Insights on fungal solid-state fermentation for waste valorization: conidia and chitinase production in different reactor configurations

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24/06/21

CHEMICAL PESTICIDES

Major drawbacks:

1. Harmful for the environment(toxicological effect).

2. Harmful for humans (mutagenic capabilities).

3. Resistance induction in pests.

4. Not host specific.

BIOPESTICIDES

Major advantages:

1. Harmless both for the environment and humans.

2. Effective on more than 1000 species.

3. Host specific.

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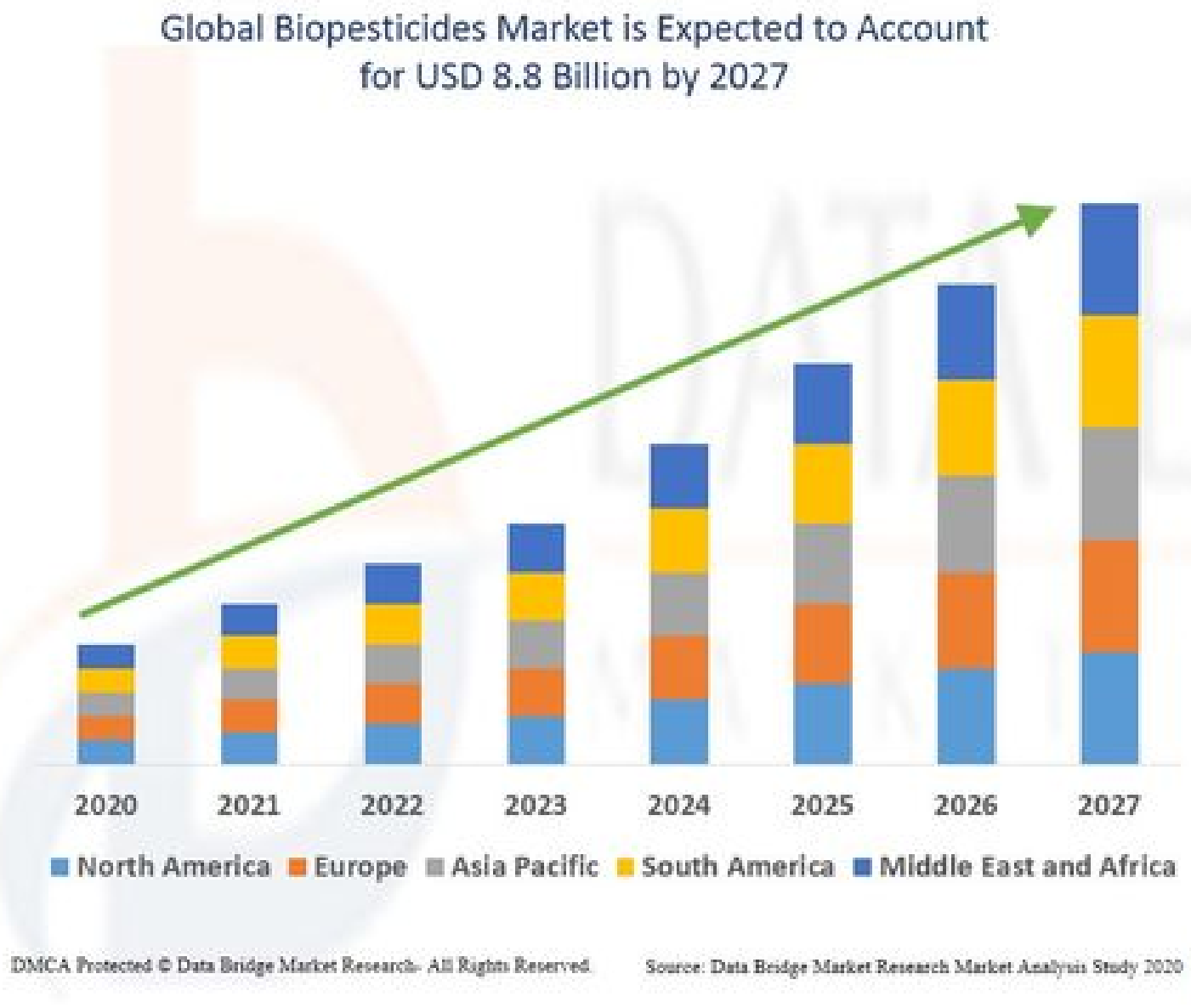

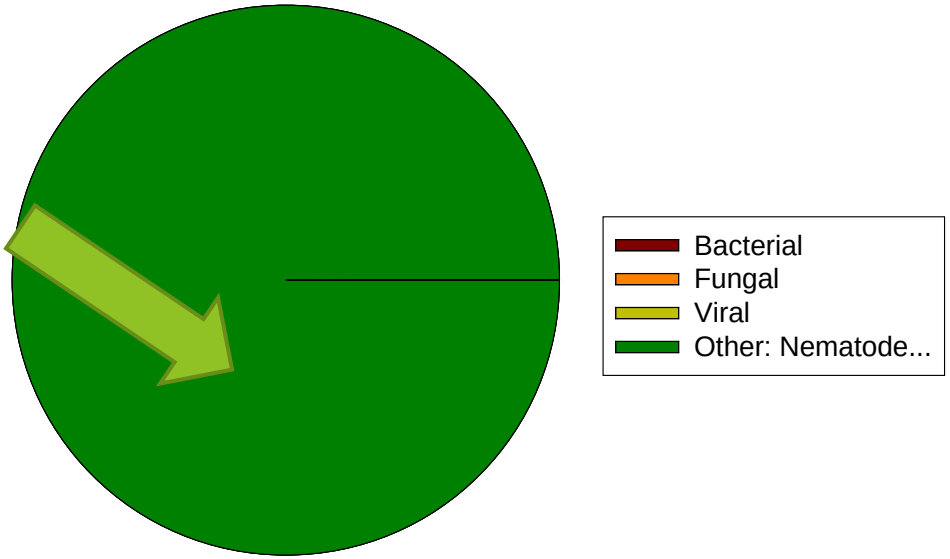

Adapted from Mishra et al., 2015

Major fungal biopesticides advantages:

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2. Direct pathogens of more than 1000 invertebrate species.

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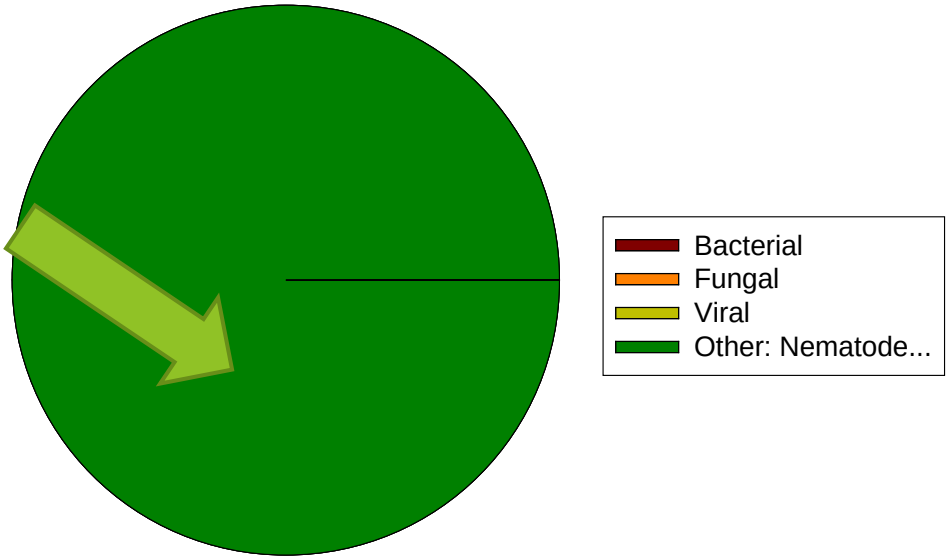

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B.Bassiana (BB)

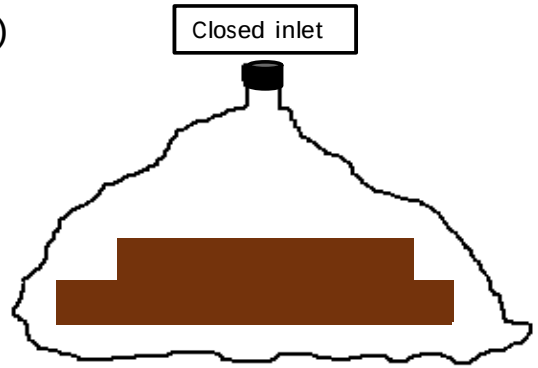
Entomopathogenic fungi, pathogenic to more than 700 host species.

T.Harzianum (TH)

Antagonistic fungi, specially effective against soil-borne diseases.

SOLID-STATE FERMENTATION (SSF) CONFIGURATIONS

a)



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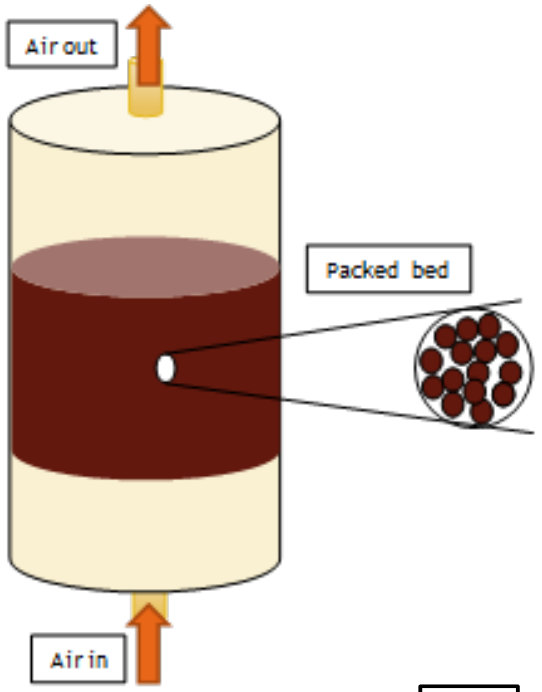

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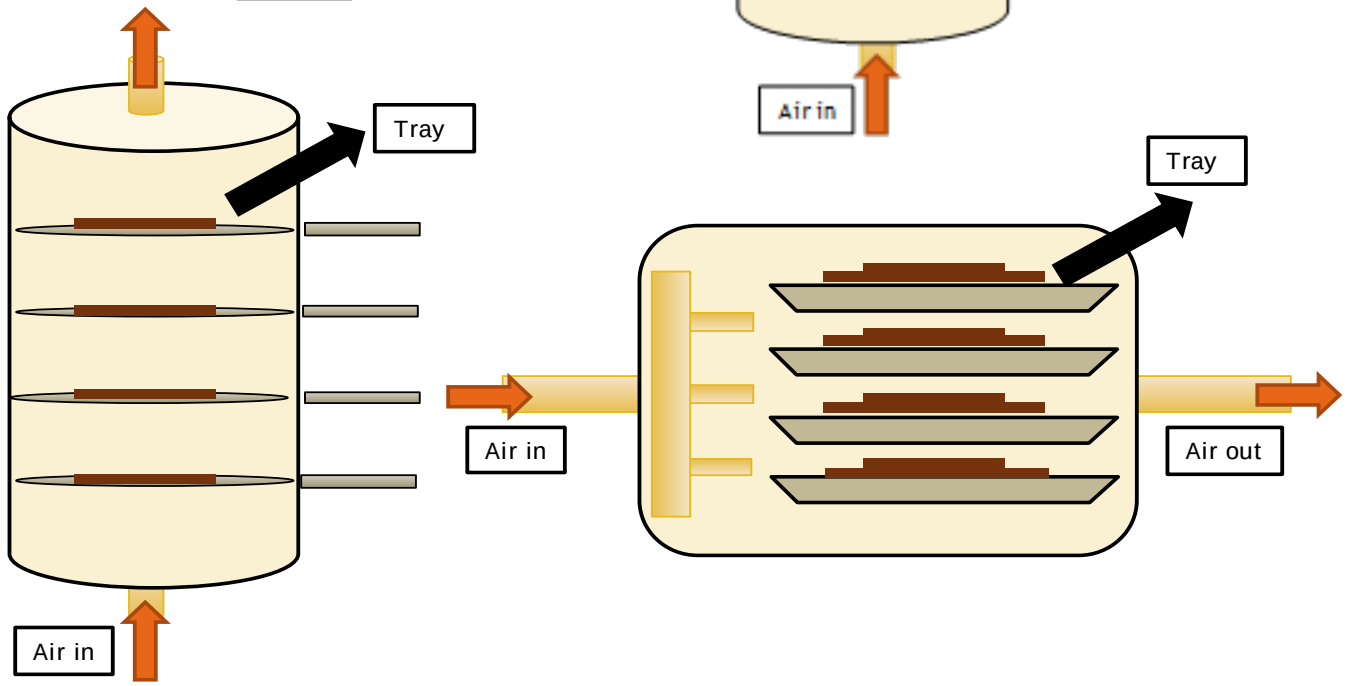

a) Bags.
- Preferred for commercial production.
- Easy and simple.
- Less occupied space.

b) Columns/packed bed reactors (PBB).
- Least used at commercial scale.
- Heat transfer and oxygen limitations due to bed thickness.
- Better forced aeration.
- Easy to handle and less labour intensive when compared to tray.

c) Tray reactors (TB).
- Used for commercial production despite required space in comparison to bags.
- Heat transfer and oxygen limitations due to bed thickness.
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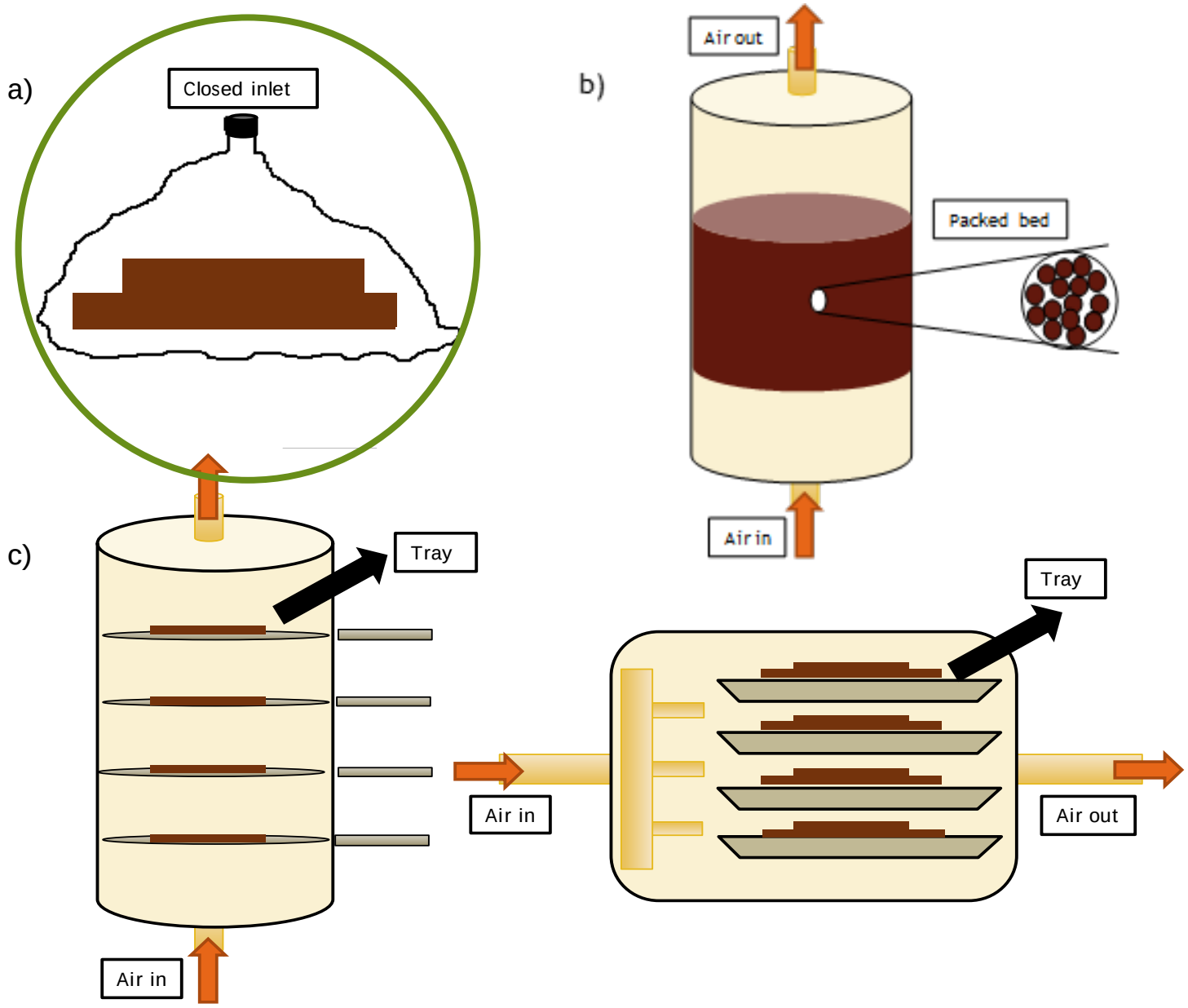

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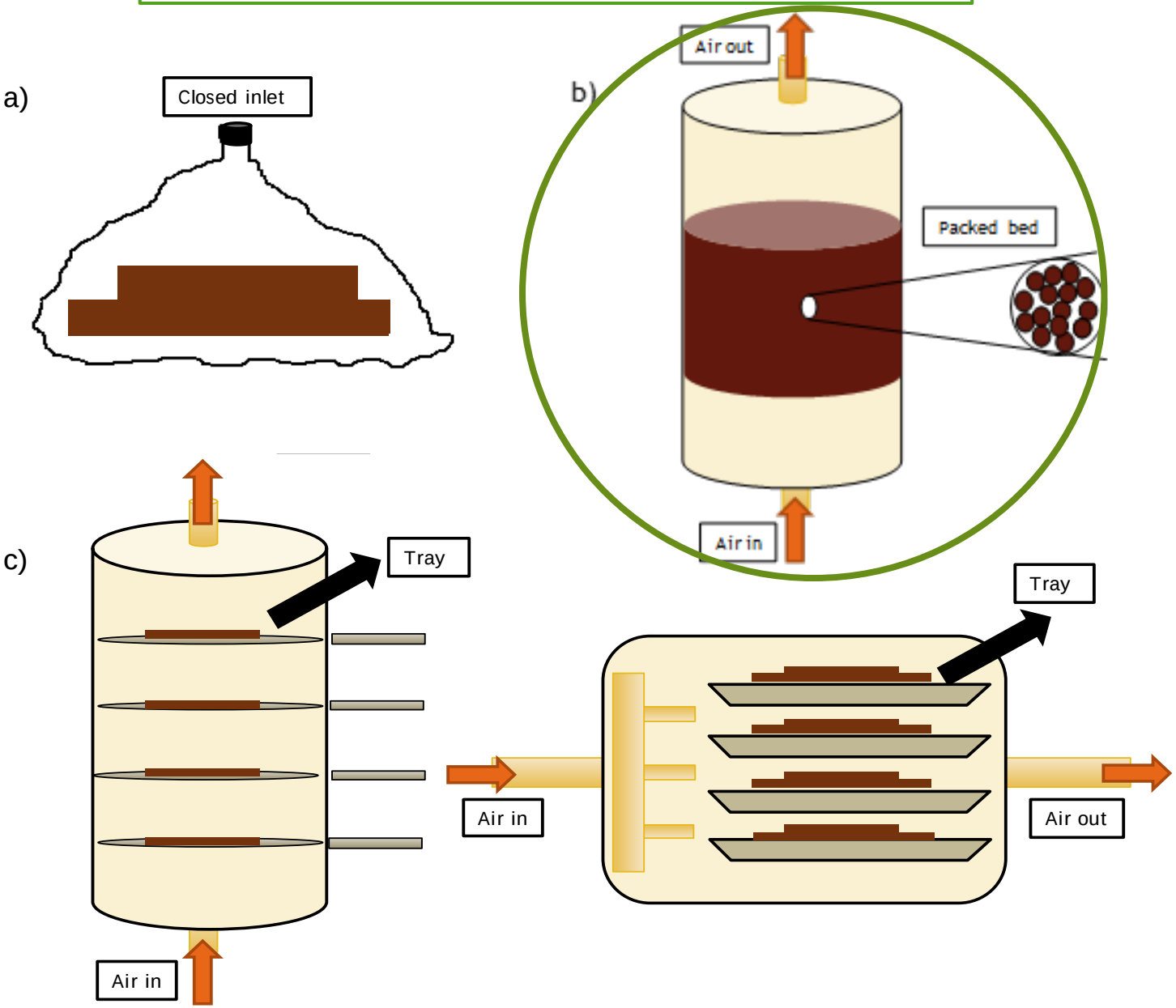

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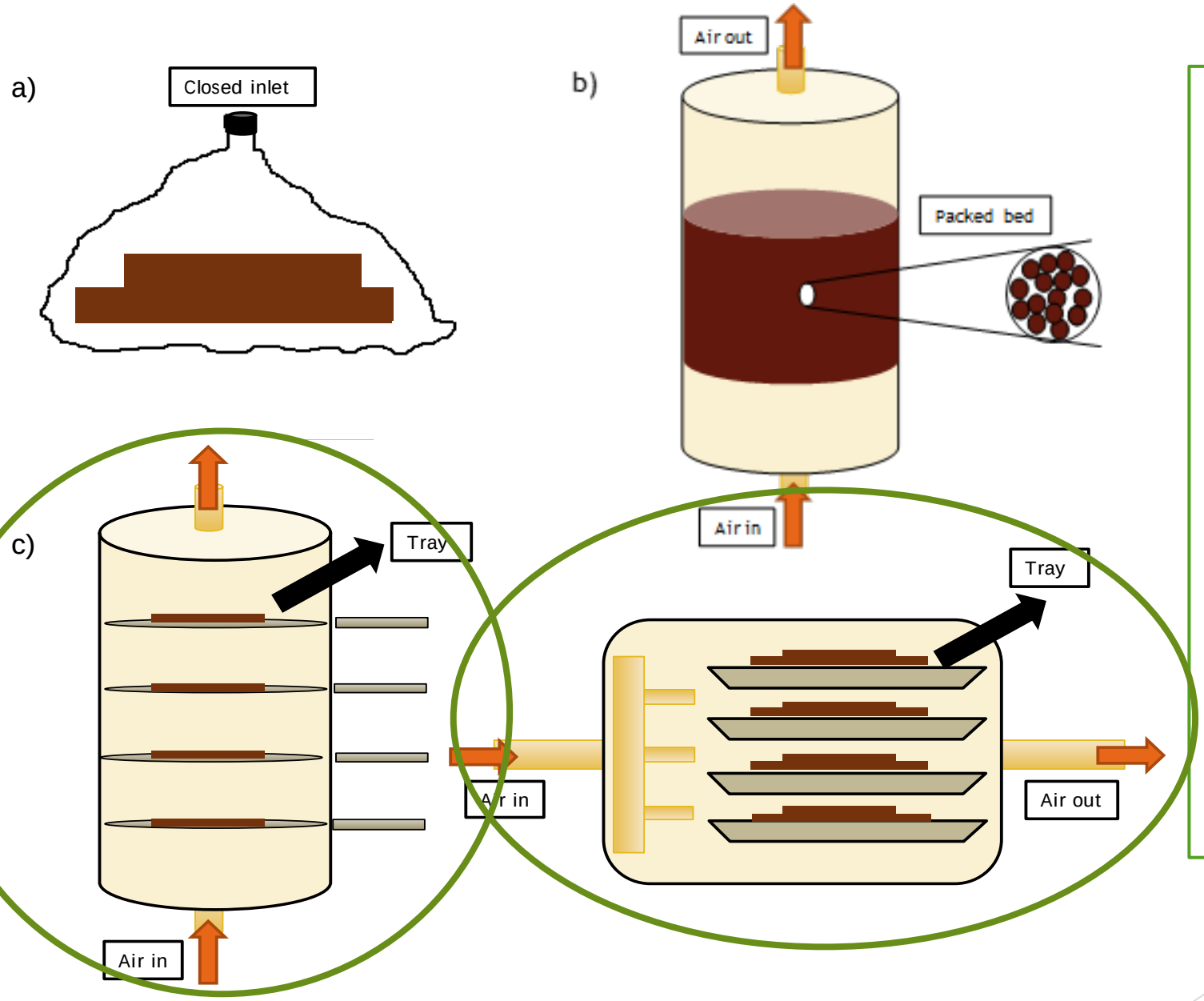

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1.5L PBB

22L PBB

TRAY BIOREACTORS

2 TRAY TB

3 TRAY TB

In both tray designs: TRAY 1 – closest to the air inlet

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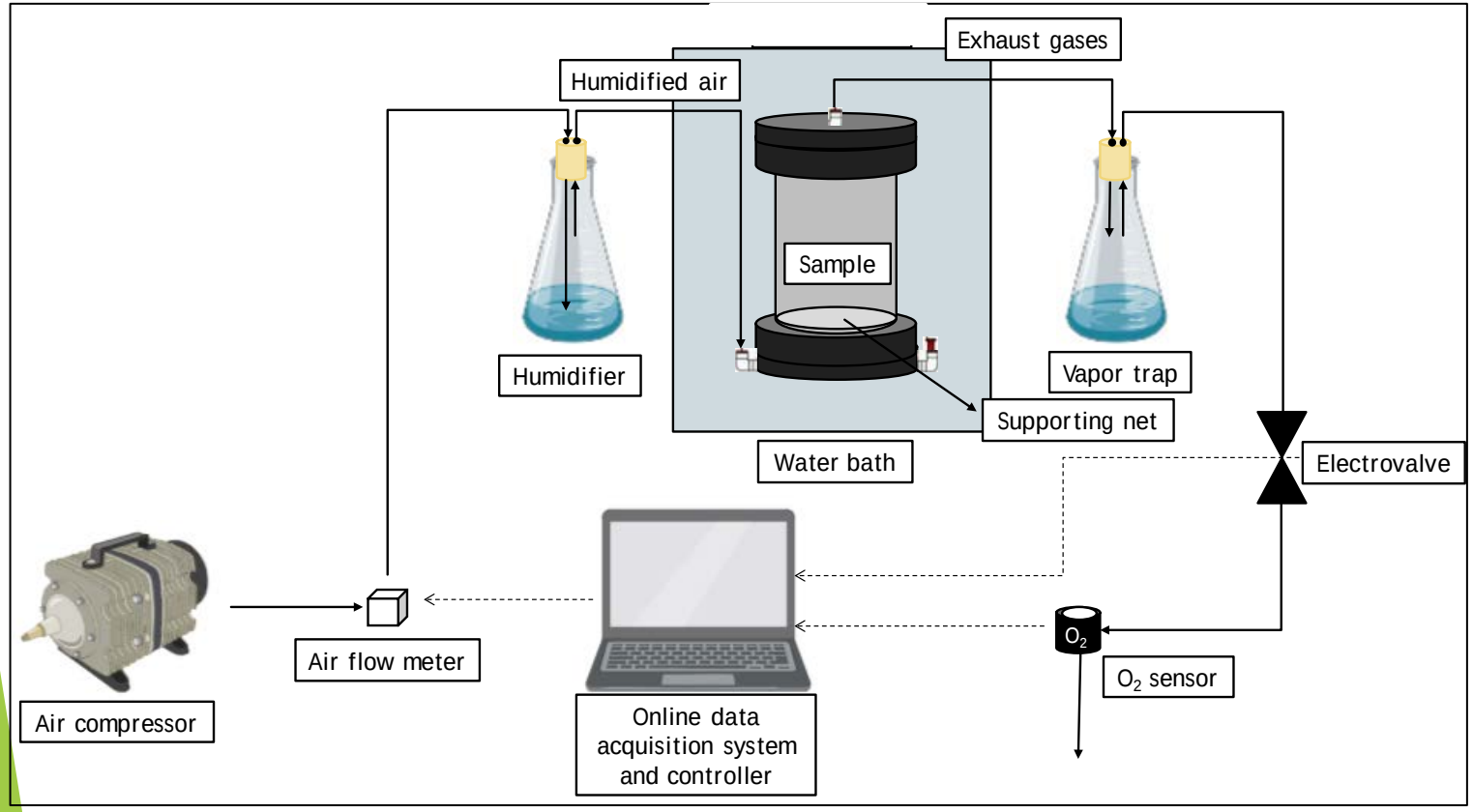
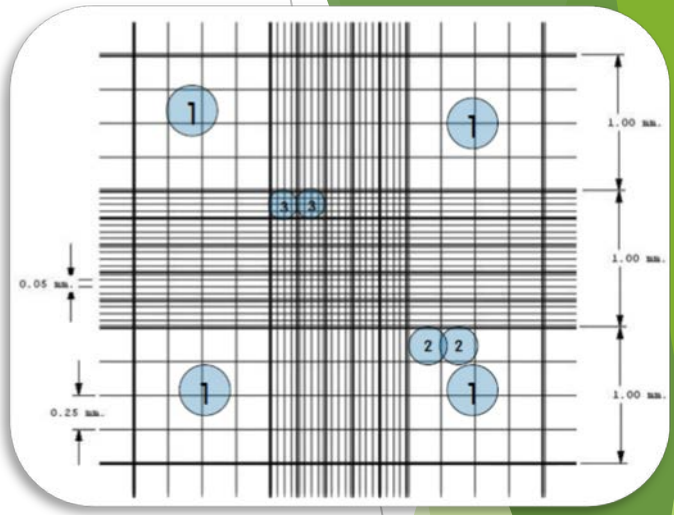
OPERATIONAL PARAMETERS

Specific oxygen consumption rate (sOUR)



Temperature (Tº)

Conidia concentration (conidia g^{-1}dm)



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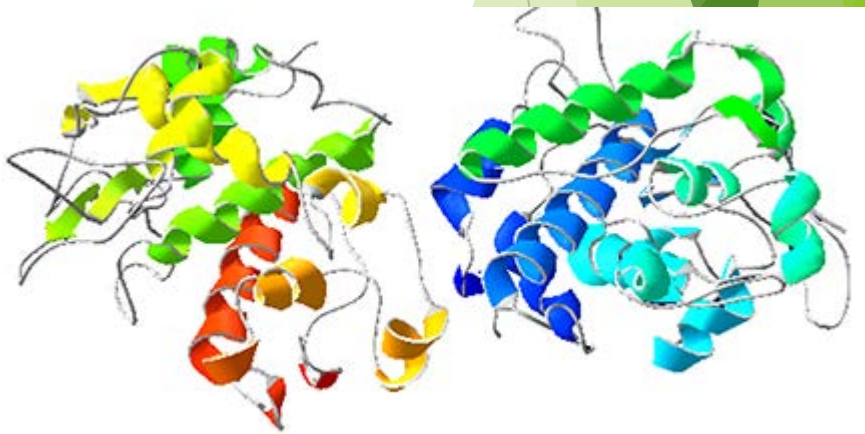

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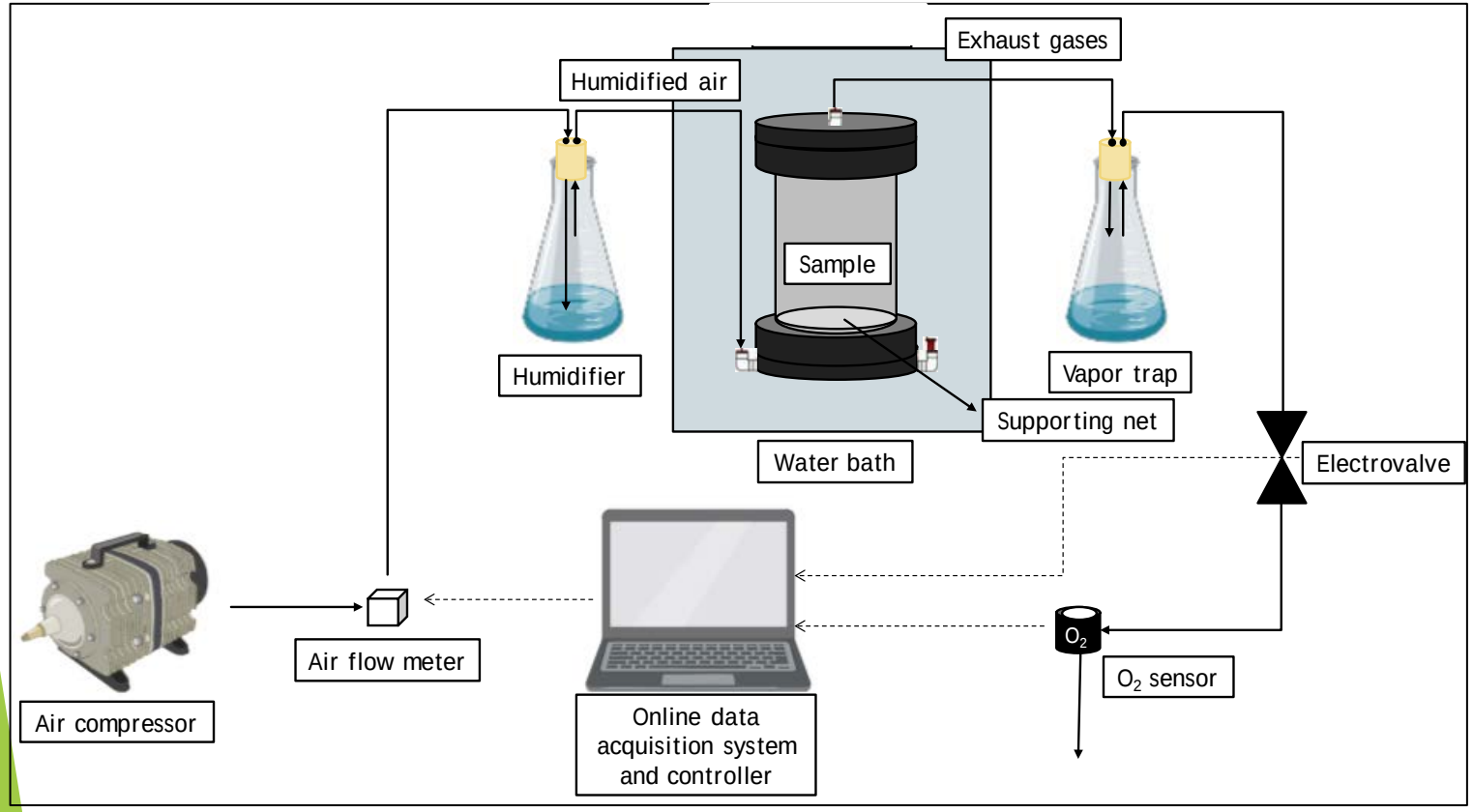

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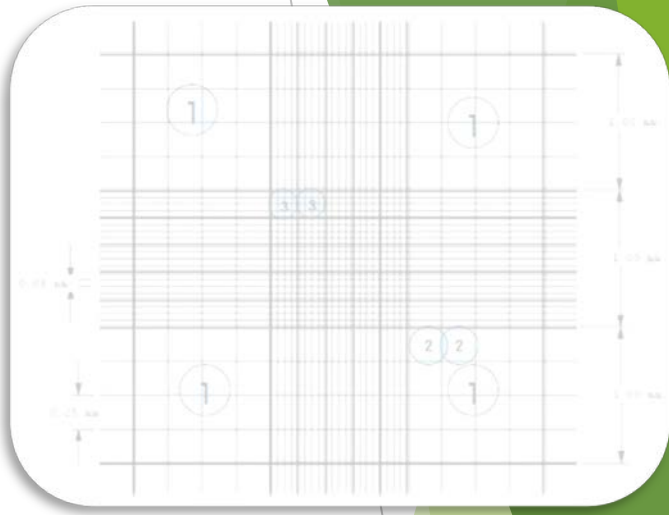

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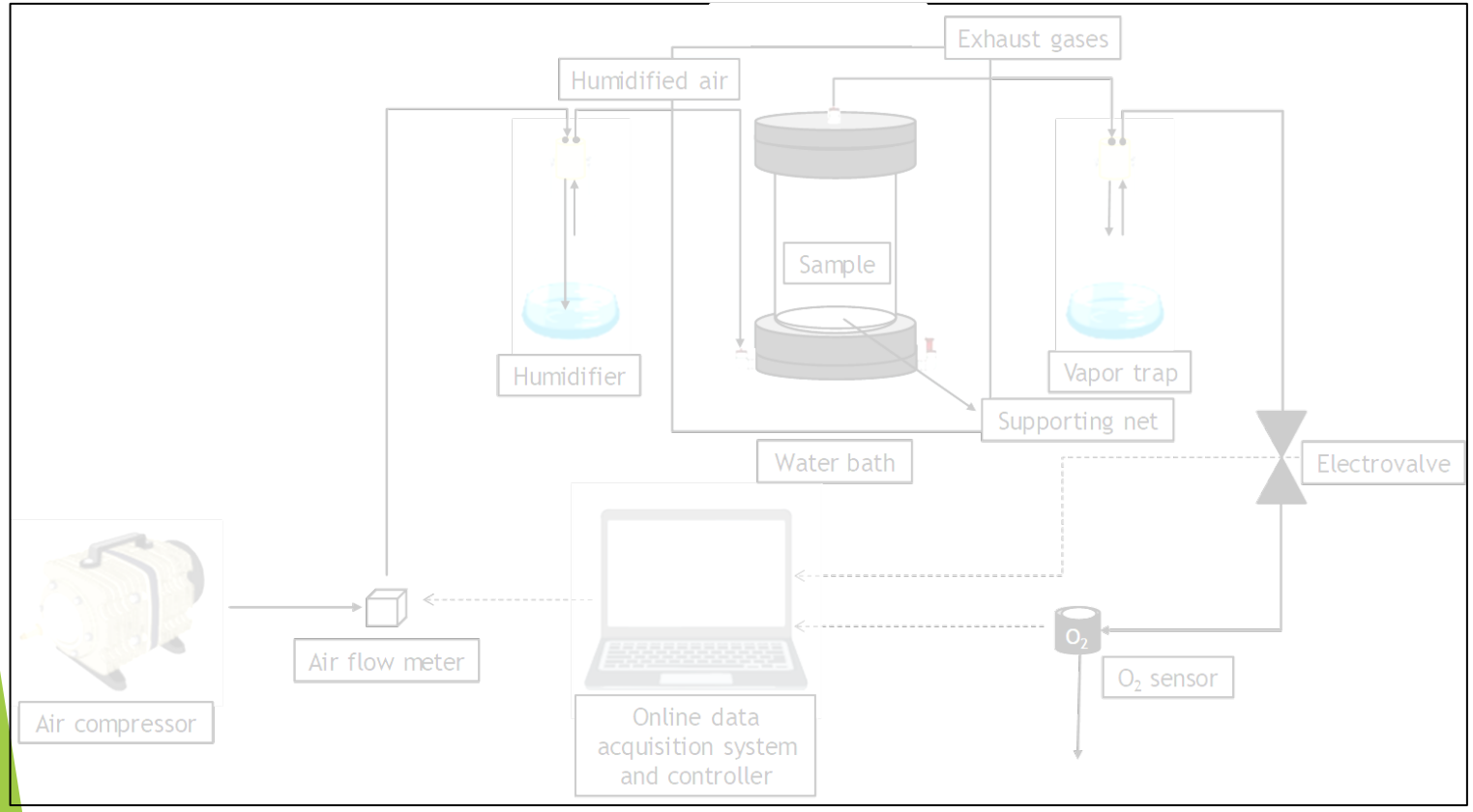

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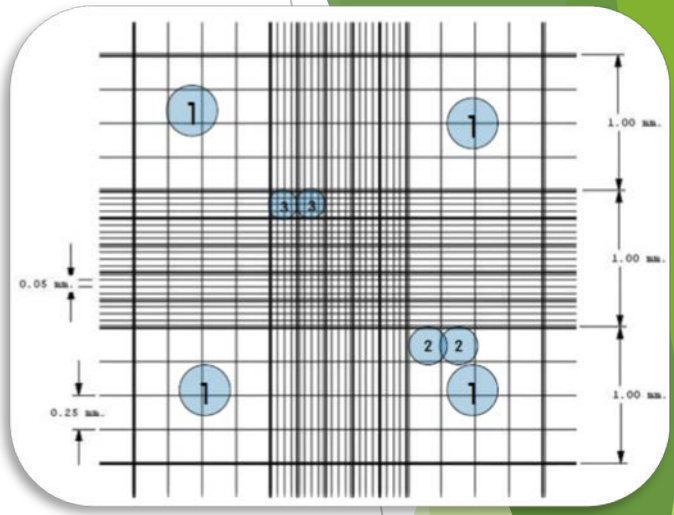

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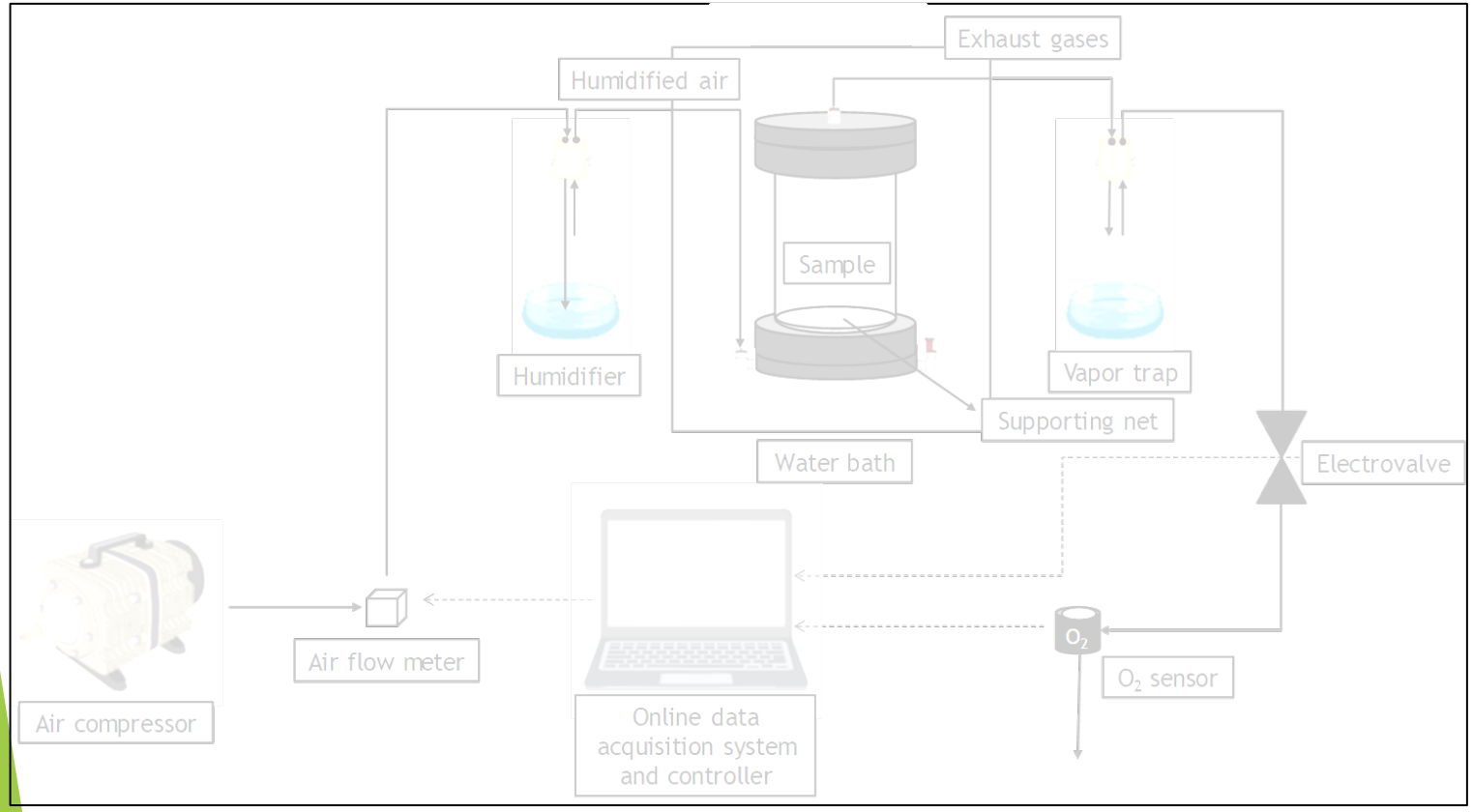

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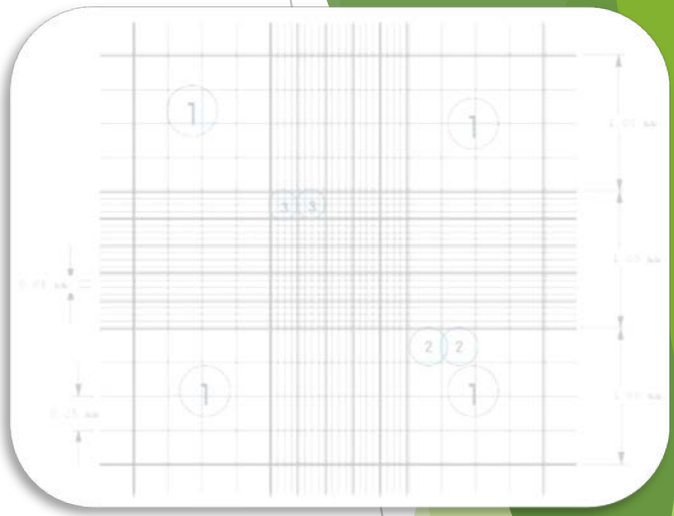

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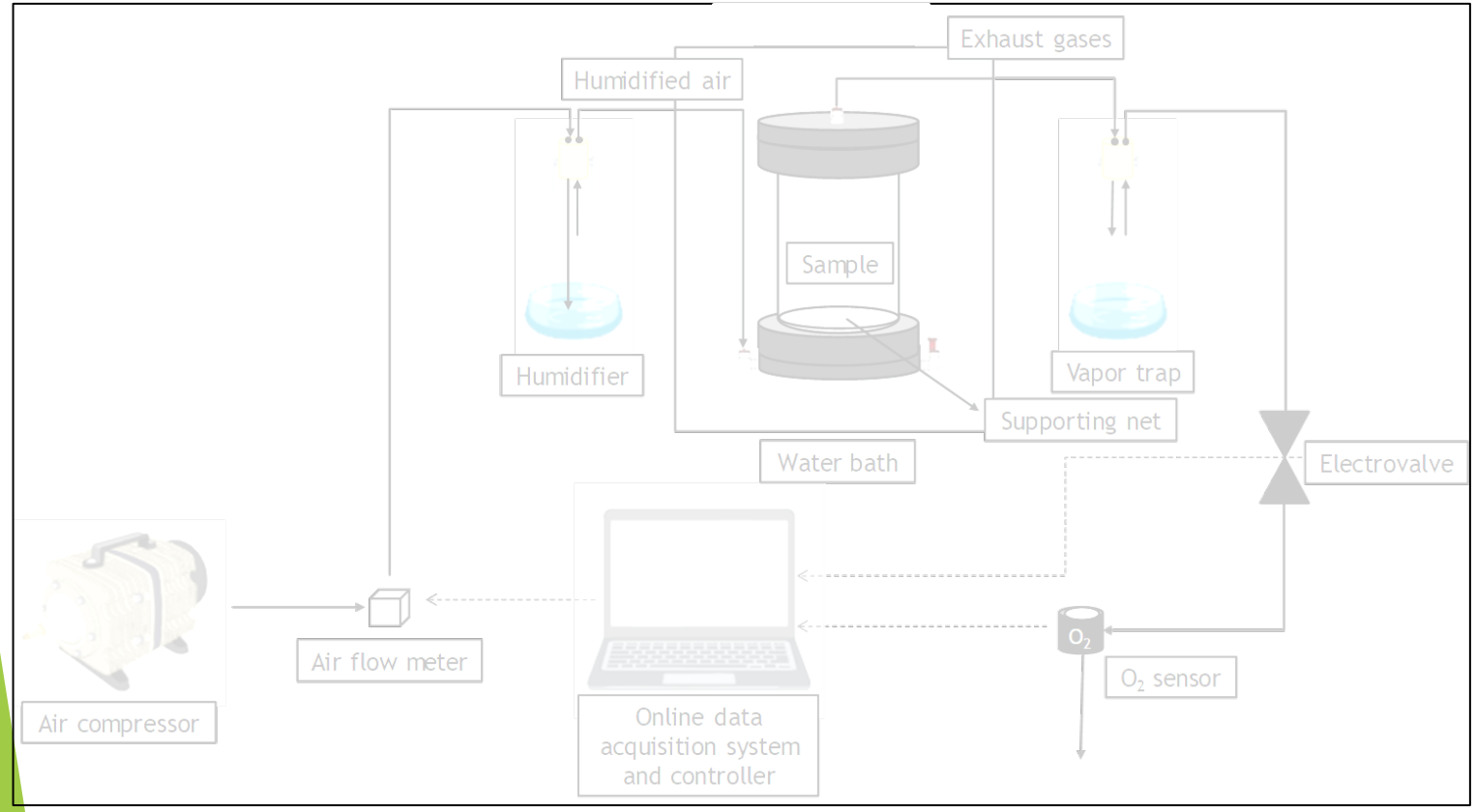

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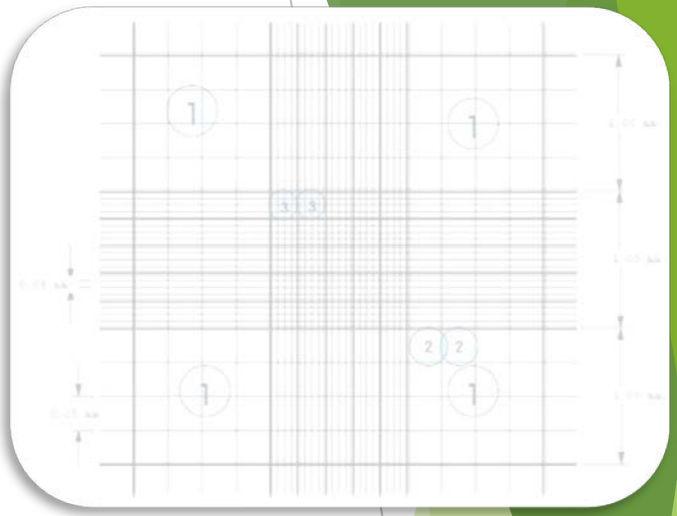

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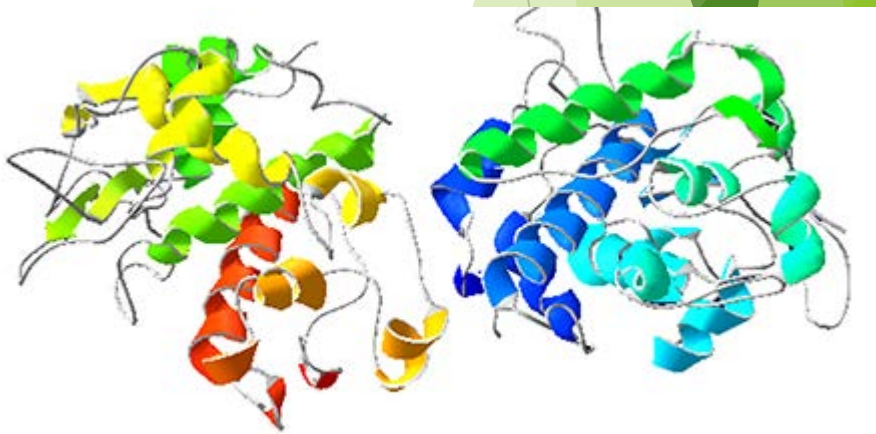

SUBSTRATES

RICE HUSK (RH)

BEER DRAFF (BD)

BEER DRAFF + WOOD CHIPS (w/w)

70/30
1.5L PBB
TB

40/60
22L PBB

sOUR ($gO_2\ kg^{-1}dm$)	0.6 - 1.2	4.0 - 5.0	2.6 – 3.5
Air filled porosity (AFP_R) (%)	90 - 95	55 - 60 ⇊	69 - 72 (70/30) 79 - 82 (40/60)
Total sugar content (mg $g^{-1}dm$)	17.3 – 18.1	114.4 – 131.0	90.0 – 117.0 (70/30) 62.6 – 73.2 (40/60)

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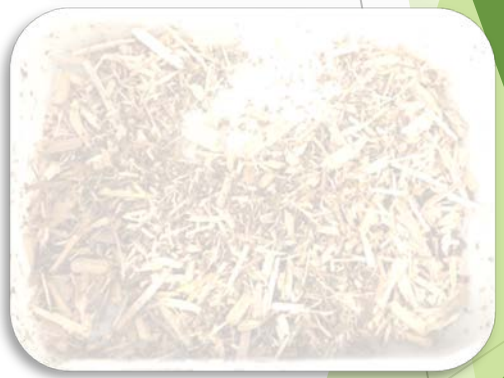

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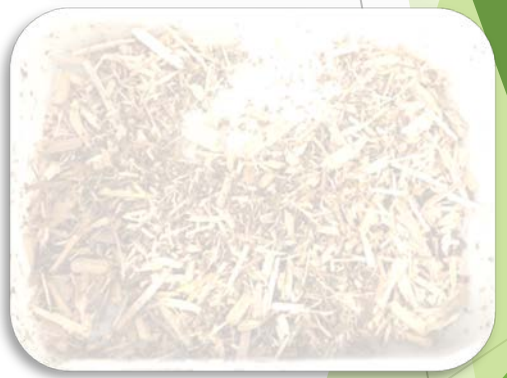

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TESTS - PBB

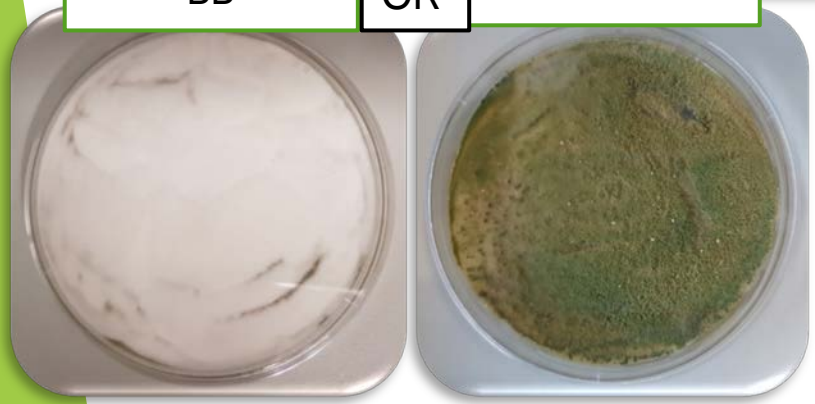
1.5L

RH

OR

BD (70/30)

BB OR TH



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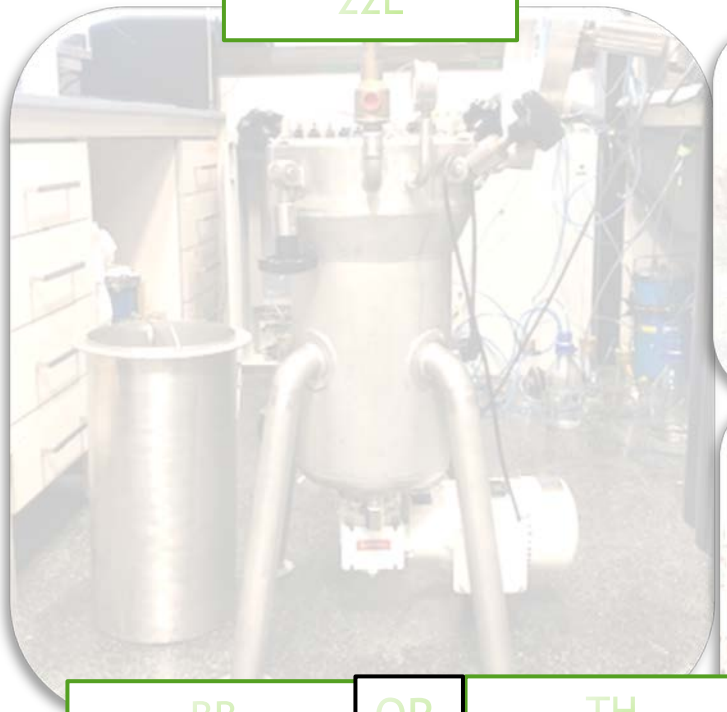

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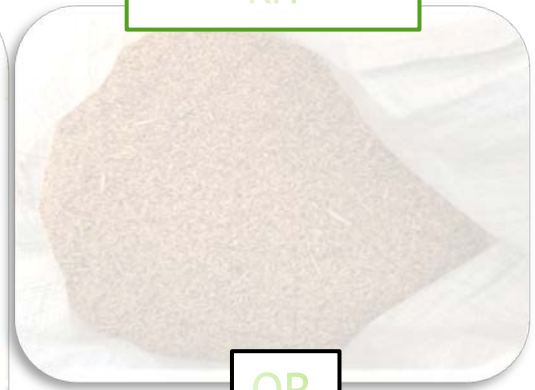

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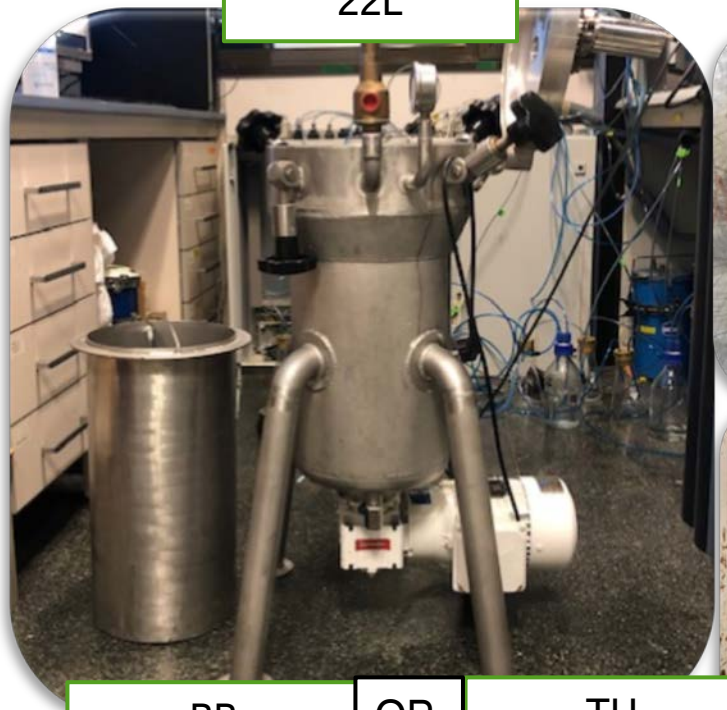

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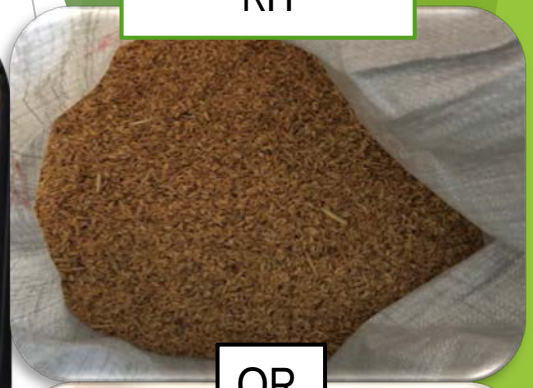

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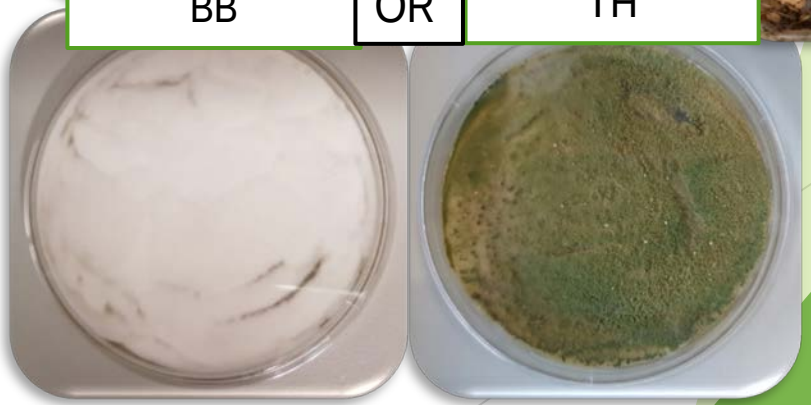


TESTS - TB

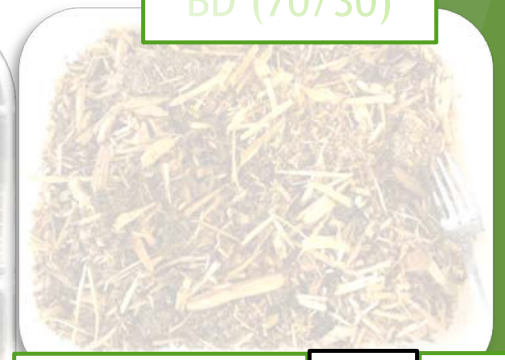
2 TRAY

RH

TH

3 TRAY

BD (70/30)



BB OR TH

CHITINASE

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TH

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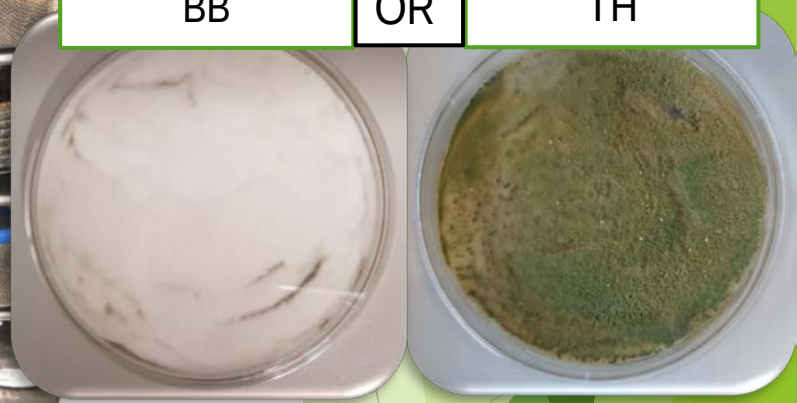

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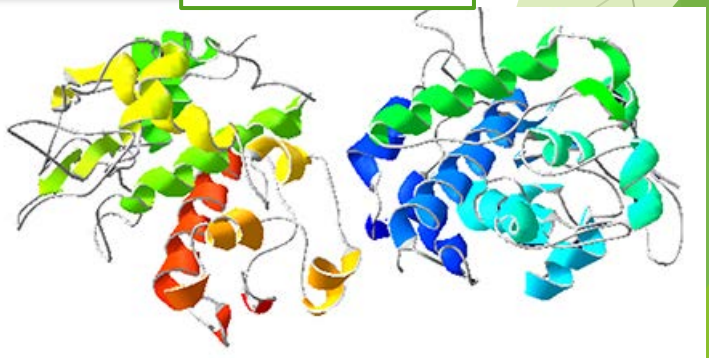

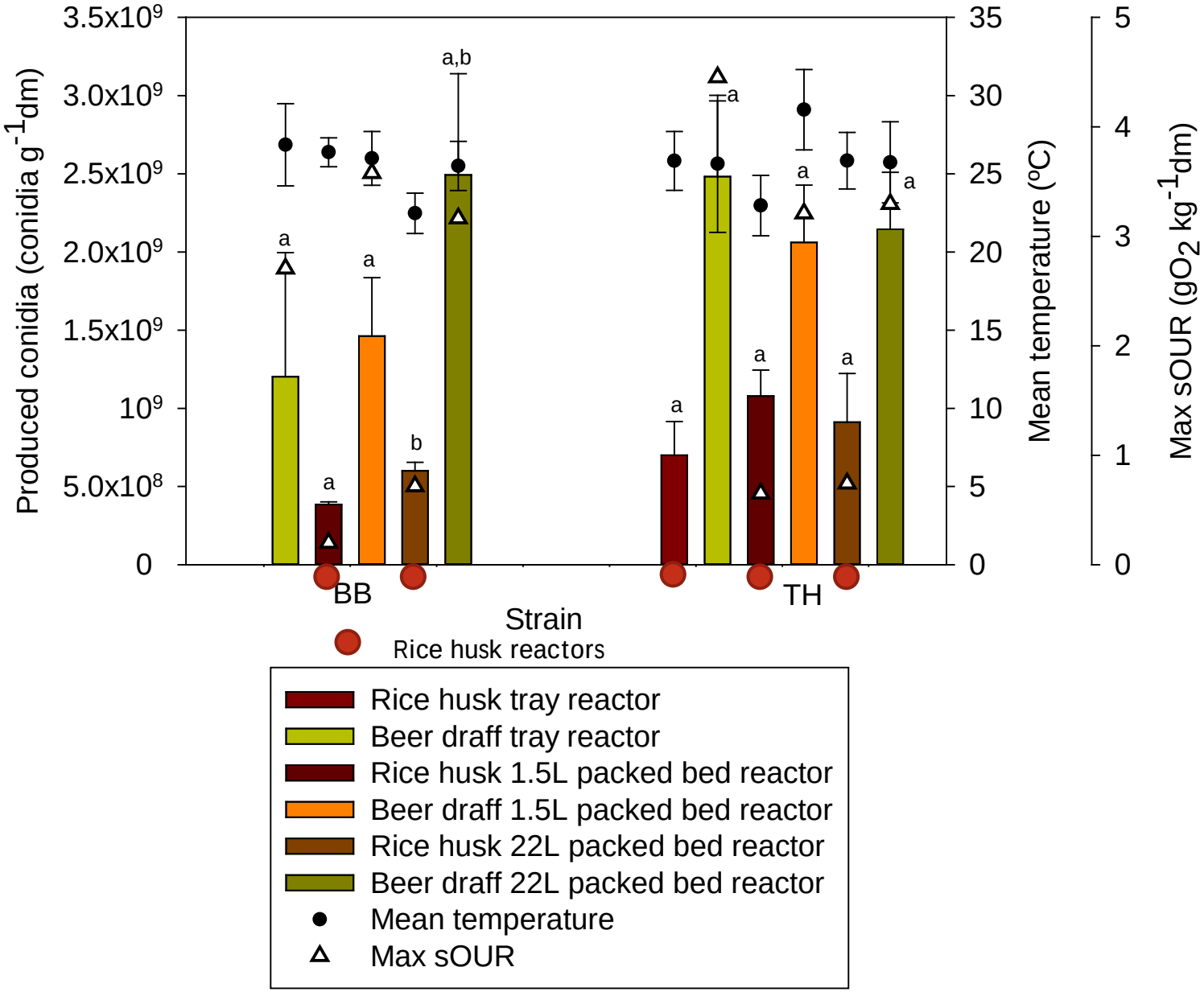

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- No significant differences in conidia production when comparing with same substrate and strain.
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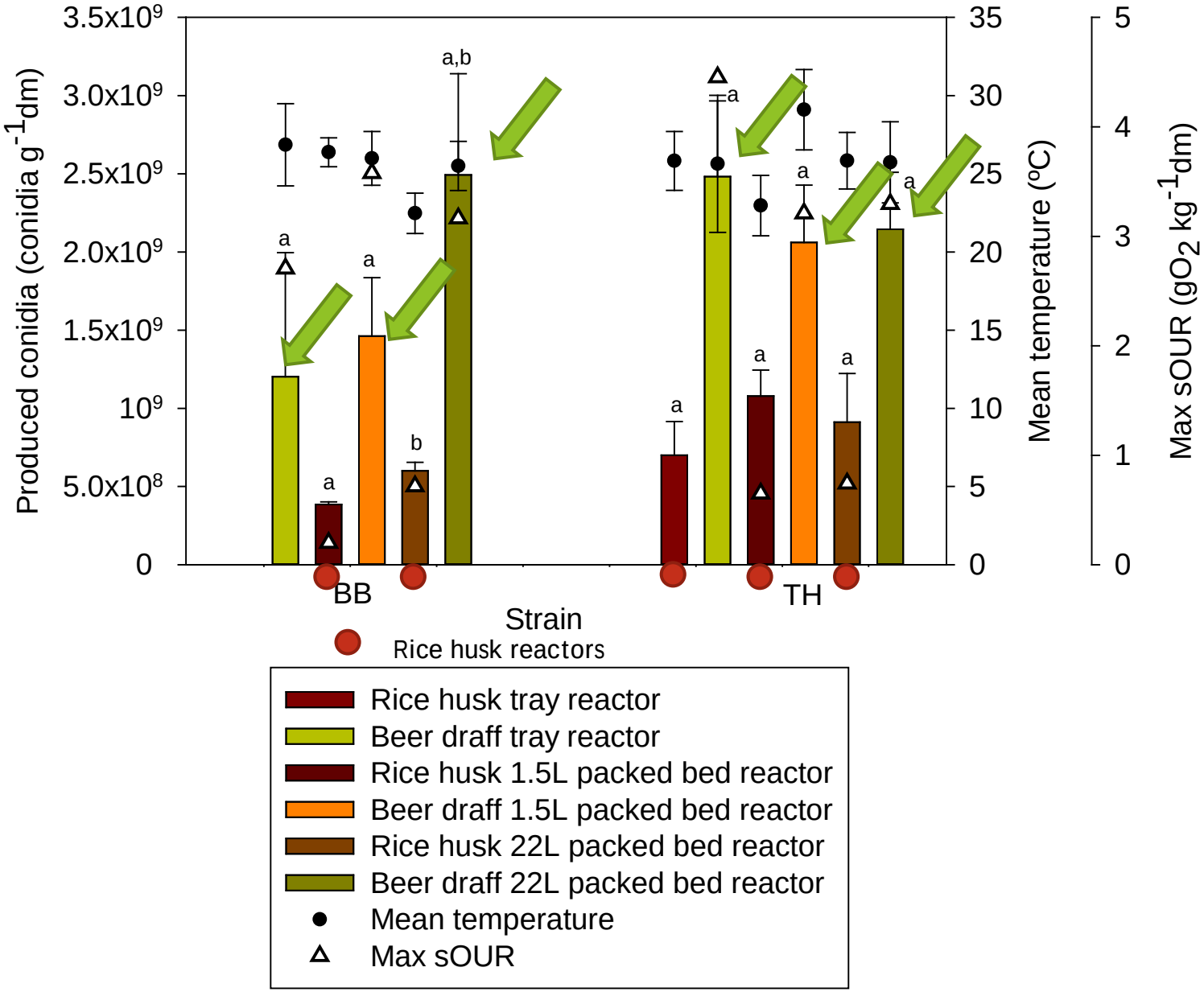

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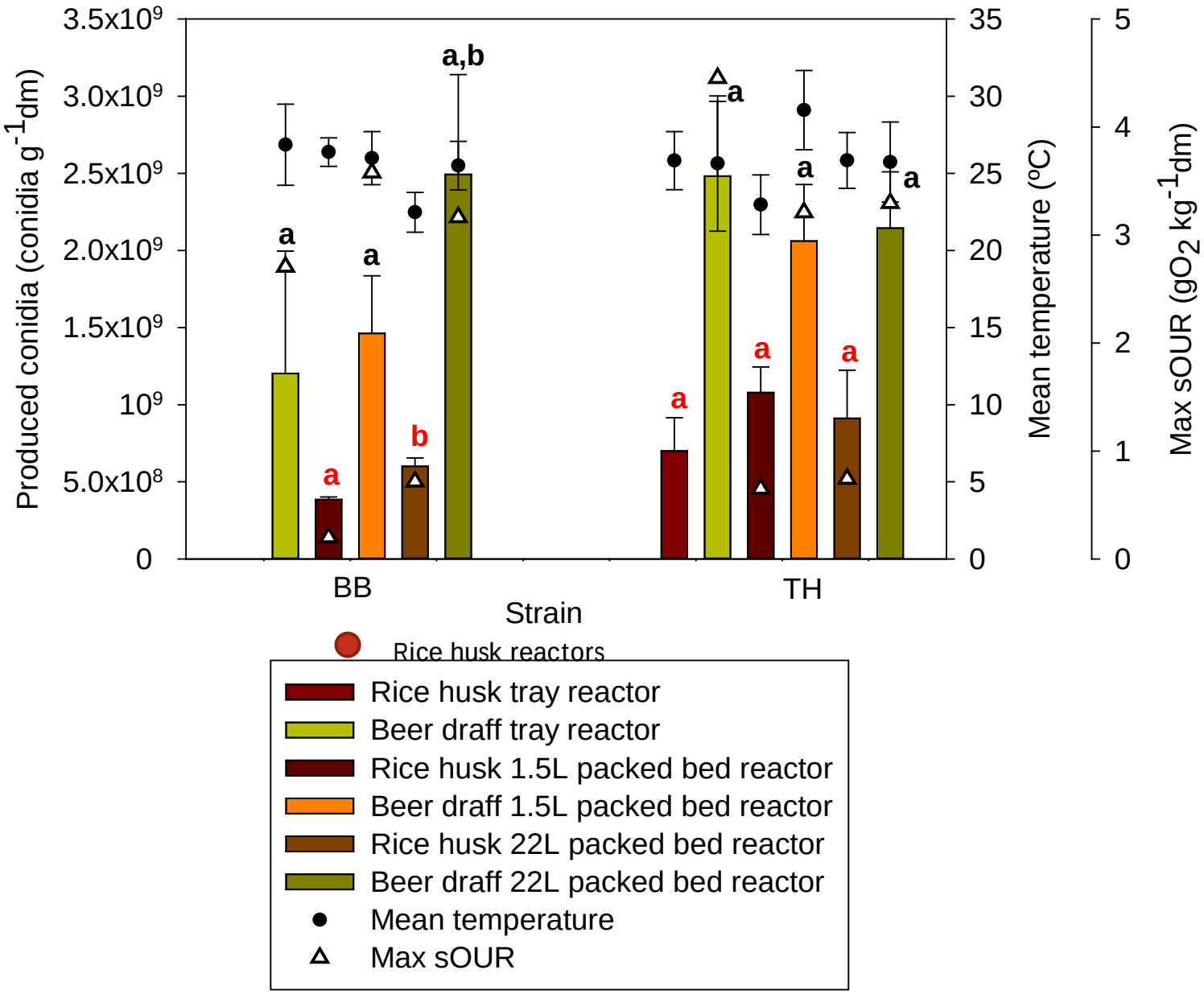

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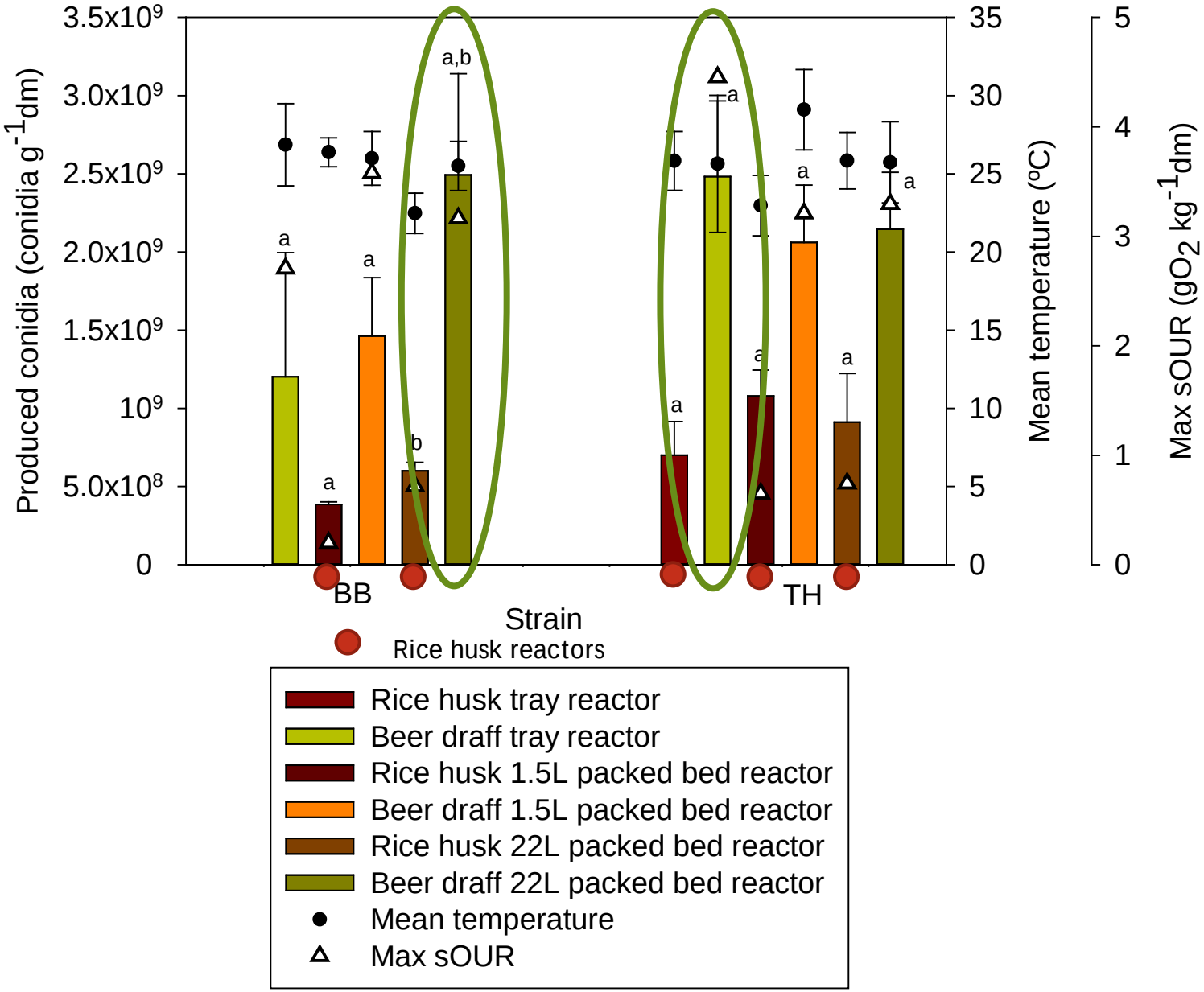

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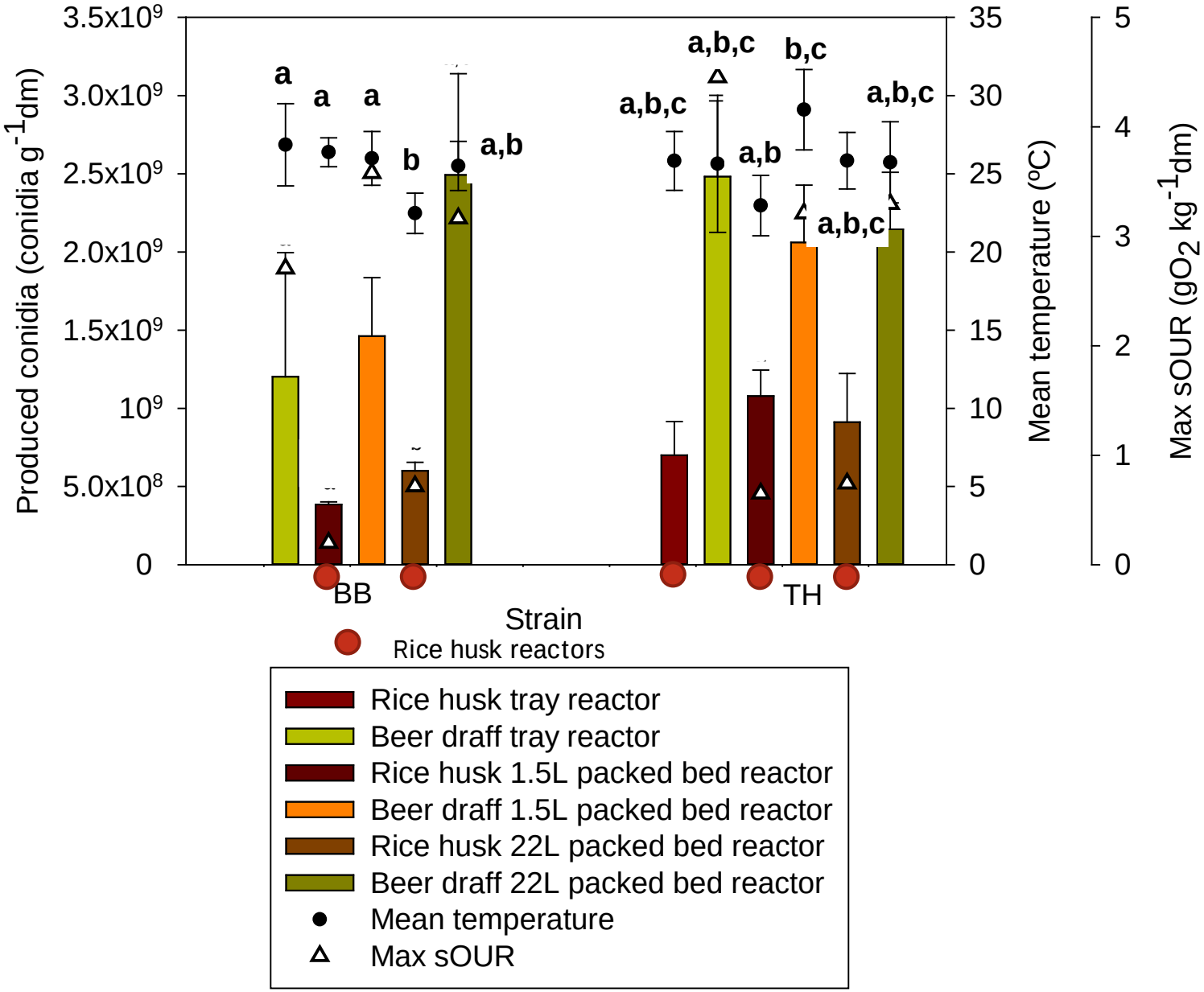

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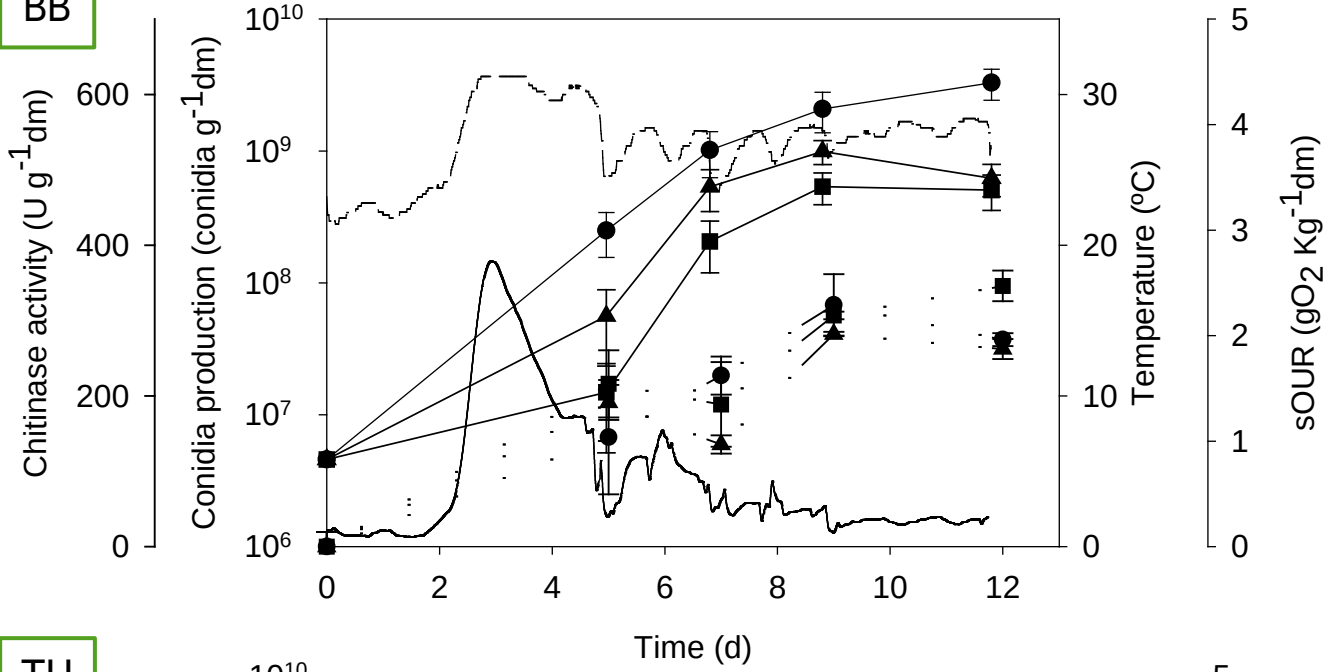
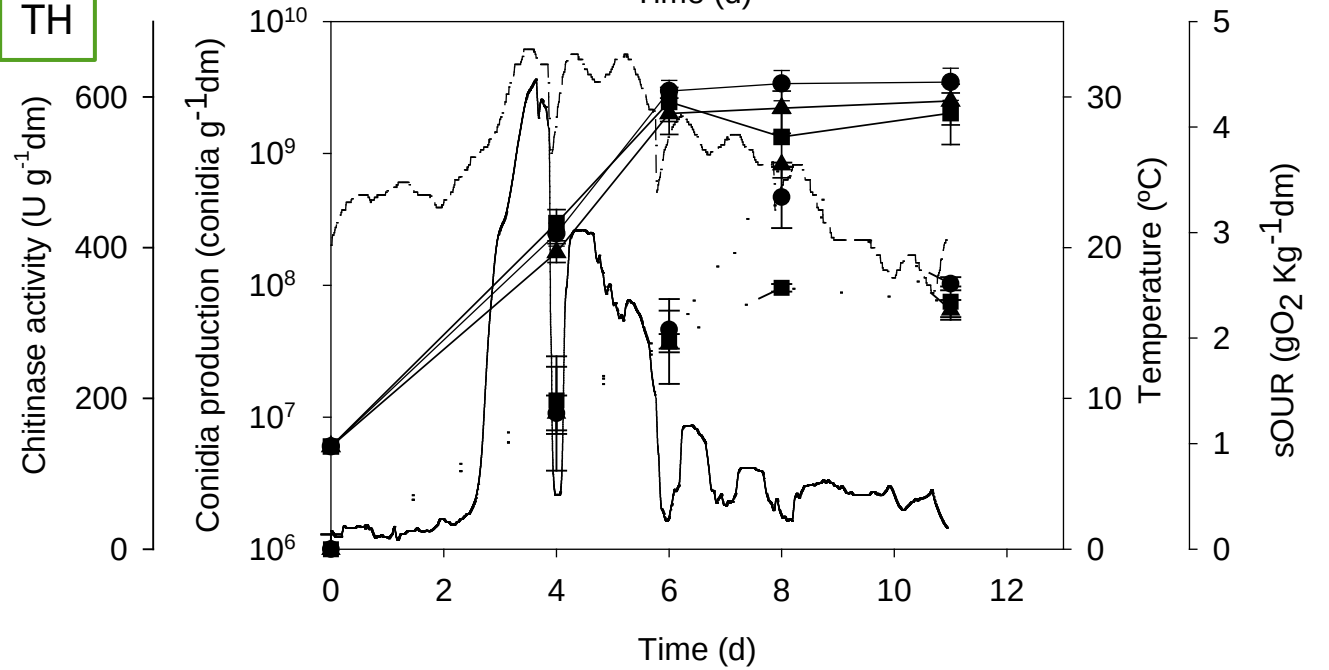
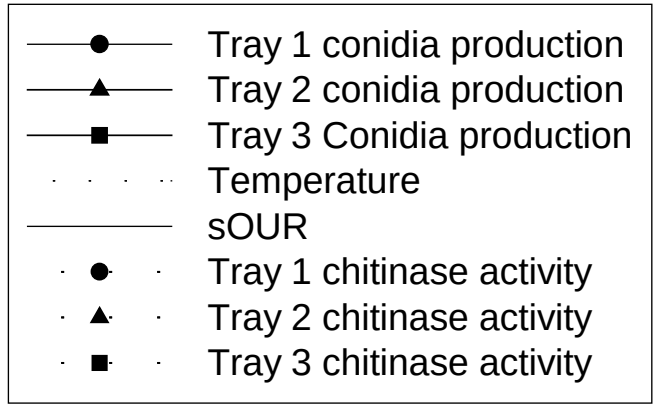


TH



- Higher chitinase production obtained in TH batch.
- Maximum chitinase production achieved after maximum conidia productivity when using TH.
- Conidia production is dependant on distance from airflow when working with BB, but chitinase production is not dependant.
- Conidia production in independent on distance from airflow when working with TH, but chitinase production is dependant.



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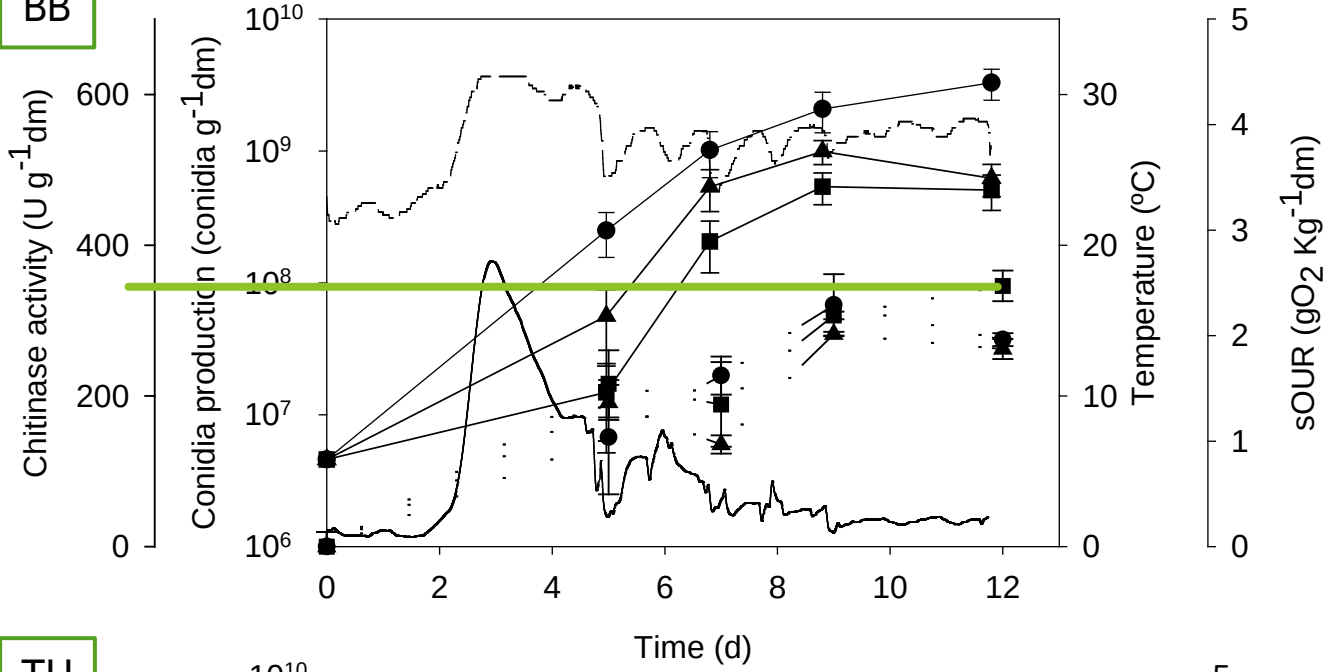
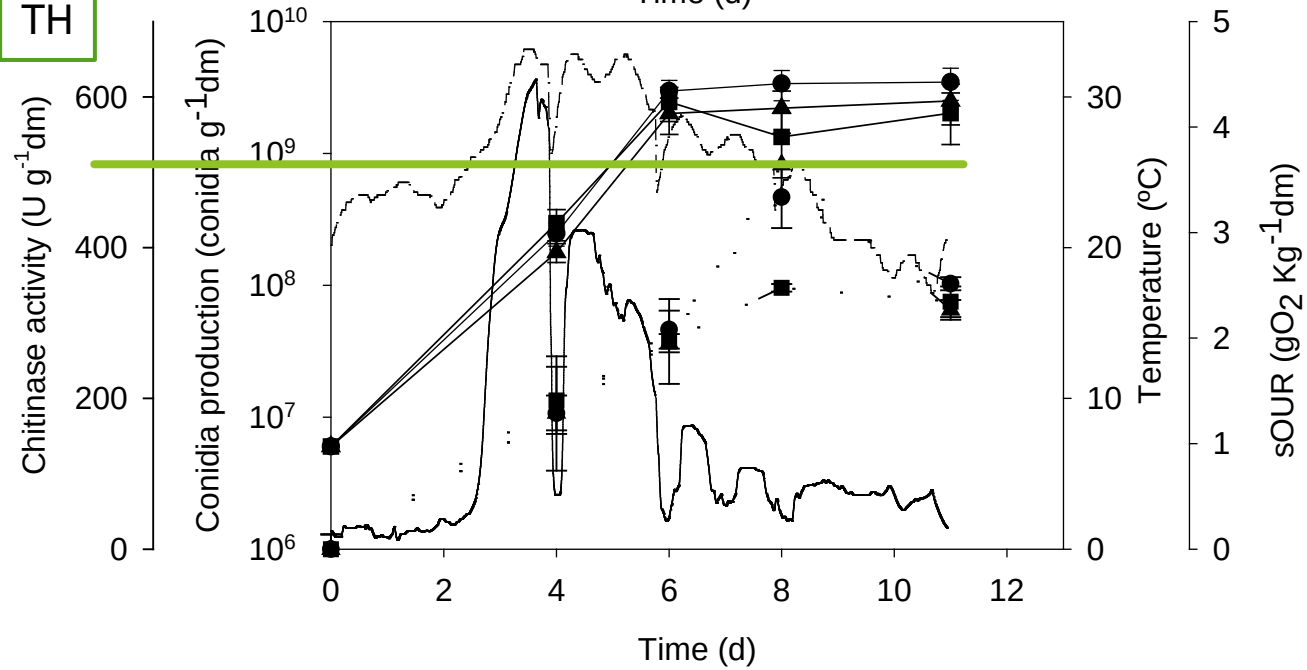


TH



- Higher chitinase production obtained in TH batch.
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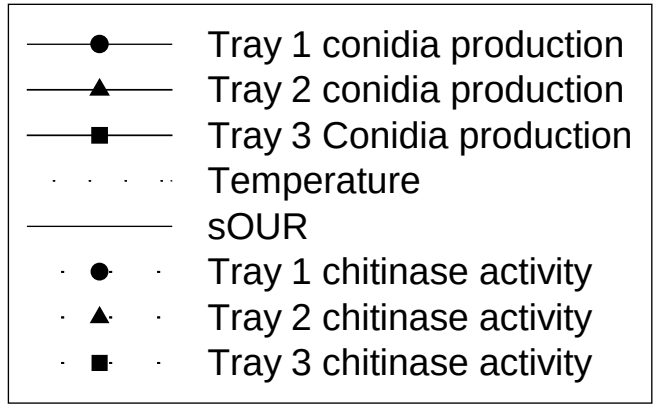

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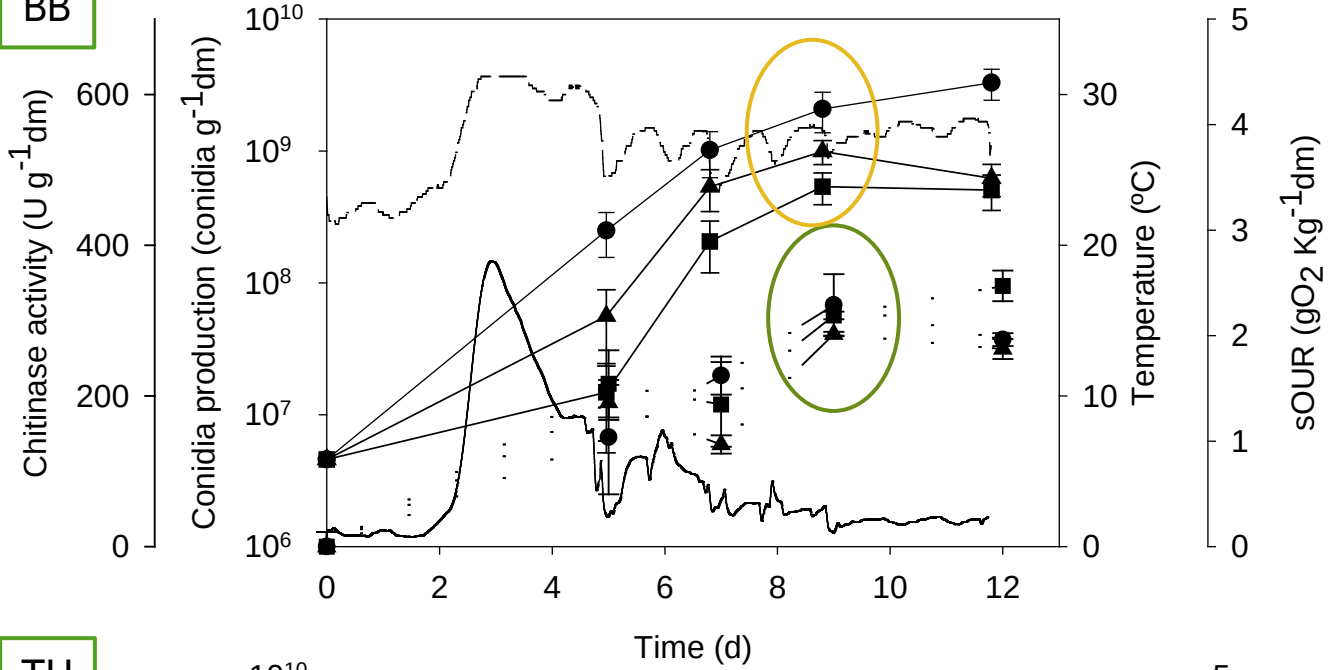

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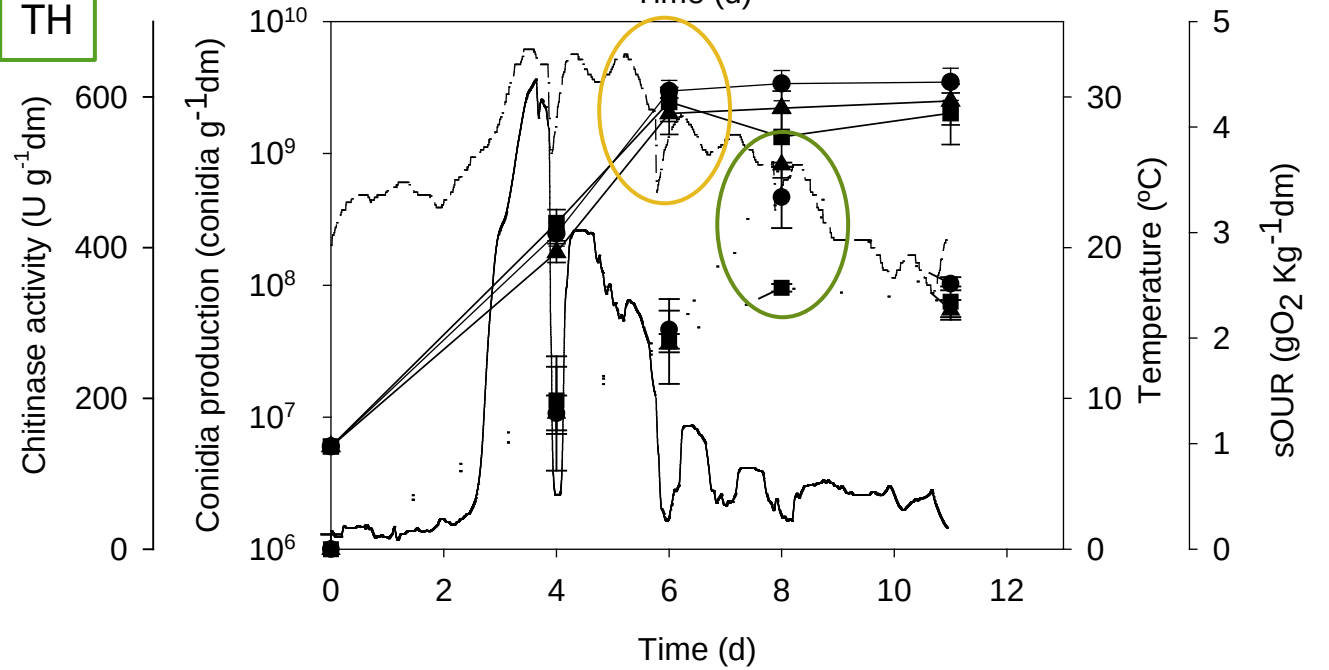

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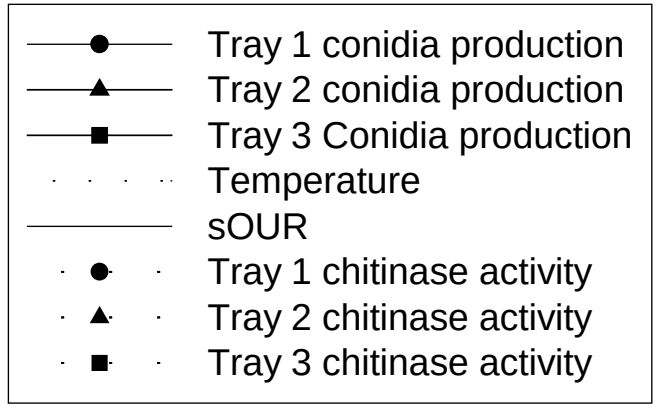

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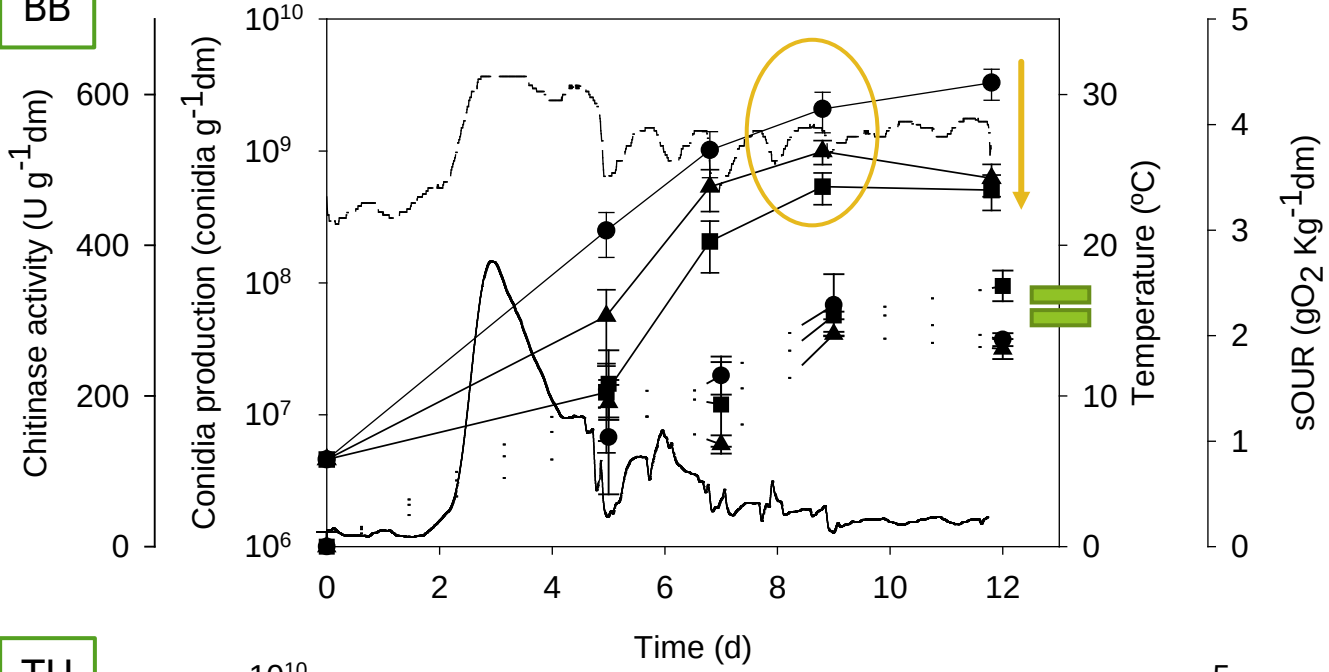

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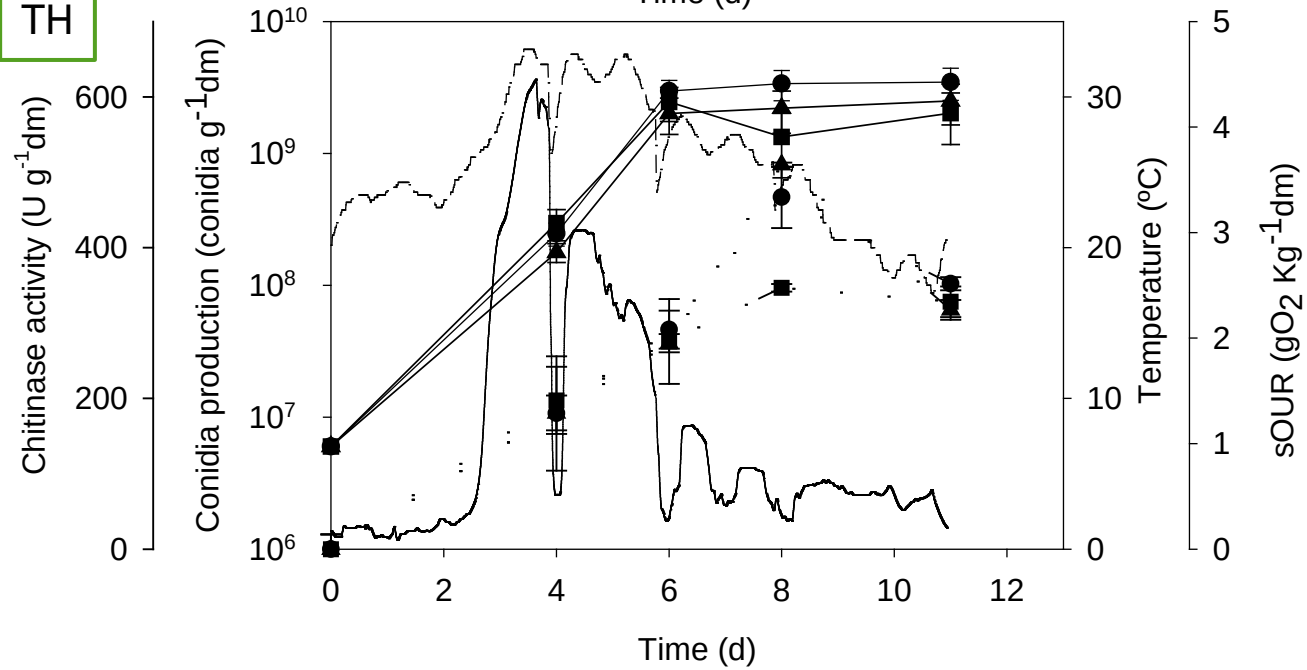

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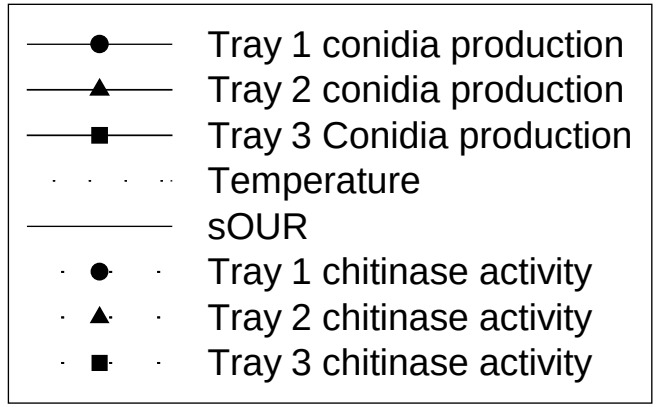

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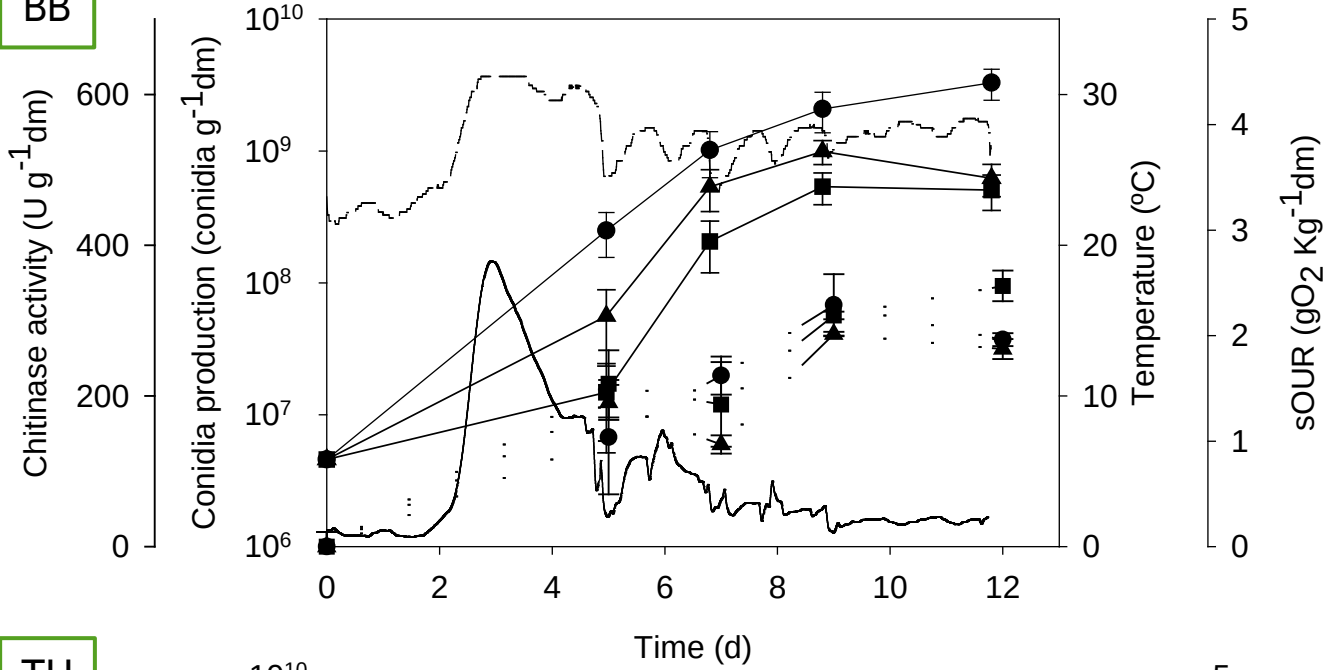

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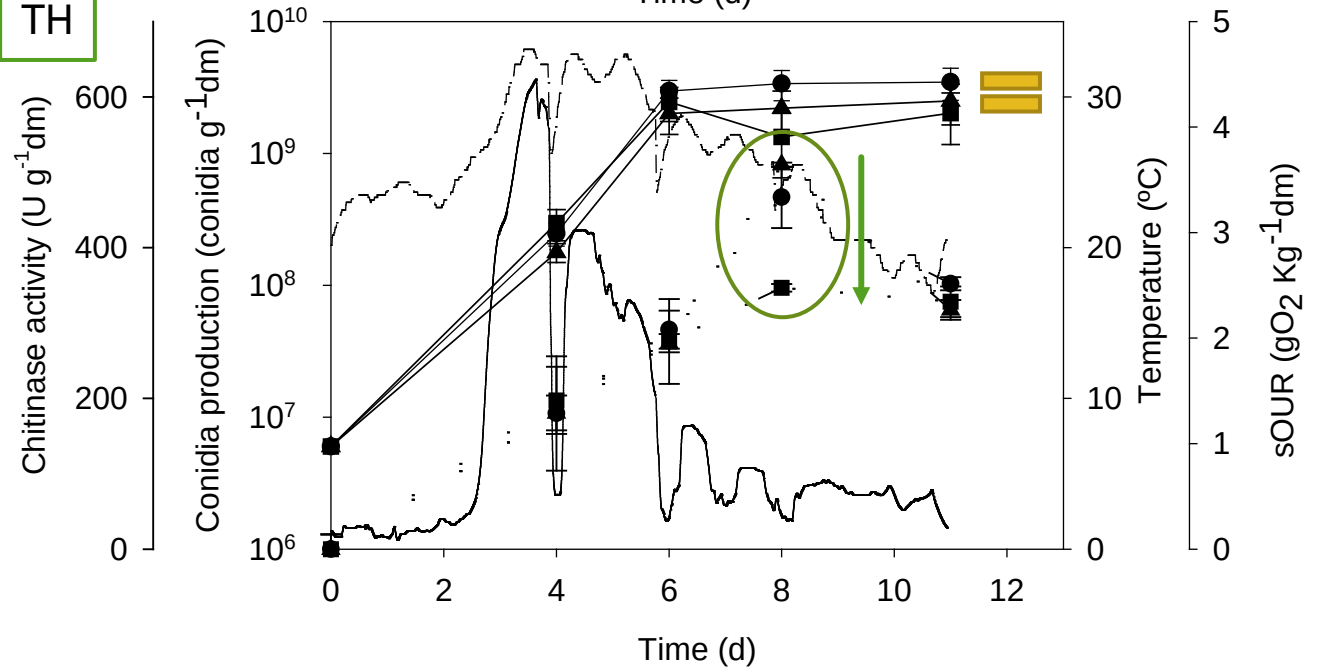

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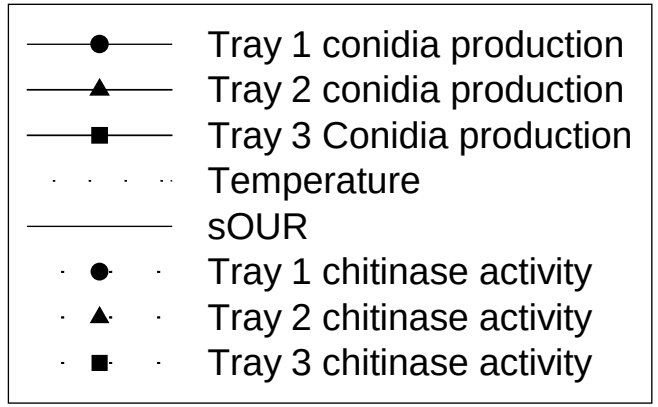

CONCLUSIONS:

- Fungal SSF conidia production has been achieved using agro-industrial wastes of different biodegradability.
- Wastes presenting biodegradability properties similar to beer draff are better as fungal producers than wastes similar to rice husk if their AFP_R is properly adjusted.
- Promising results shown by PBBs in terms of conidia production and temperature variation when comparing to TBs open scaling up possibilities for this configuration.
- Similar chitinase profiles were obtained in both TB strains' fermentations. Maximum values were achieved using TH.
- Airflow role in conidia and chitinase production is strain dependent.

FUTURE WORK:

- Improvement and scaling up of PBBs using beer draff as substrate, at least up to pilot scale.
- Obtain more data on chitinase performance in SSF, specially with PBBs but also with TBs.

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THANKS FOR YOUR ATTENTION!

QUESTIONS?