Fungal Decay: Using Fungi as a Biological Pretreatment for Anaerobic Digestion

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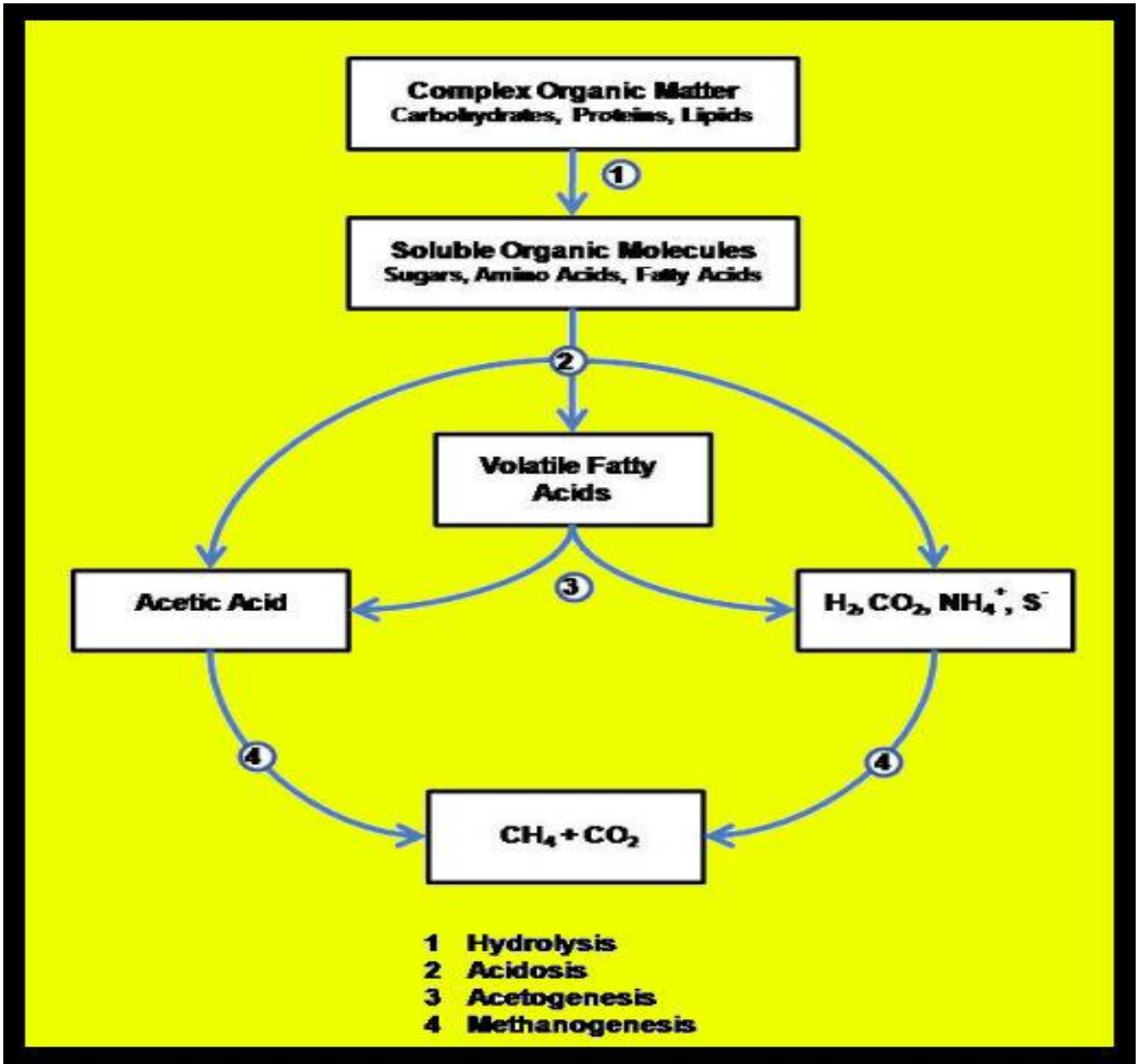
Introduction

- Anaerobic digestion is defined as the microbial degradation of organic material under anaerobic conditions.
- It is a natural process that occurs in oxygen-free environments, such as swamps.
- Anaerobic digestion produces two products: biogas and biofertilizer

Hydrolysis


Complex Organic Matter
Carbohydrates, Proteins, Lipids
1
Soluble Organic Molecules
Sugars, Amino Acids, Fatty Acids
2
Volatile Fatty Acids
3
Acetic Acid
H_2, CO_2, NH_4^+, S^-
4
4
$CH_4 + CO_2$
1 Hydrolysis
2 Acidosis
3 Acetogenesis
4 Methanogenesis

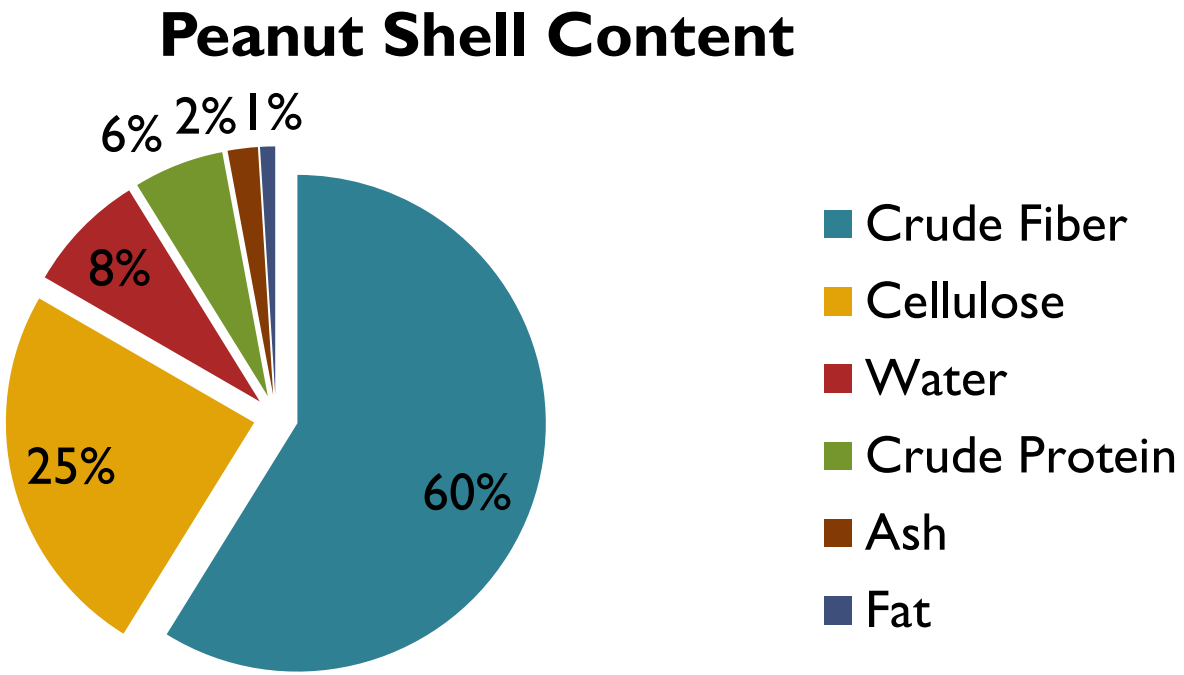
Pretreatment

Why is Pretreatment Necessary?

- Pretreatment can increase kinetics
- Physical pretreatment requires lots of heat and energy
- Chemical pretreatment requires the use of enzymes, such as cellulase
- Biological pretreatment can be an inexpensive alternative

Feedstock

- The feedstock used in this experiment were peanut shells and coffee grounds.



Objectives

- Determine the baseline biological methane potential of peanut shells and coffee grounds
- Find and cultivate local fungi
- Test if fungi can increase hydrolysis step by solubilizing cellulosic materials

Hypothesis

- Fungal pretreatment will show an increase in biogas production in coffee grounds and peanut shells as a result of the increase in the hydrolysis step.

Methods

- Total solids (dry matter content, at 105° C) and volatile solids (organic matter content 500° C) tests were conducted to characterize peanut shells (PS) and coffee grounds (CG).

Methods

BMP bottles (12) were filled with 200 mL of dairy manure and 0.4 grams of untreated substrates.

Biochemical Methane Potential (BMP) tests were conducted using peanut shells and coffee grounds

An active microbial consortium (dairy manure) was added as an inoculum and also used as the blank. Cellulose was used as a control.

The BMP test determines actual potential methane production under specific conditions.

Measurement of Biologically-produced Methane Gas

Methods

- The three species of fungi were cultivated in petri dishes at 35° C.
- Fungal solutions containing fungi, cellulose broth, and deionized water were created in Erlenmeyer flasks.
- 1mL of solution were placed on petri dishes. Solutions were diluted to a 1:10 and 1:100 ratio.

Methods

- Total Chemical Oxygen Demand (COD) and Soluble COD were measured over time.
  - Total COD measures the total quantity of oxygen required for oxidation and gives a theoretical maximum methane production.
  - Soluble COD is a similar process that tells how much organic matter is soluble in water and available for biogas production.

Fungal Prospects

- Collected from rotting wood
  - Already capable of using a high lignocellulose material
- Three organisms were investigated:
  - *Stemonitis sp.*
  - *Tramates versicolor*
  - *Cyathus sp.*

Fungal Prospects for Pretreatment

Stemonitis sp.

"Chocolate Tube Slime"

Fungal Prospects for Pretreatment

Tramates versicolor

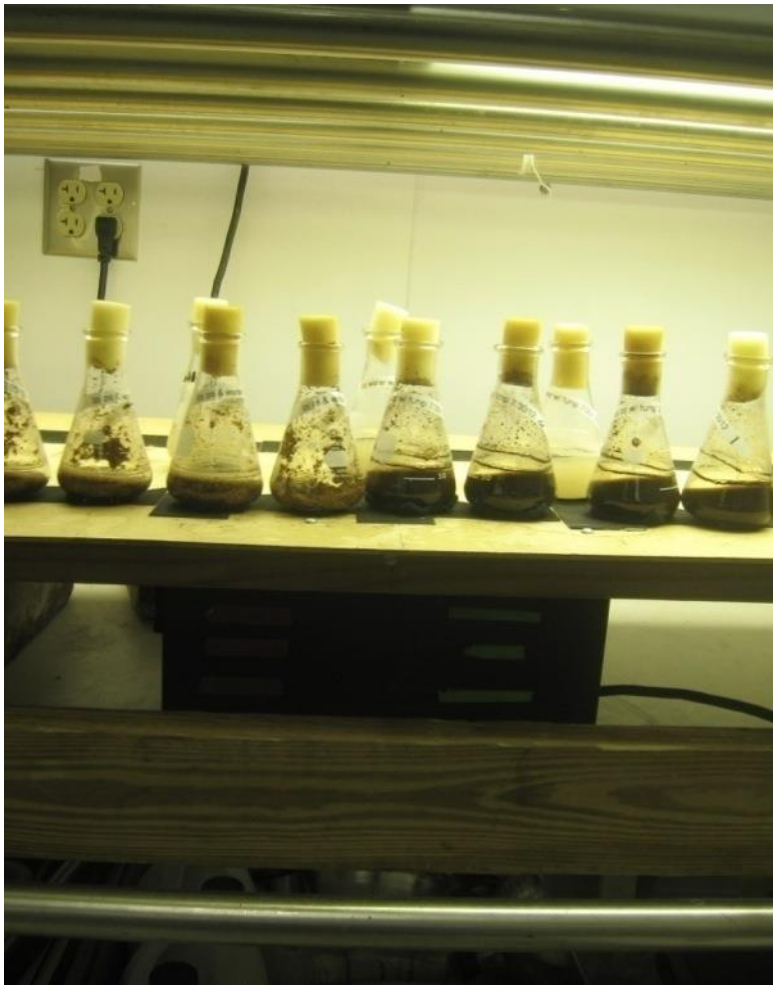
"Turkey-Tail Fungi"

Fungal Prospects for Pretreatment

Cyathus sp.

“Bird’s Nest Fungi”

Biological Incubation

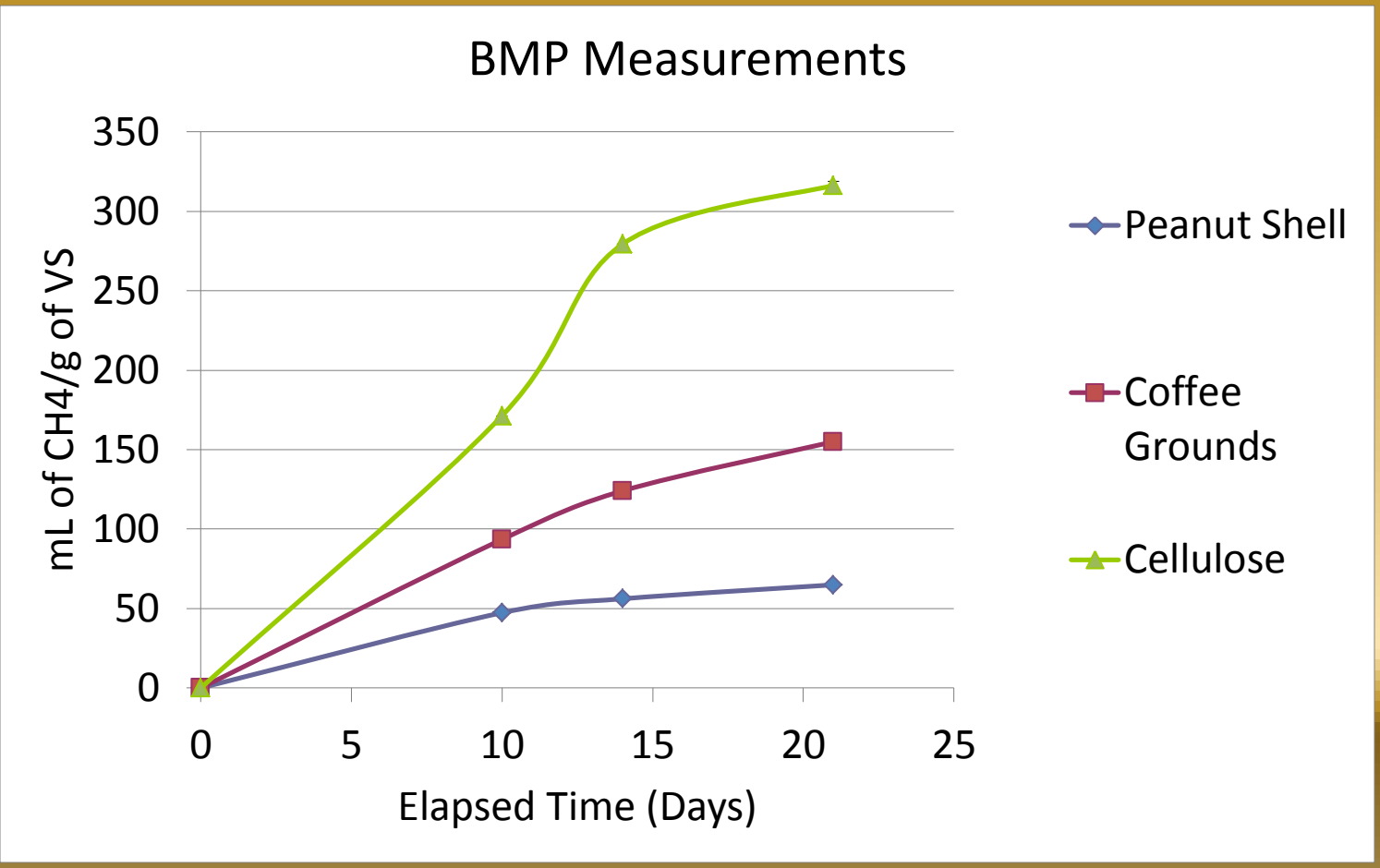


- Pretreatments were placed in 125mL flasks and shaken for 24 & 48 hours. Measurements were recorded each day.

Results

Feedstock	Total Solids	Volatile Solids
Average CG	28.43 ± 2.65	96.43 ± 0.31
Average PS	90.33 ± 0.07	96.68 ± 0.156

Results



Pretreatment is necessary to increase maximum CH_4 production

*BMP measurements are of untreated substrates

Results-Fungal Cultivation

Tramates versicolor

After Day 1

After Day 5

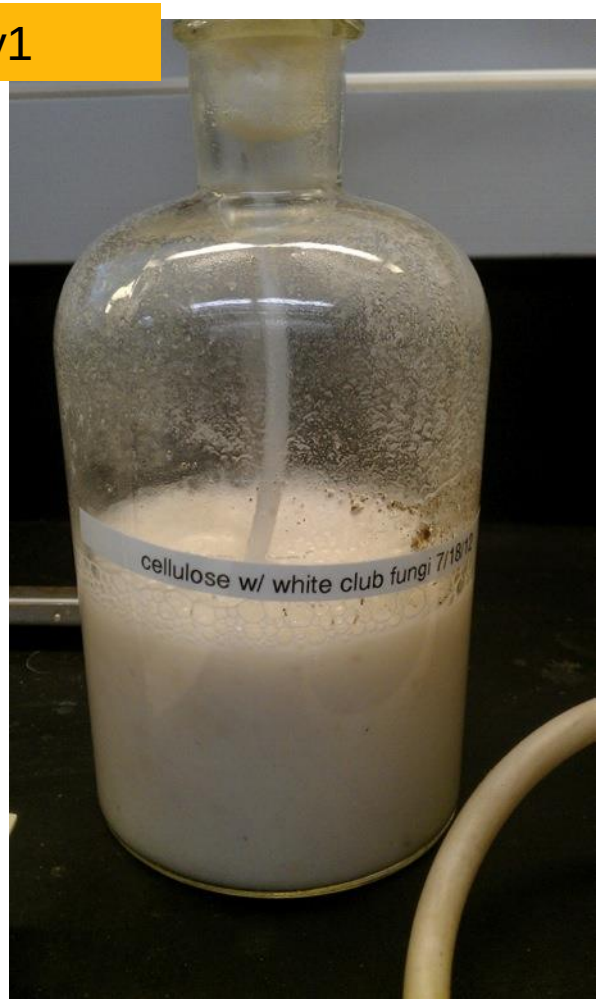
Stemonitis sp.

After Day 1

After Day 5

Tramates versicolor

Day1

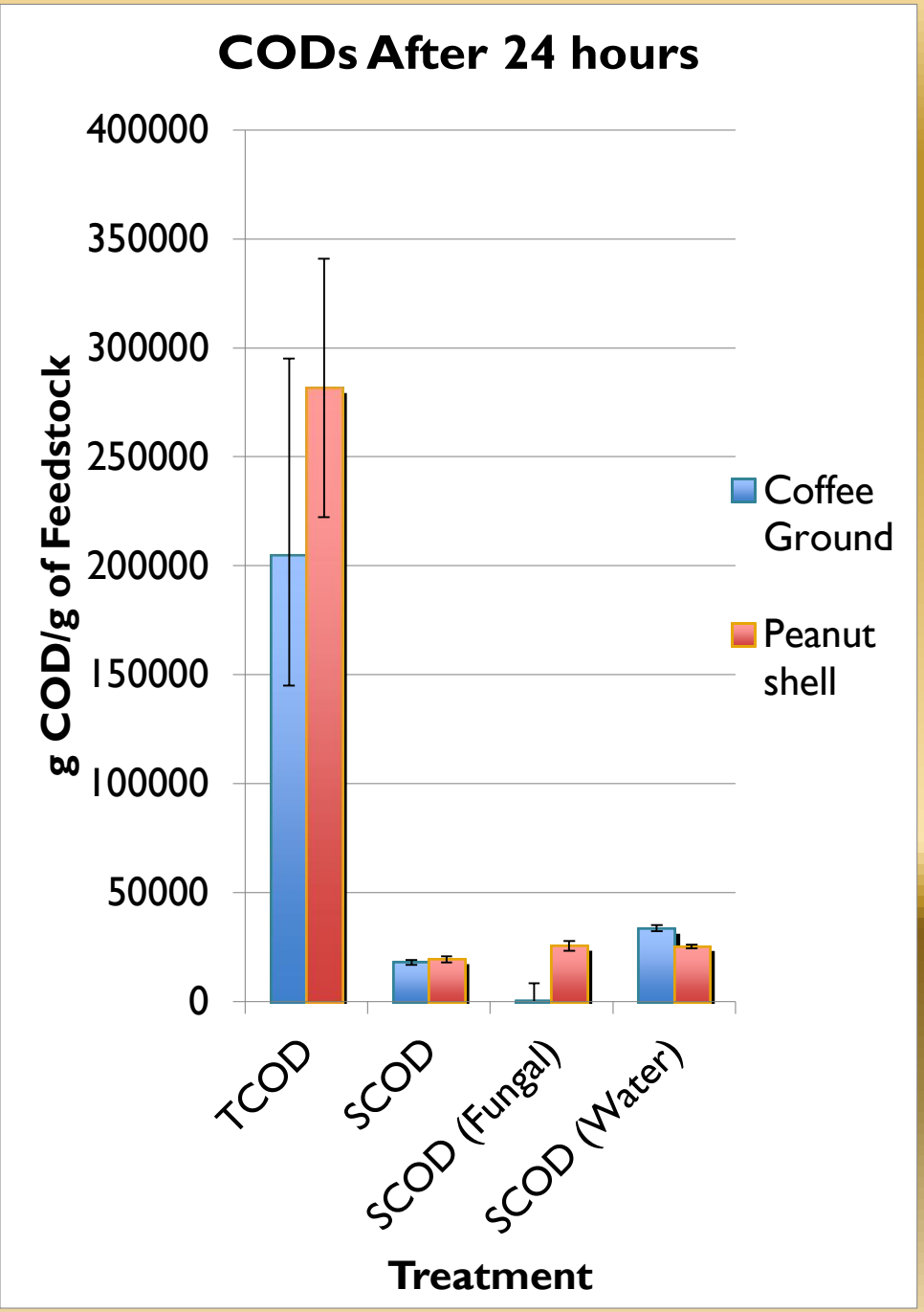


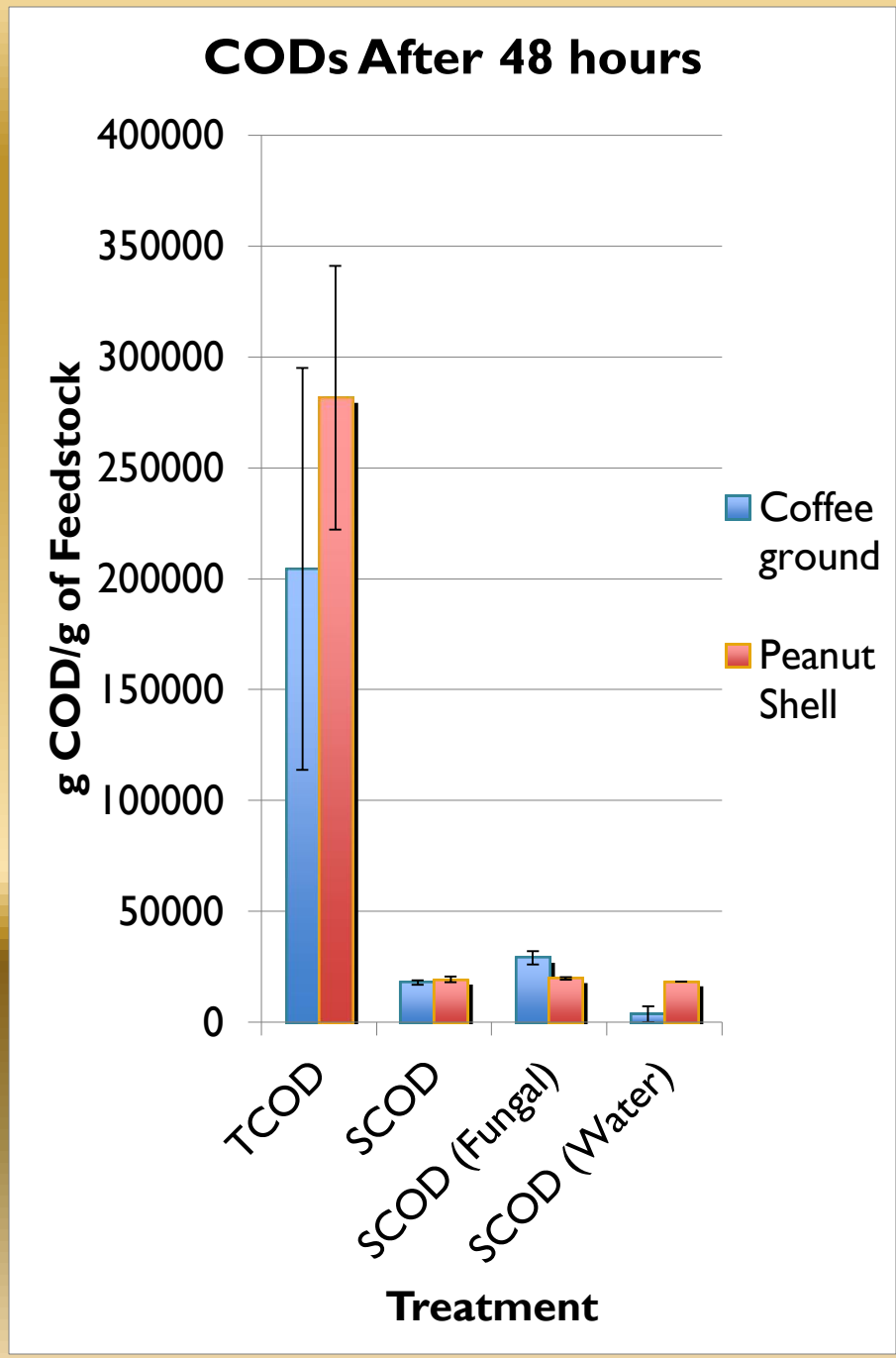
Day 12

Cyathus sp.

Day 1

Day 12


CODs After 24 hours
400000
350000
300000
250000
200000
150000
100000
50000
0
g COD/g of Feedstock
Coffee Ground
Peanut shell
TCOD
SCOD
SCOD (Fungal)
SCOD (Water)
Treatment


CODs After 48 hours
400000
350000
300000
250000
200000
150000
100000
50000
0
g COD/g of Feedstock
Coffee ground
Peanut Shell
TCOD
SCOD
SCOD (Fungal)
SCOD (Water)
Treatment

Conclusion

- TS/VS tests indicate that both substrates consist of at least 96% of organic matter.
- Pretreatment is necessary for PS and CG.
- Biological incubations did not rapidly increase the soluble COD of either coffee grounds or peanut shells

Future Studies

- Test SCODs for a longer period of time. (ex. 2-4 weeks)
- Cultivate the fungi under various temperatures to maximize the growth potential.
- Test the BMPs with the pretreated substrates.
- Testing more substrates to compare the SCODs and BMPs. (ex. wood chips, leaves, and filter paper)

Questions or Comments?