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Extraction of products from algae using green solvents

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Extraction of Products from Algae using Green Solvents

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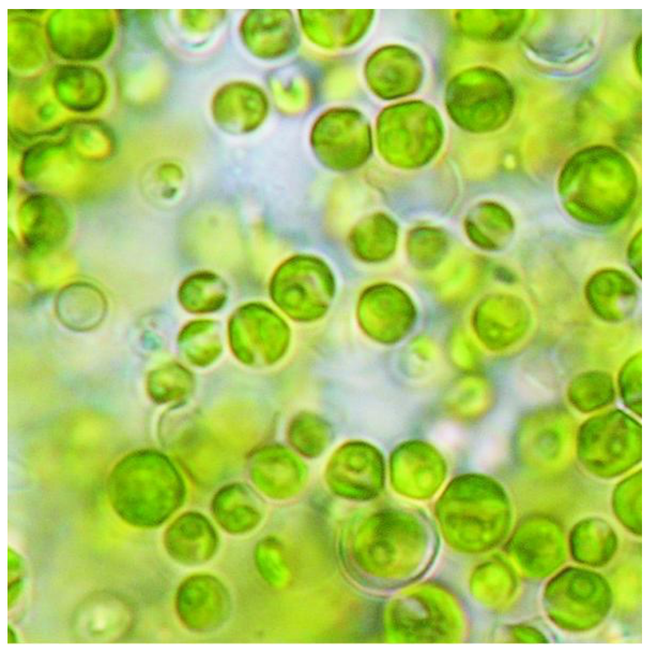
Departments of Chemistry and Civil Engineering
Queen's University



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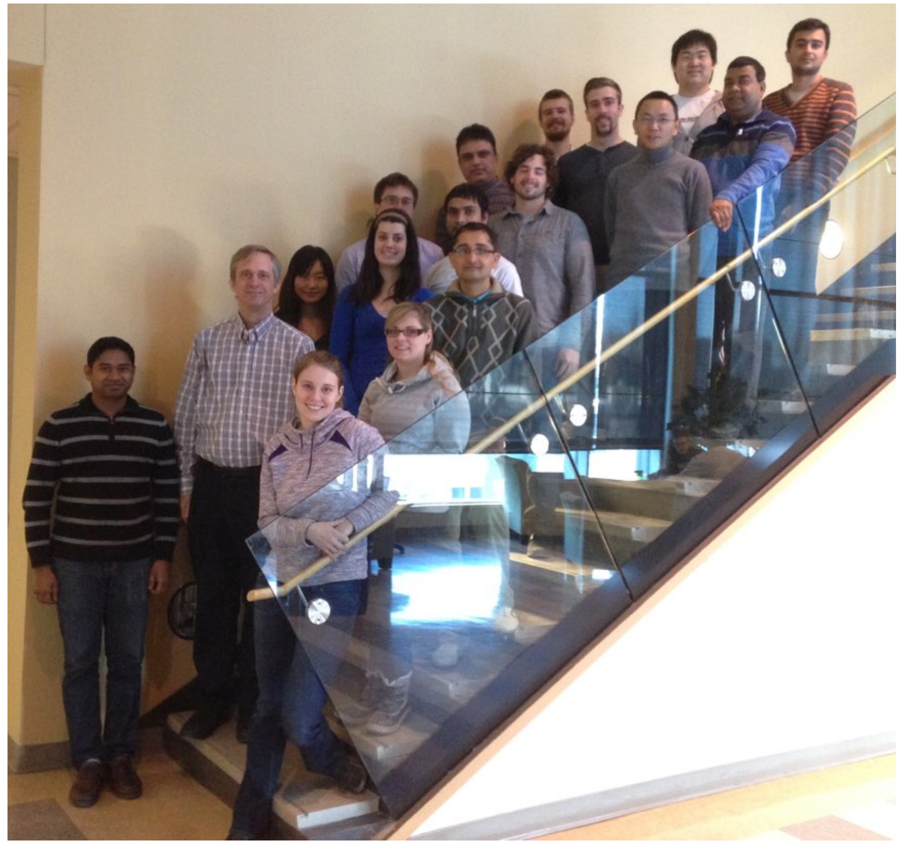

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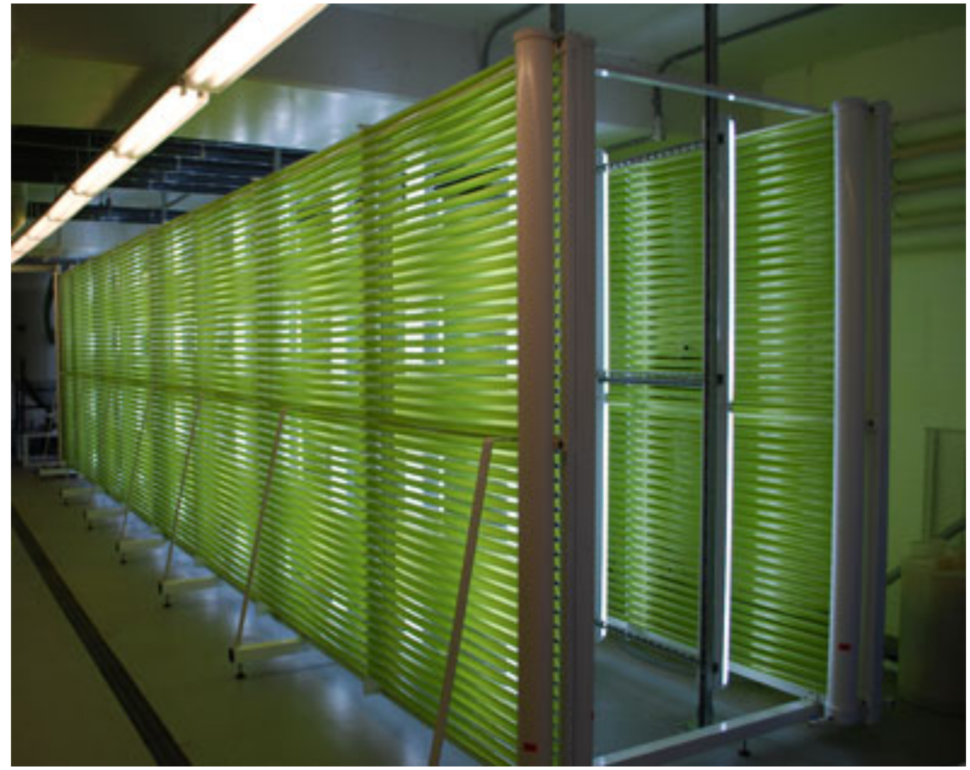
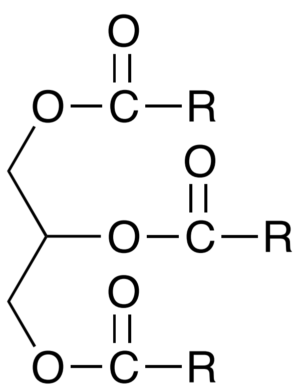
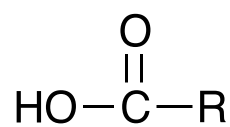
MICROALGAE



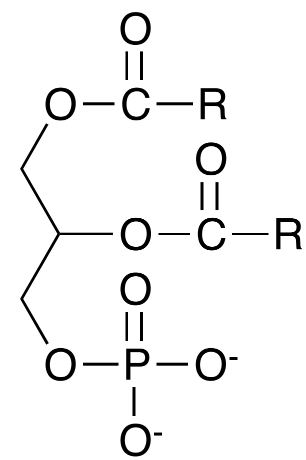
- High lipid content
- Robust
- Non-competitive (food v. fuel)
- Fast growth
- Minimal land use



Triacylglycerides (TAG)
Diacylglycerides (DAG)
Monoacylglycerides (MAG)



Free fatty acids (FF)



Polar lipids

LIPID EXTRACTION STRATEGY #1: EXTRACT FROM *DRIED ALGAE*

Algae in water

remove water

Dry algae

extract with organic solvent

Lipids in solvent

remove solvent

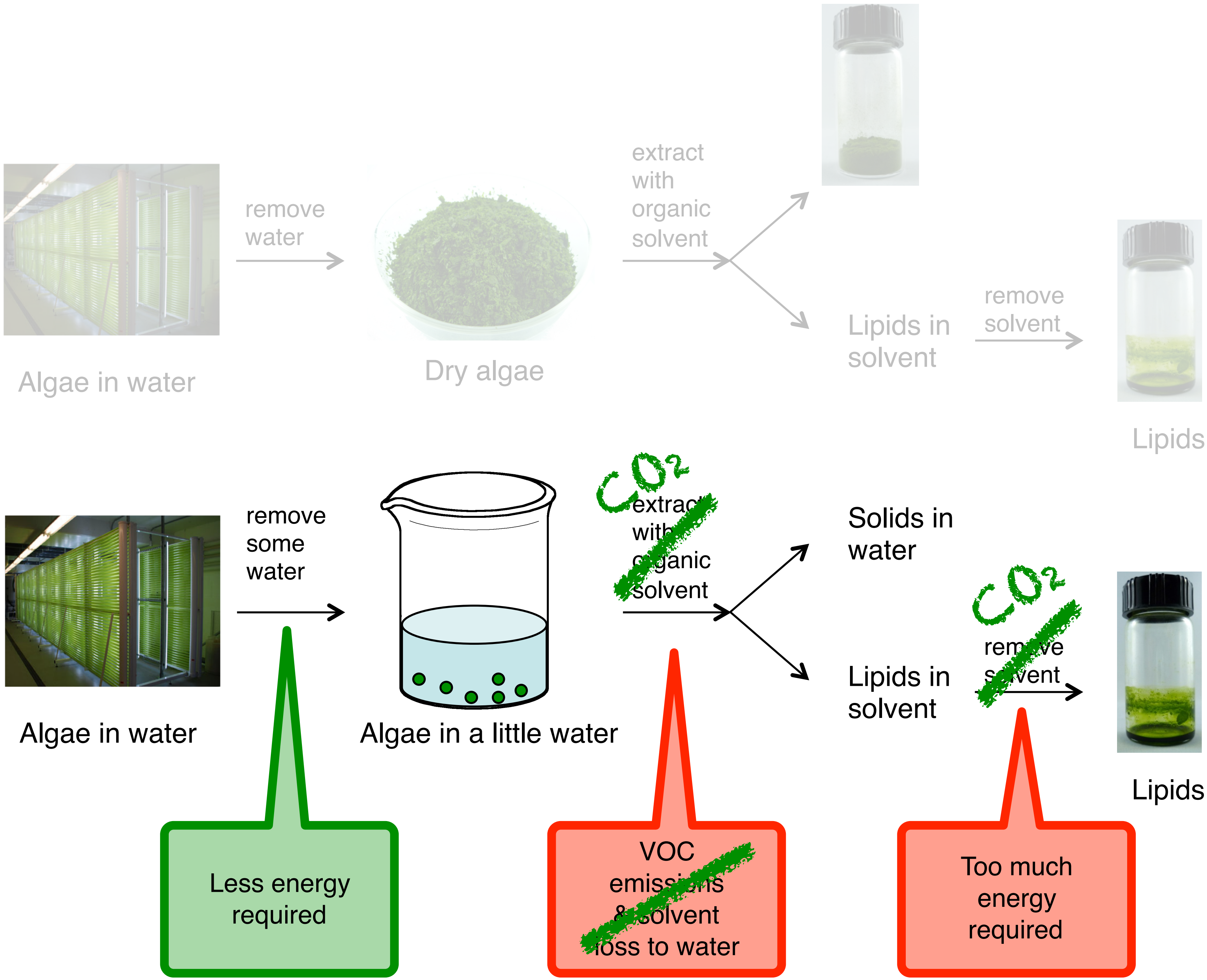
Lipids

Too much energy required

VOC emissions

Too much energy required

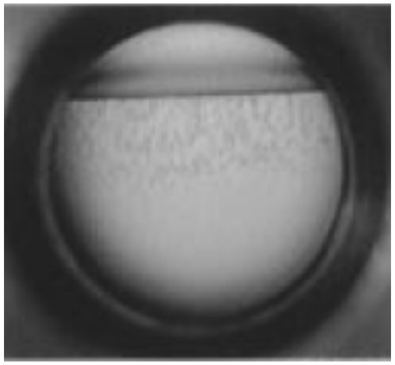
LIPID EXTRACTION STRATEGY #2: EXTRACT FROM ***WET ALGAE***



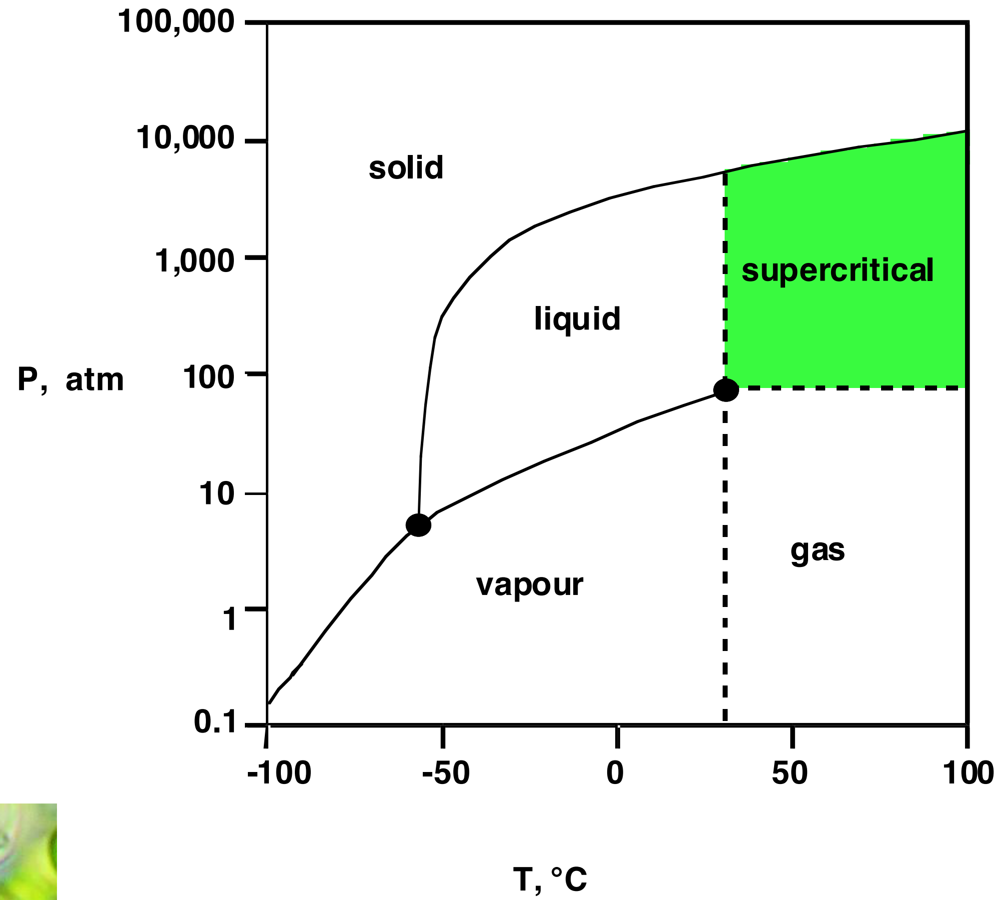
MICROALGAE EXTRACTION SOLVENTS

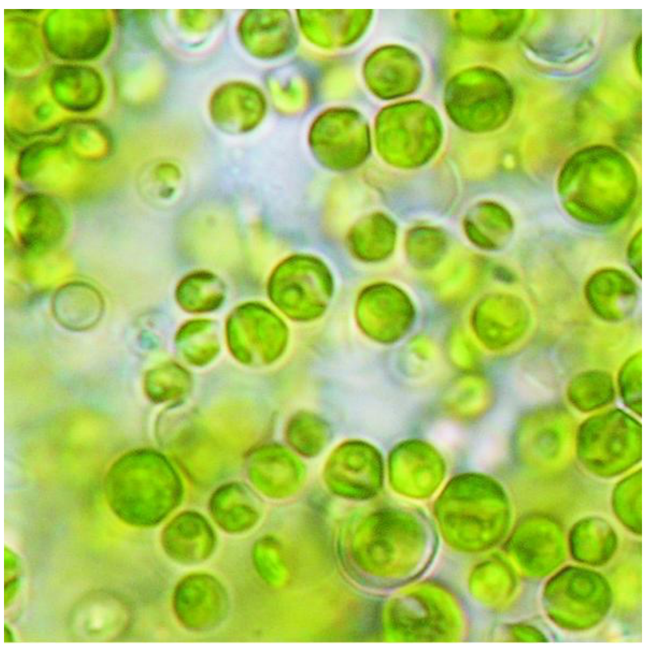
Solvent	Advantage	Disadvantage
chloroform/methanol (Bligh & Dyer)	• high yield	• chlorinated • flammable • polar lipids extracted
supercritical CO_2 (Zimmerman)	• easily removed • not flammable • selective for nonpolar lipids	• high pressure
switchable-polarity solvents (Samori)	• easily removed • not flammable	• must be dry
switchable-hydrophilicity solvents (Jessop)	• easily removed • not flammable	• poor separation

LIQUID CO_2



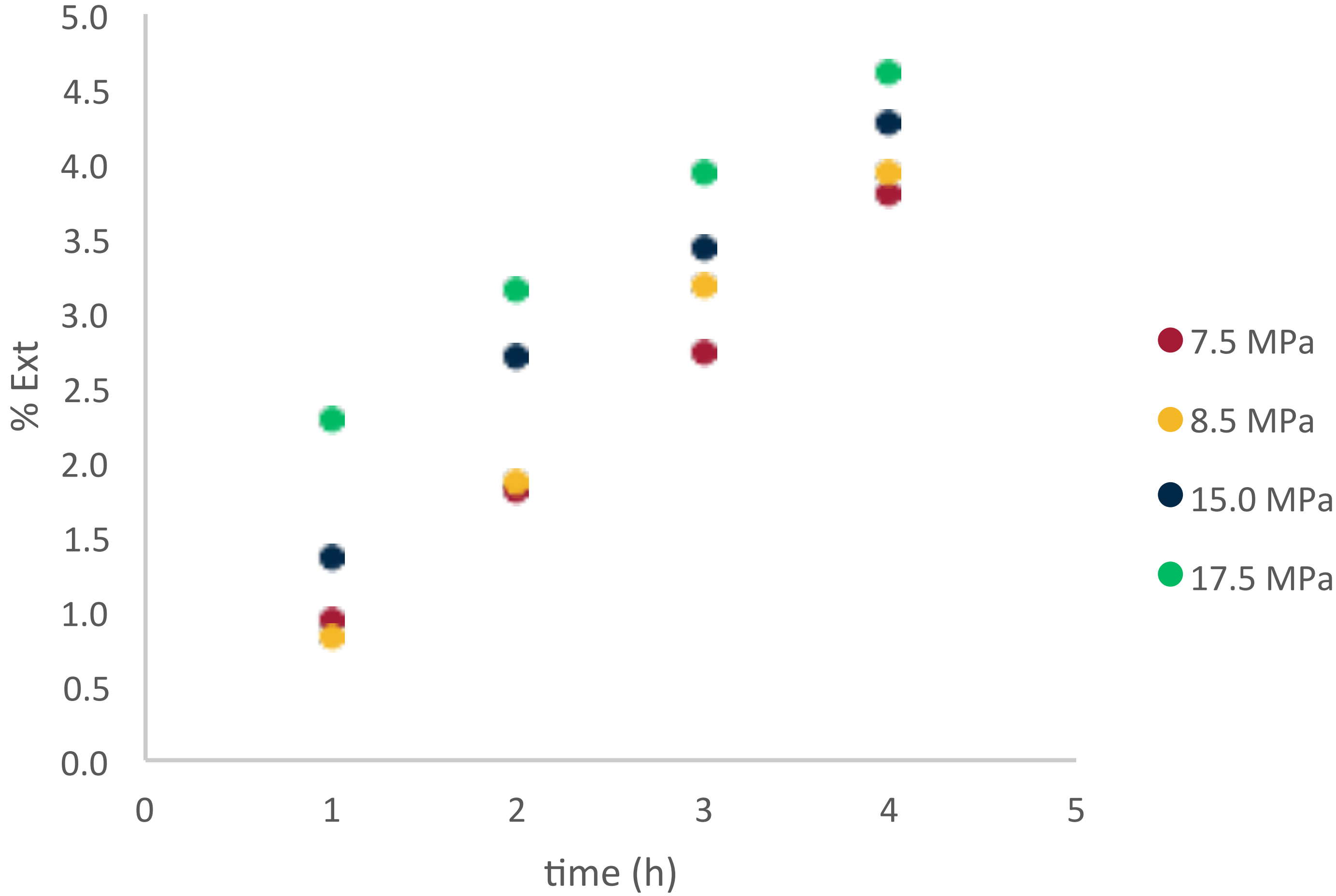
Liquid CO_2





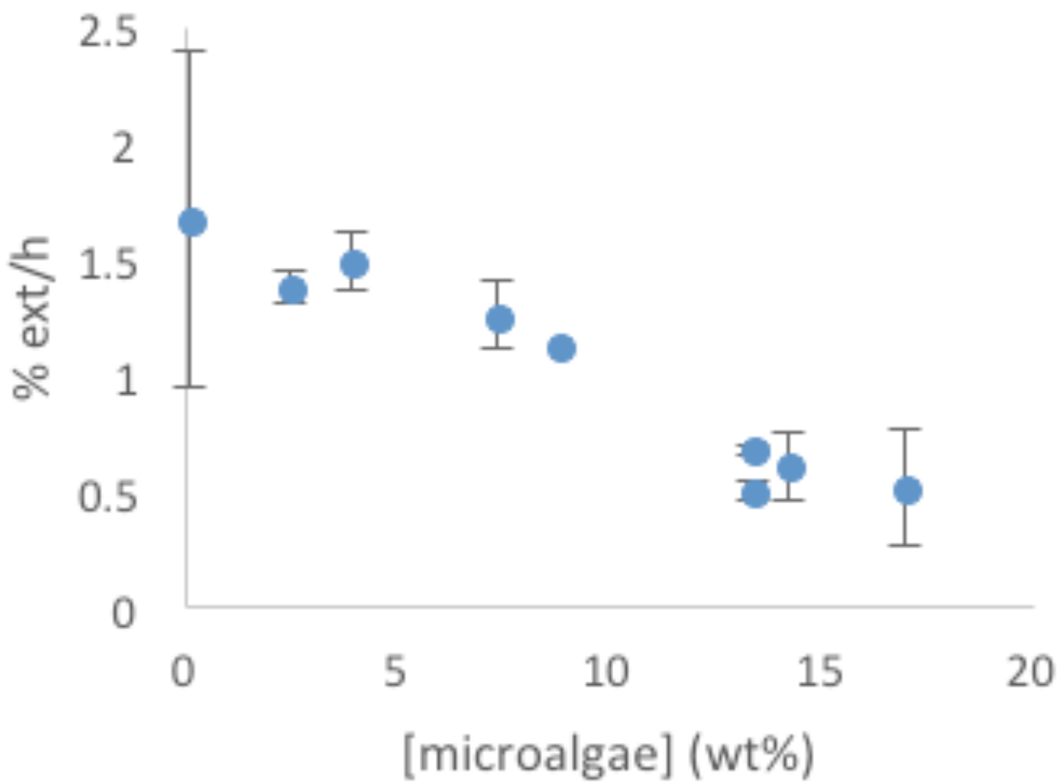
Chlorella vulgaris

EXTRACTION FROM *WET ALGAE* WITH LIQUID CO_2



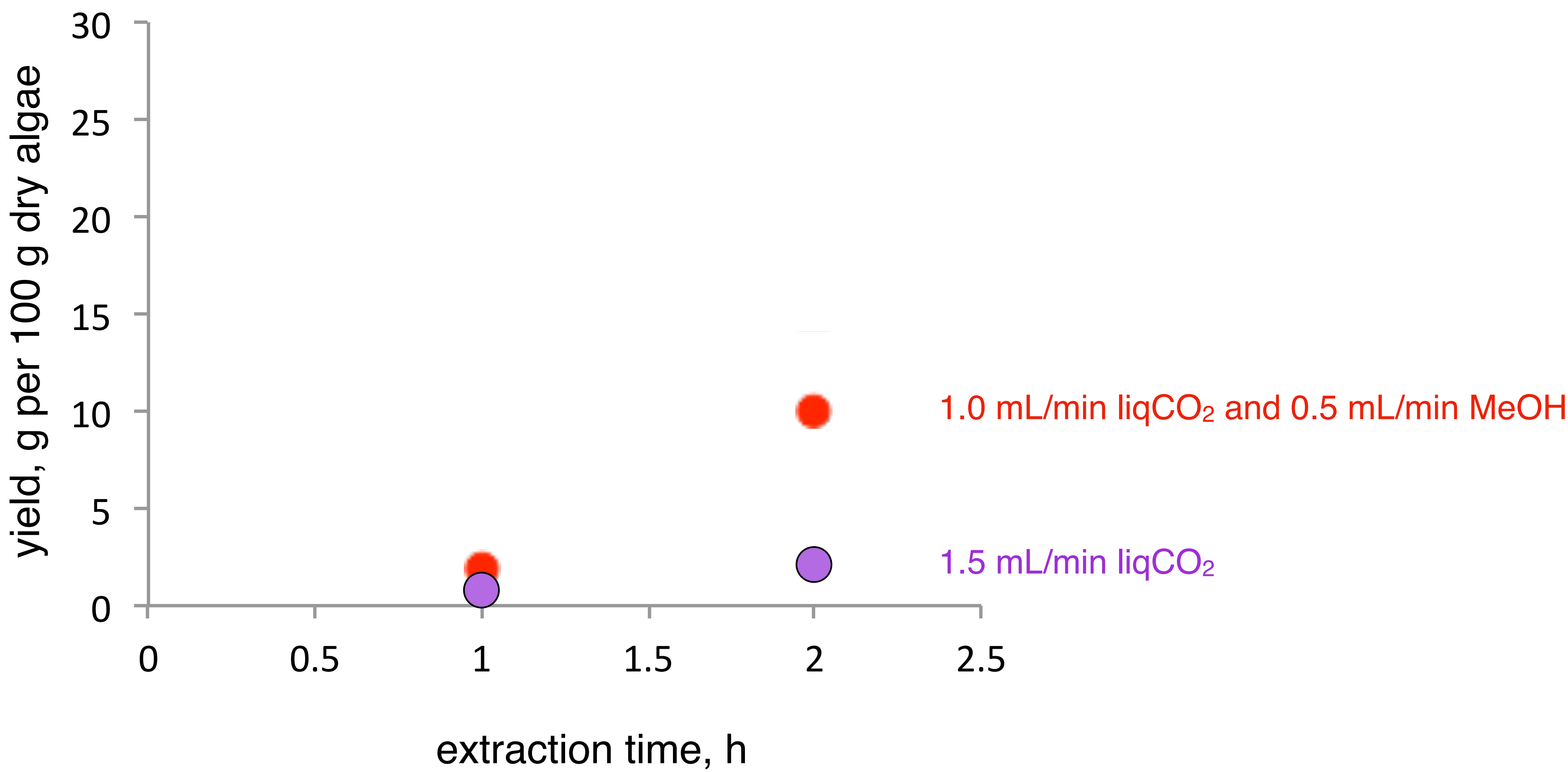
25 ˚C, 14.3 wt% chlorella vulgaris slurry, 1.5 mL/min of liquid CO_2

EXTRACTION FROM *WET ALGAE* WITH LIQUID CO_2



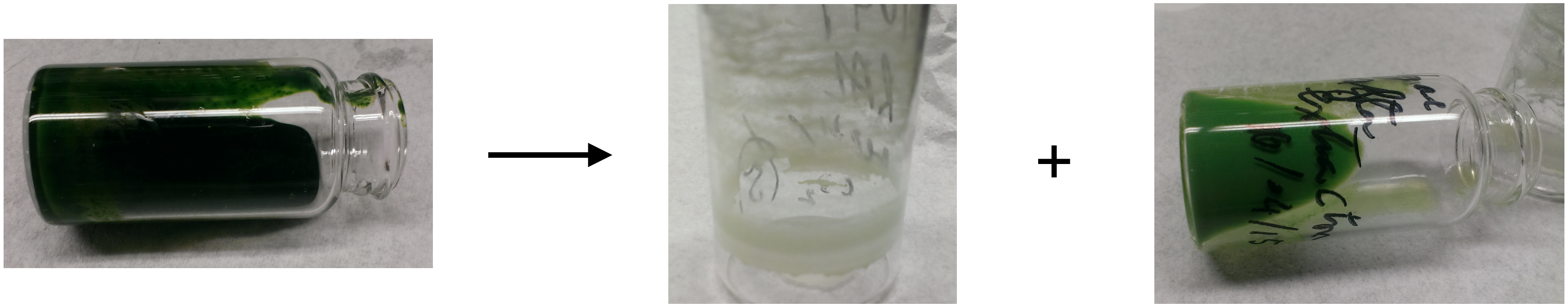
25 ˚C, chlorella vulgaris, 15 MPa of liquid CO_2

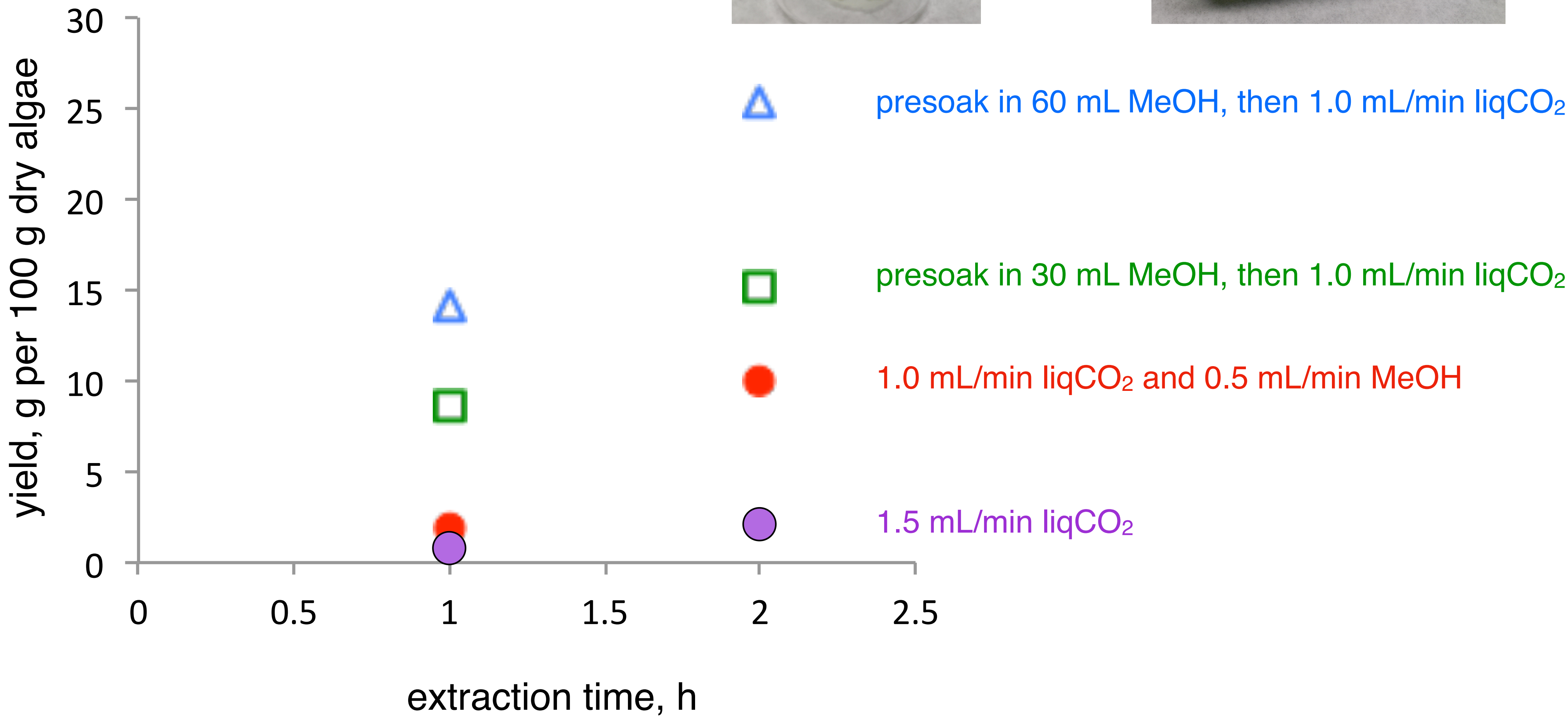
EXTRACTION FROM *WET ALGAE* WITH CO_2 & MeOH



25 ˚C, liquid CO2, 7.5 MPa, 14 wt% chlorella vulgaris slurry

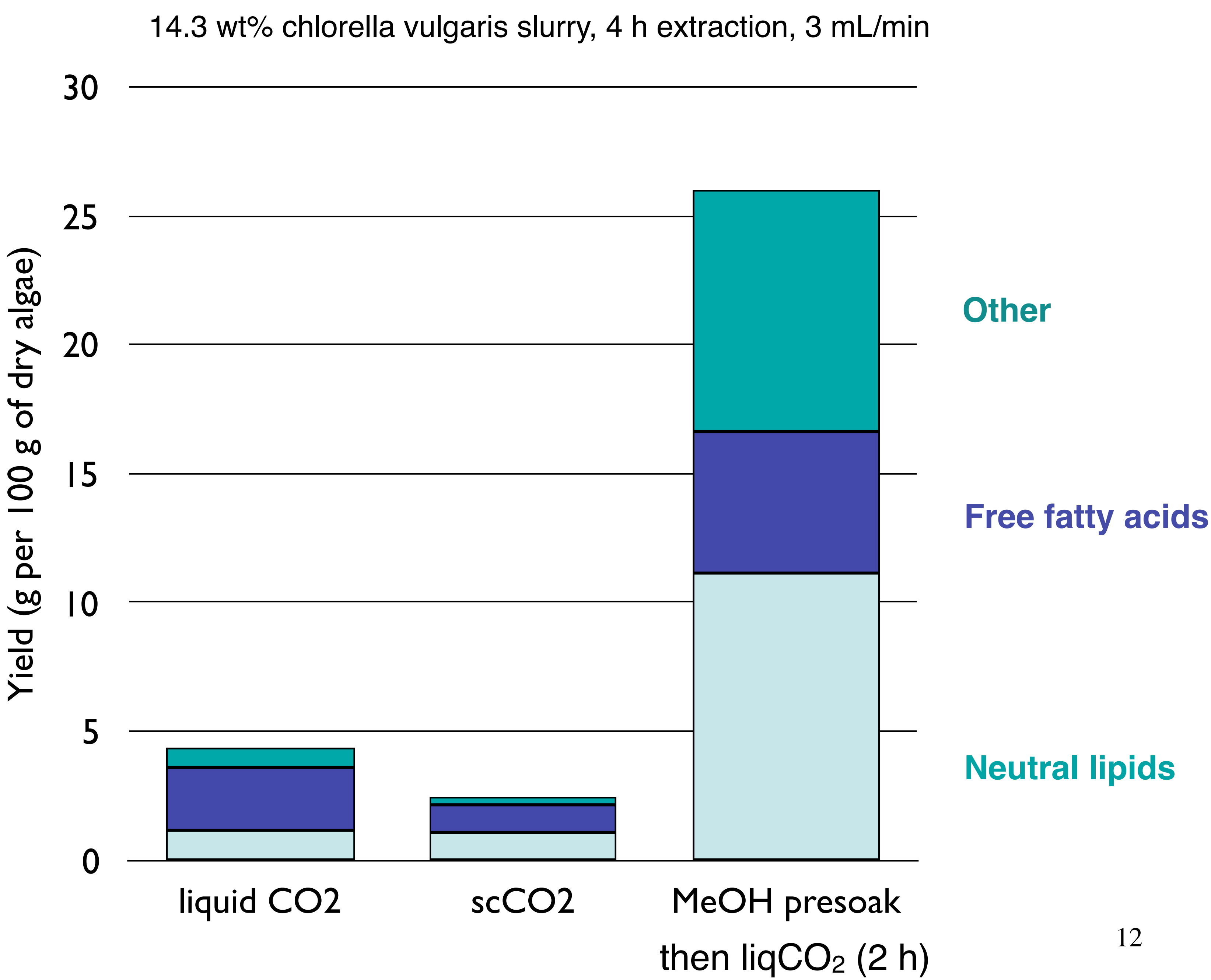
EXTRACTION FROM ***WET ALGAE*** WITH CO_2 & MeOH



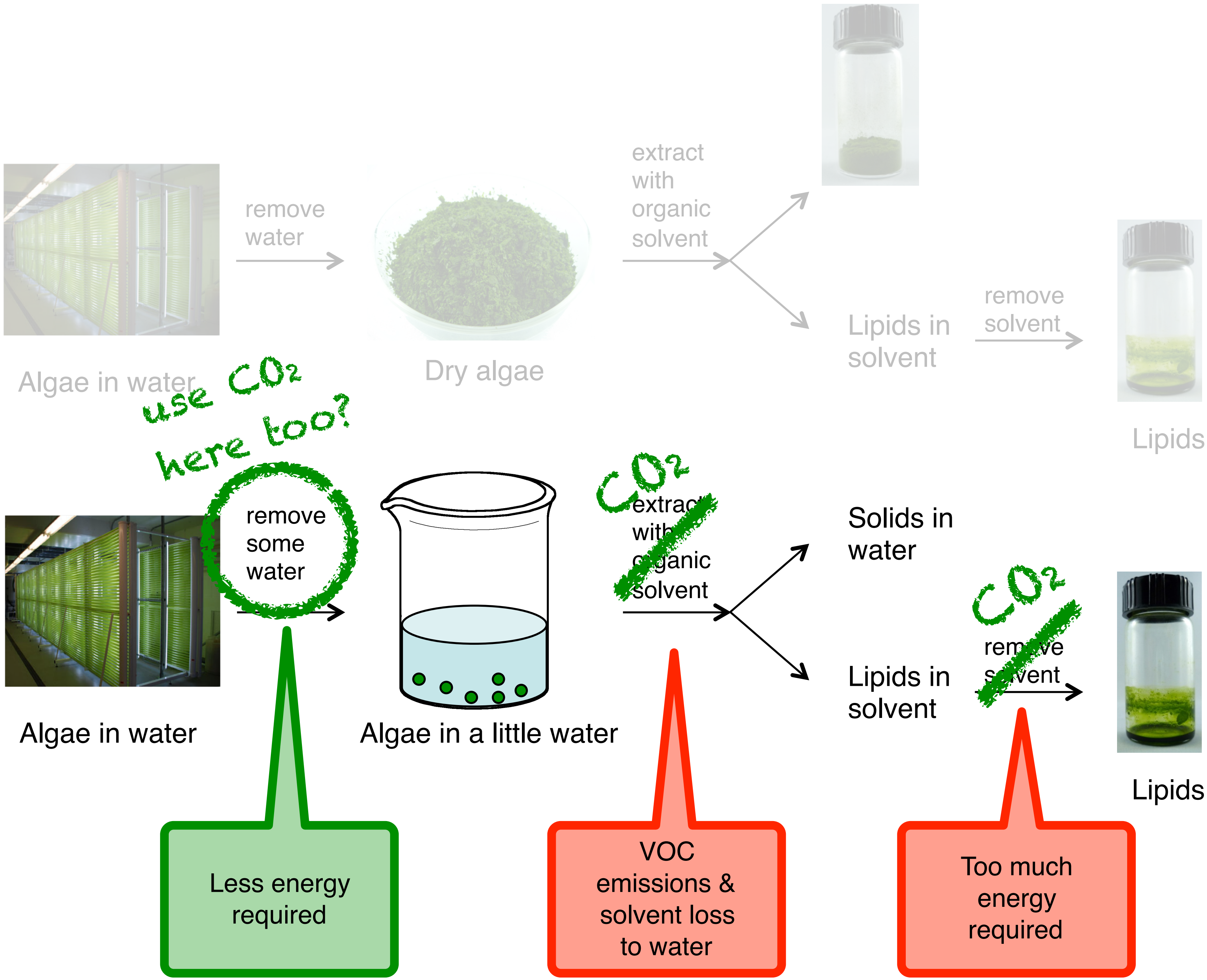


25 ˚C, liquid CO2, 7.5 MPa, 14 wt% chlorella vulgaris slurry

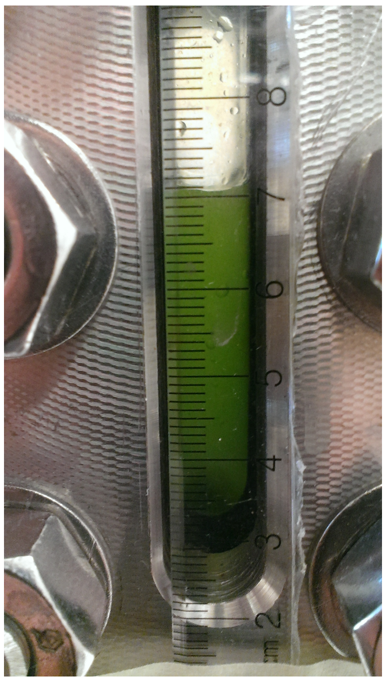
EXTRACTION FROM *WET ALGAE*



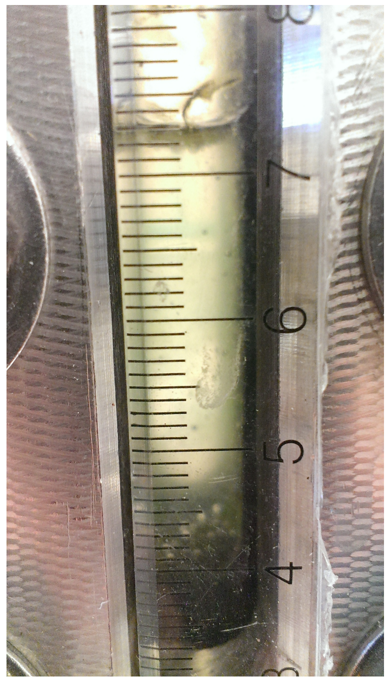
LIPID EXTRACTION STRATEGY #2: EXTRACT FROM *WET ALGAE*



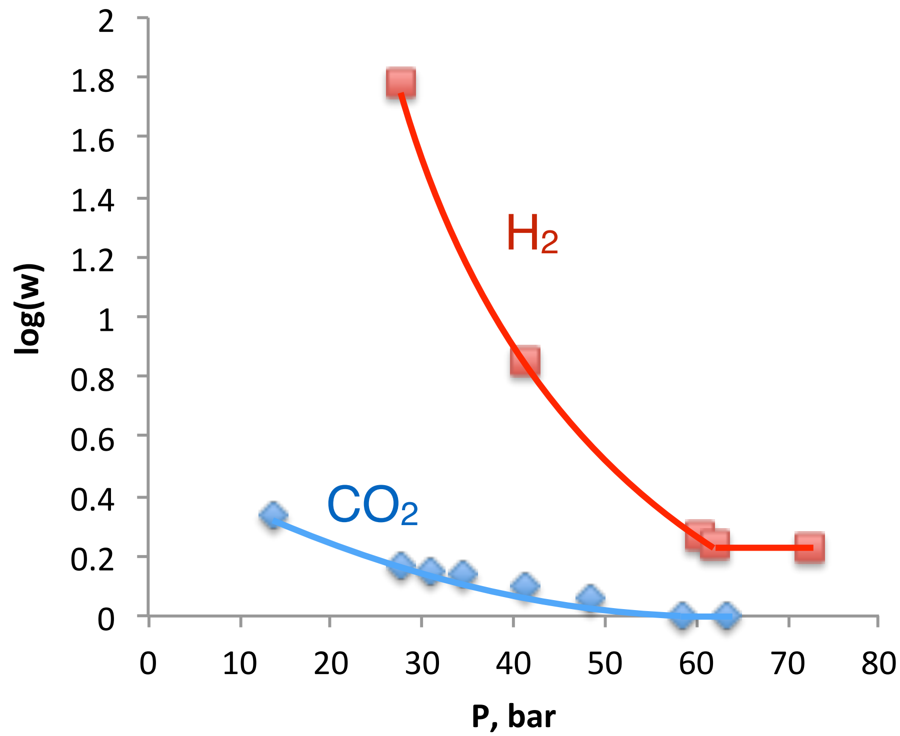
PARTIAL DEWATERING



Start



17 h at 61 bar CO_2

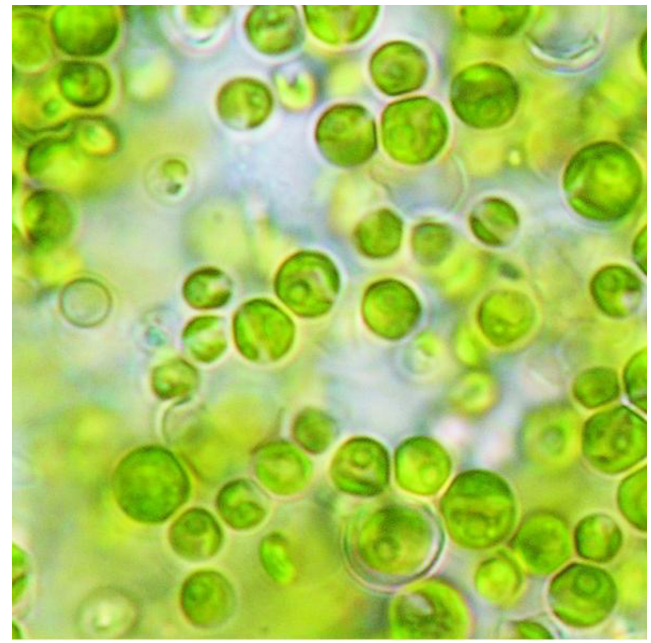


stability ratio = $W = \frac{1}{\sigma} = \frac{k^*}{k_l}$

CONCLUDING THOUGHTS

- Presoaking the wet algae in MeOH followed by liqCO_2 extraction gives excellent yields, but MeOH recovery issue remains (50% loss).

- CO_2 can help the dewatering process.



Thank You