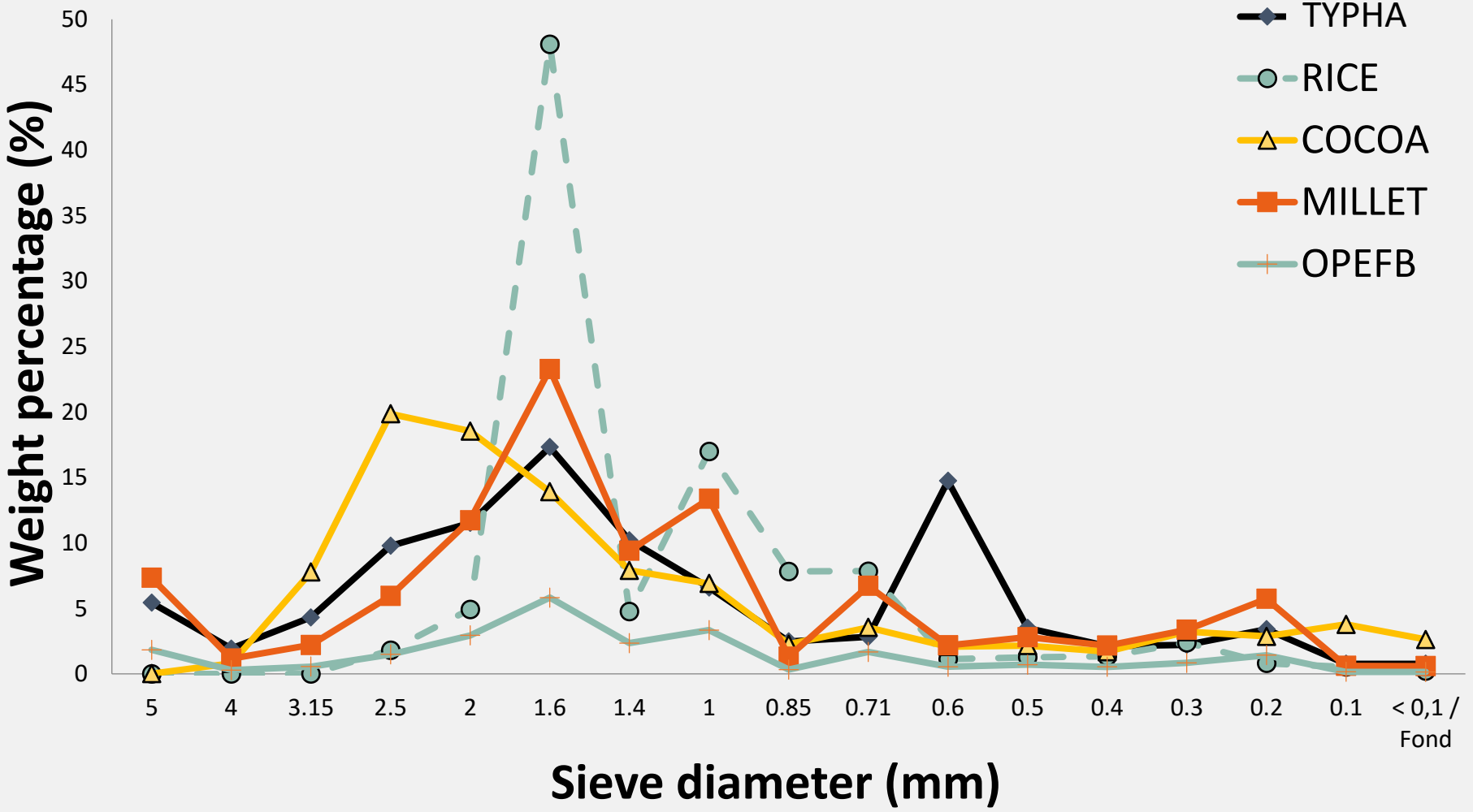
GRANULOMETRY



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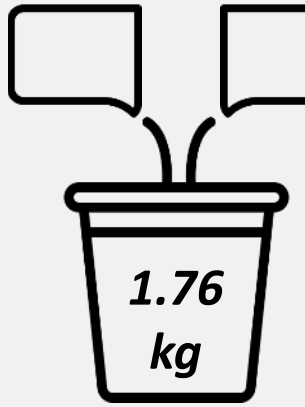
PANELS PRODUCTION

Biomass

Melamine urea formaldehyde



120 °C
10 minutes

Cooling and demolding

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PANELS FABRICATED

In Total:
25 panels with 3x5 replicates for rice

Fiber/ Binder Ratio	BIOMASS				
	COCOA	**RICE**	**OPEFB**	**MILLET**	**TYPHA**
50/50	Not tested	Not tested	The glue is difficult to dispense	Not tested	Too much powder surrounding the glue
60/40	Easy mixing between components Glue is well distributed	Easy mixing between components Glue is well distributed	Difficulty dispensing glue Poor glue absorption	Too much powder surrounding the glue	Too bulky with little glue
70/30	Easy mixing between components Glue is well distributed	Easy mixing between components Glue is well distributed	Too little glue, mixing was too difficult	Too bulky with little glue	Not tested
80/20	Mixing more difficult due to the quantity of glue	No glue at the edge Difficult to distribute the glue	Not tested	Not tested	Not tested

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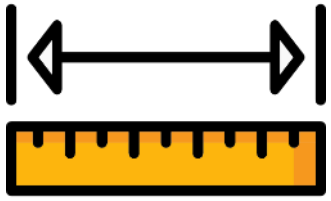
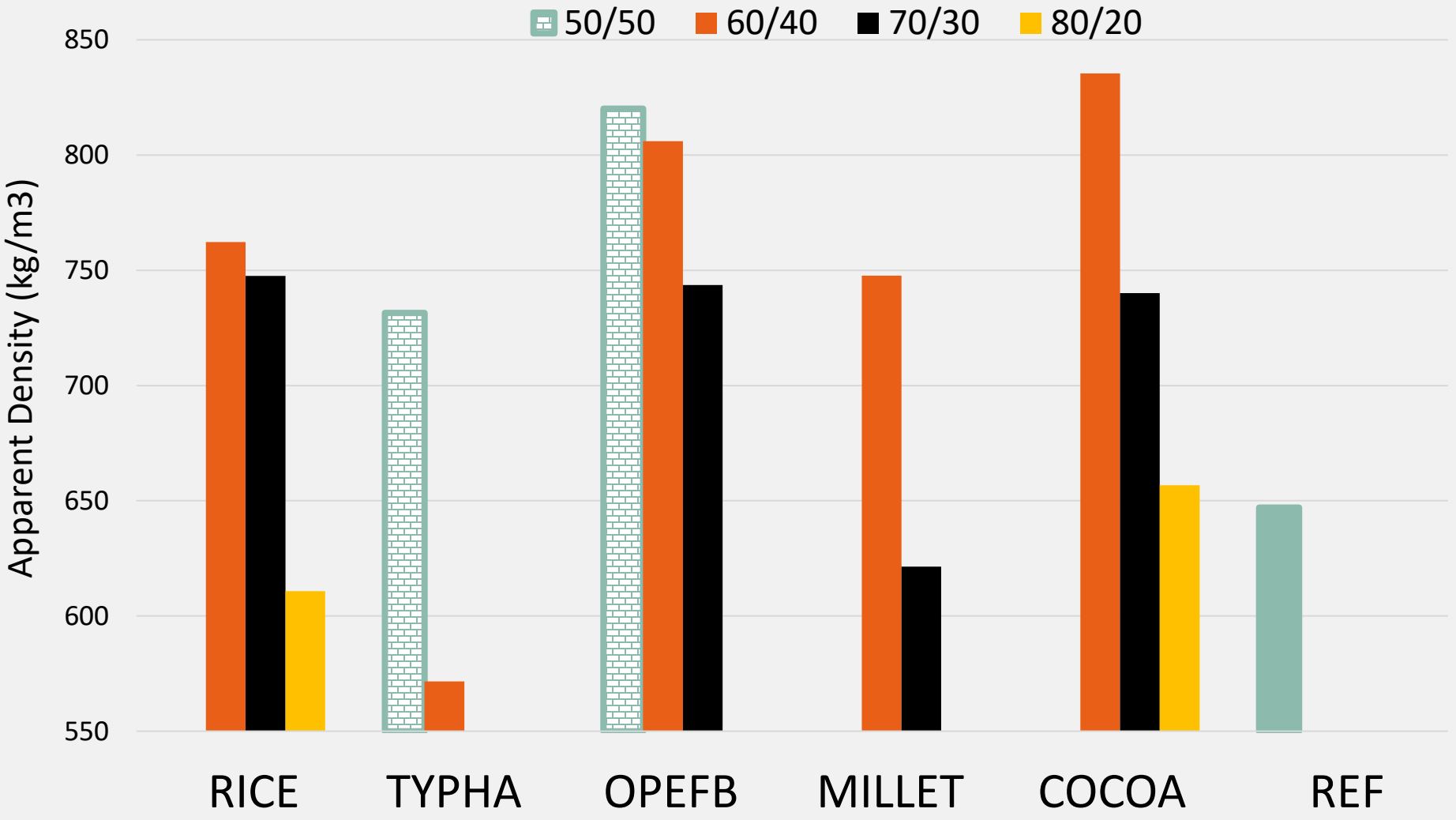
PANEL CHARACTERIZATION

1

APPARENT DENSITY





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PANEL CHARACTERIZATION

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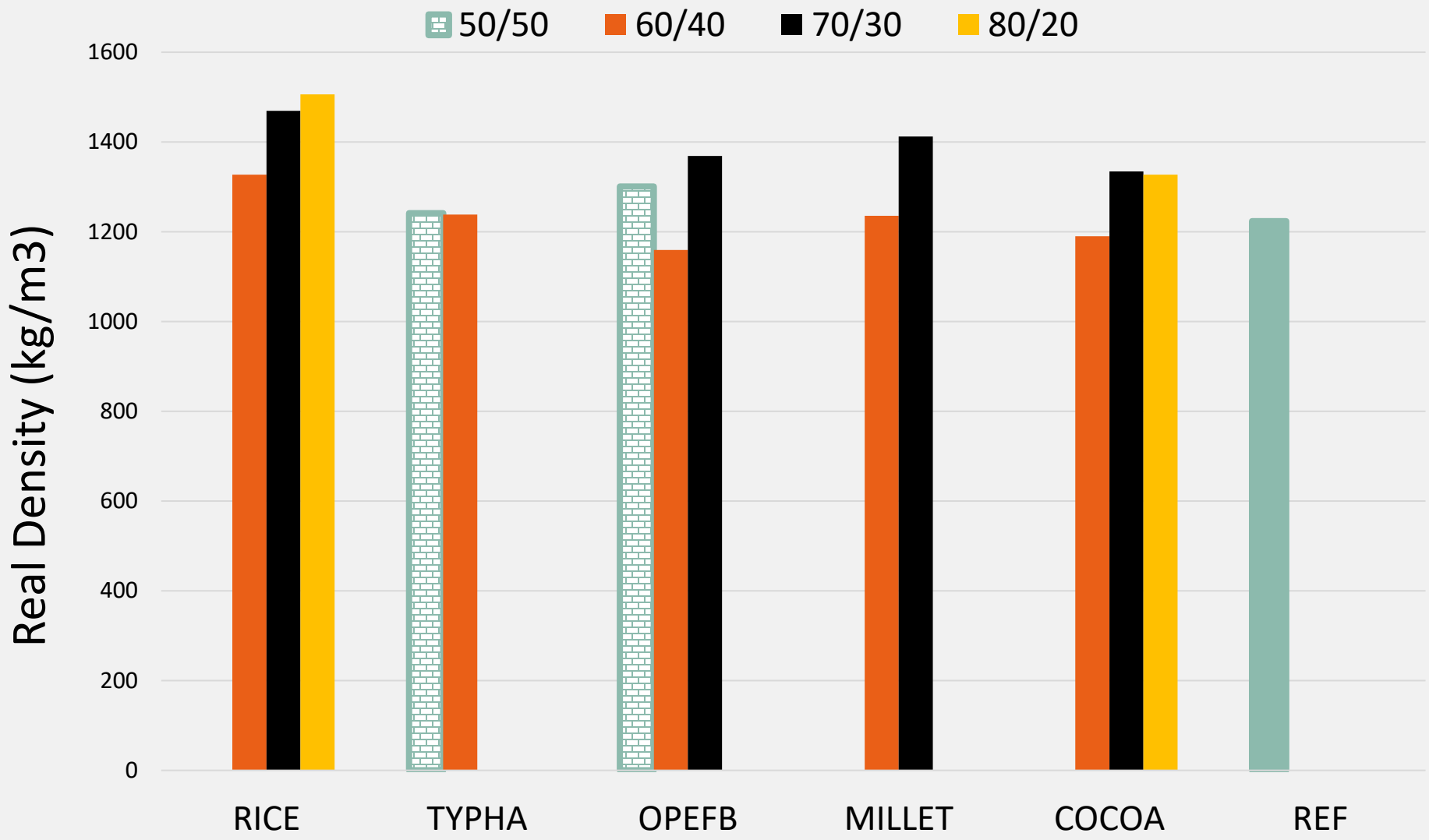
REAL DENSITY



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PANEL CHARACTERIZATION

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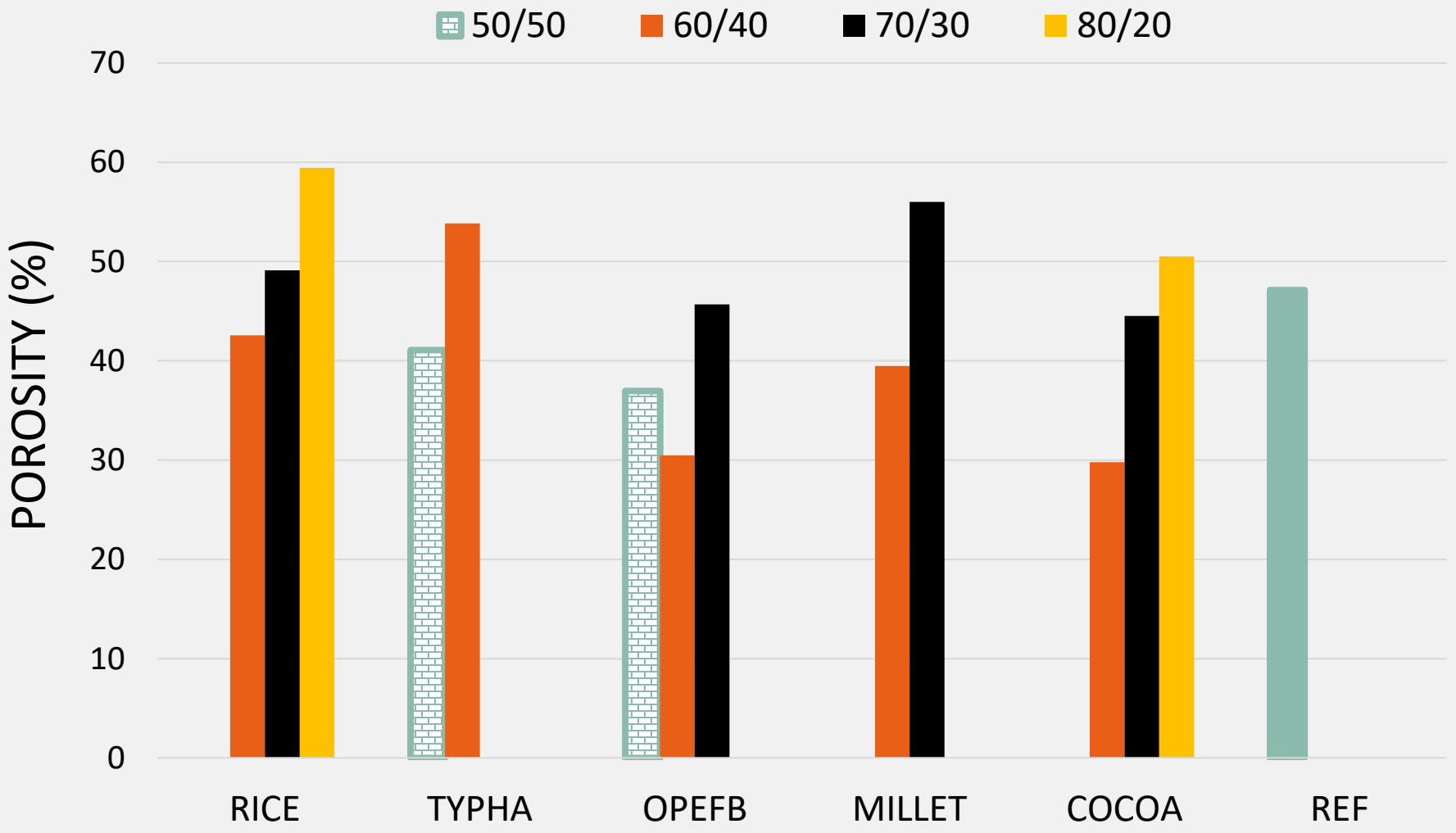
POROSITY



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PANEL CHARACTERIZATION

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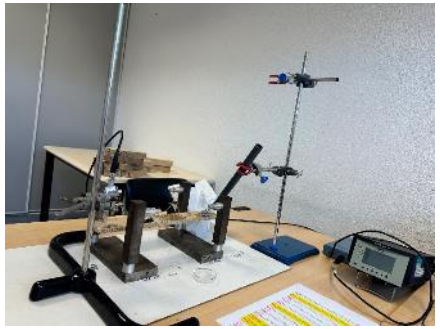
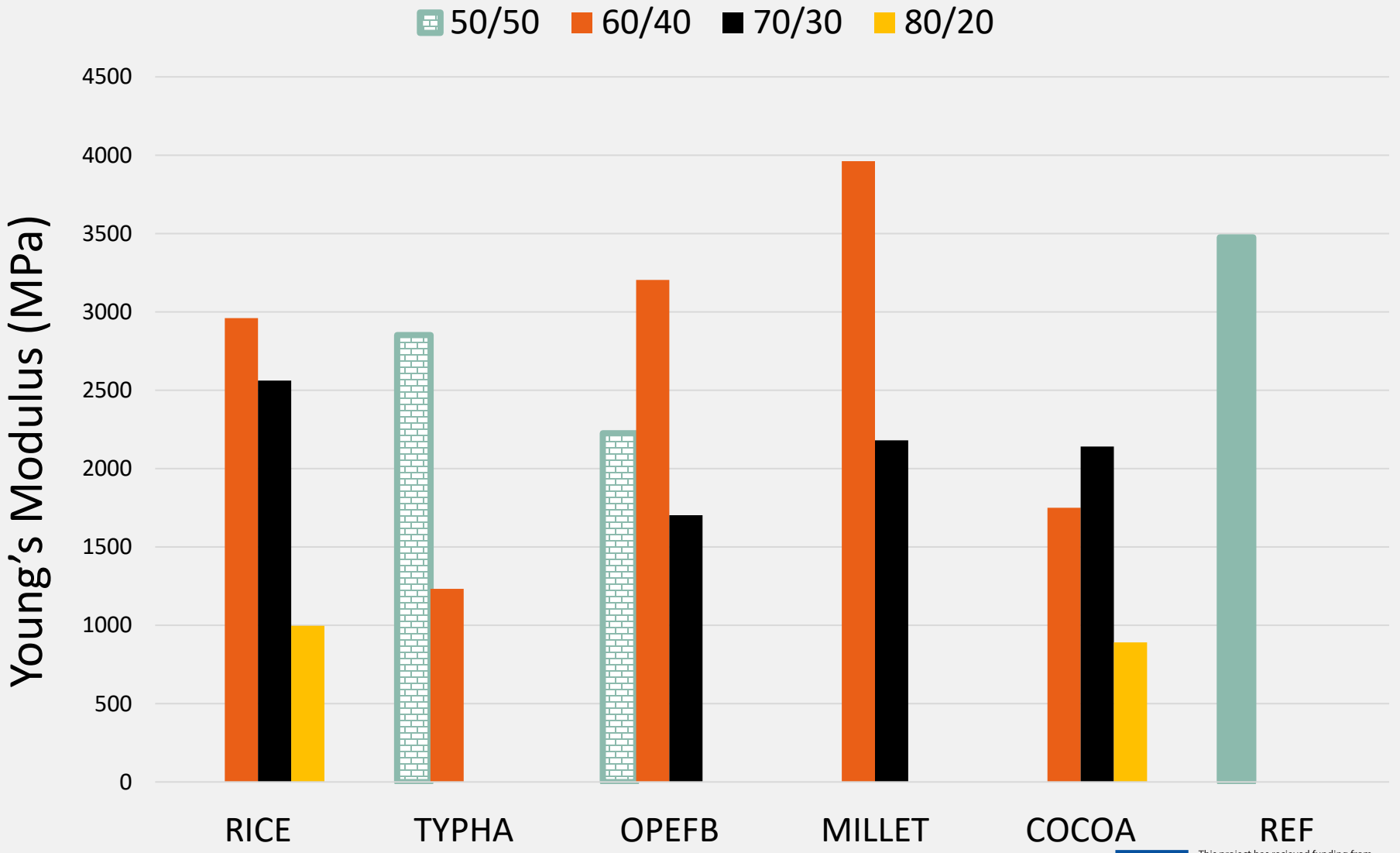
YOUNG'S MODULUS





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PANEL CHARACTERIZATION

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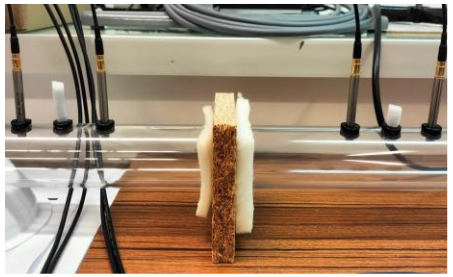
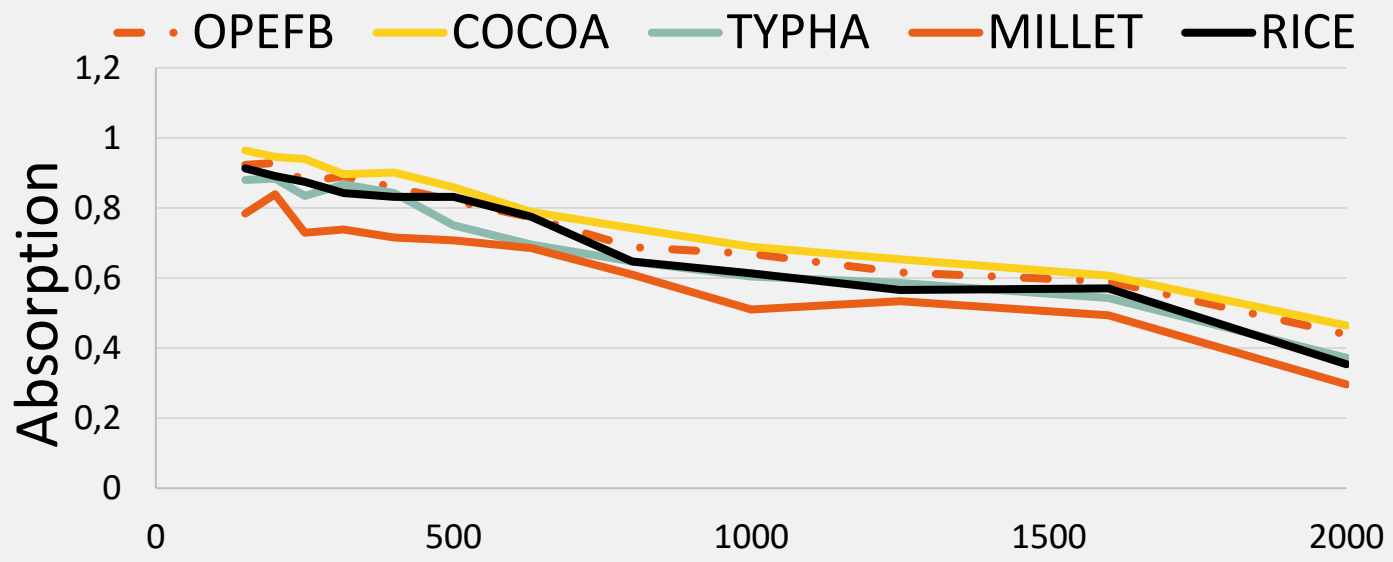
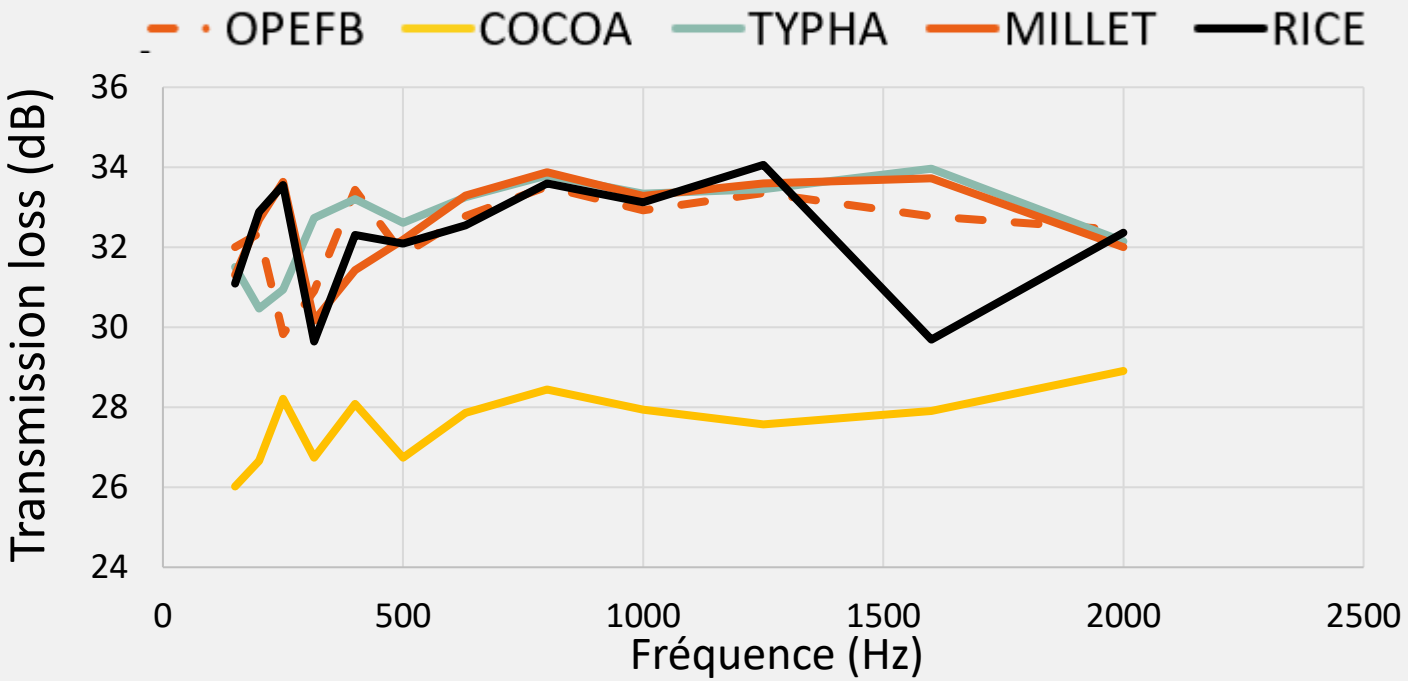
ACOUSTIC ISOLATION







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PANEL CHARACTERIZATION

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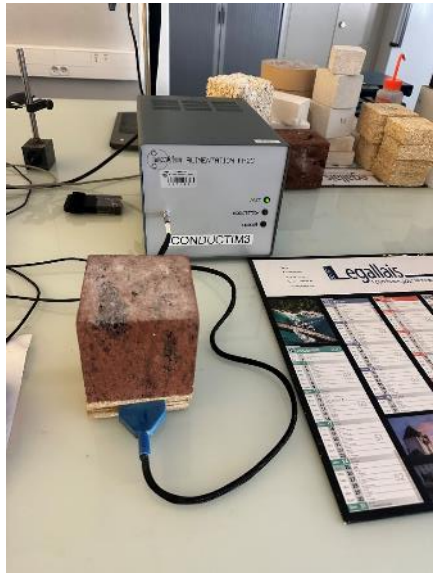
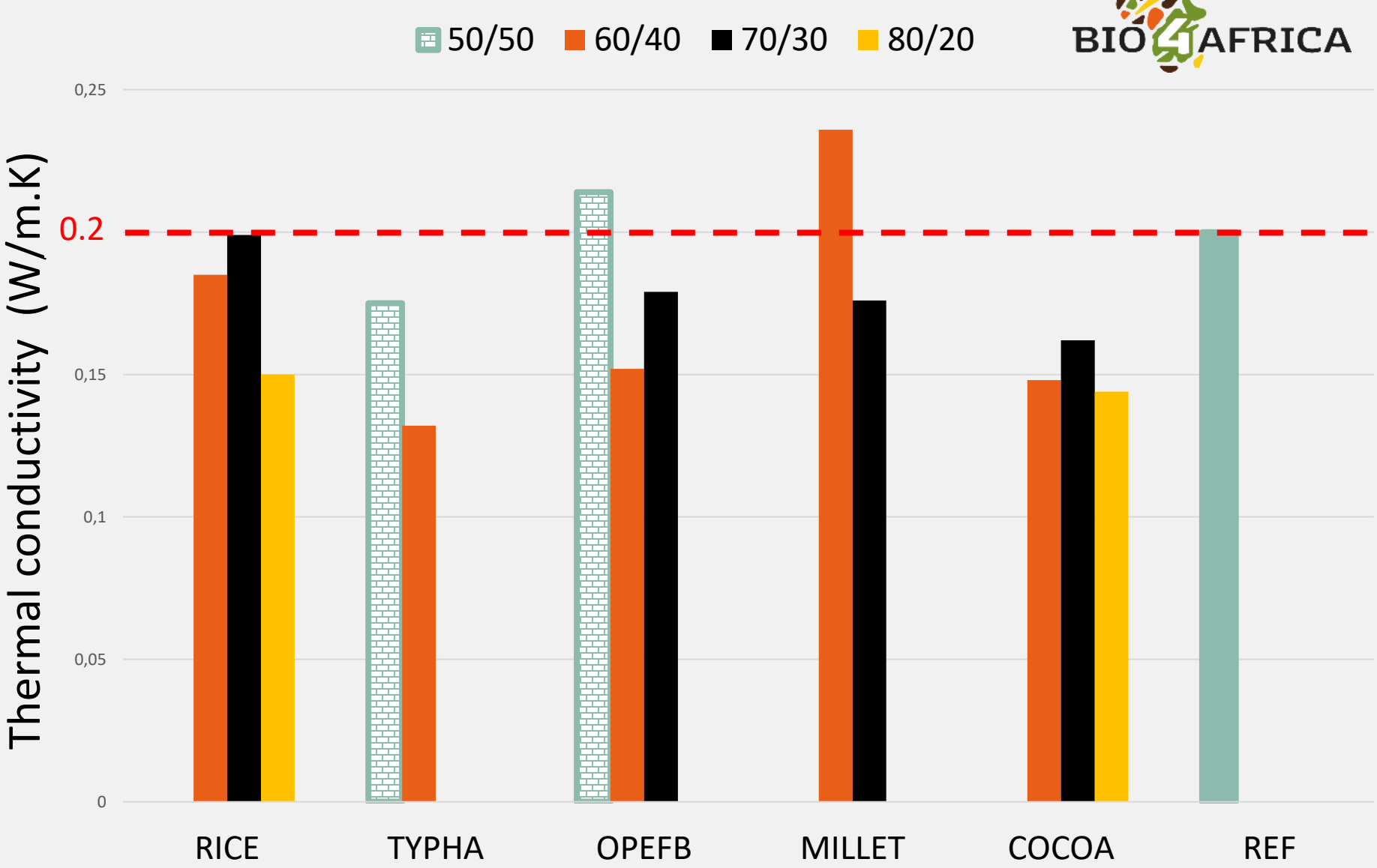
THERMAL CONDUCTIVITY





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CONCLUSIONS

The five biomasses can be used as reinforcing fibers in biocomposite panels

In terms of density

- C 60/40 panels are the most dense
- T 60/40 panels are the least dense

In terms of porosity

- R 80/20, T 60/40, and M 70/30 panels are the most porous
- C 60/40 and OPEFB 60/40 panels are the least porous

In terms of Young's Modulus

- M 60/40 panels have the highest Young's Modulus
- C 80/20 and R 80/20 panels have the lowest Young's Modulus

In terms of acoustic isolation

- Higher fiber loading had no significant effect on absorbance
- Cocoa has the highest absorption → Good for limiting echo and reverberation
- Typha, Millet, and OPEFB have high transmission loss →Good for soundproofing
- Higher filler loading lowered the transmission loss values of rice and cocoa panels

In terms of thermal isolation

- R 80/20 and T 60/40 panels provide the best thermal insulation
- M 60/40 and OPEFB 50/50 panels are not thermal insulators

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