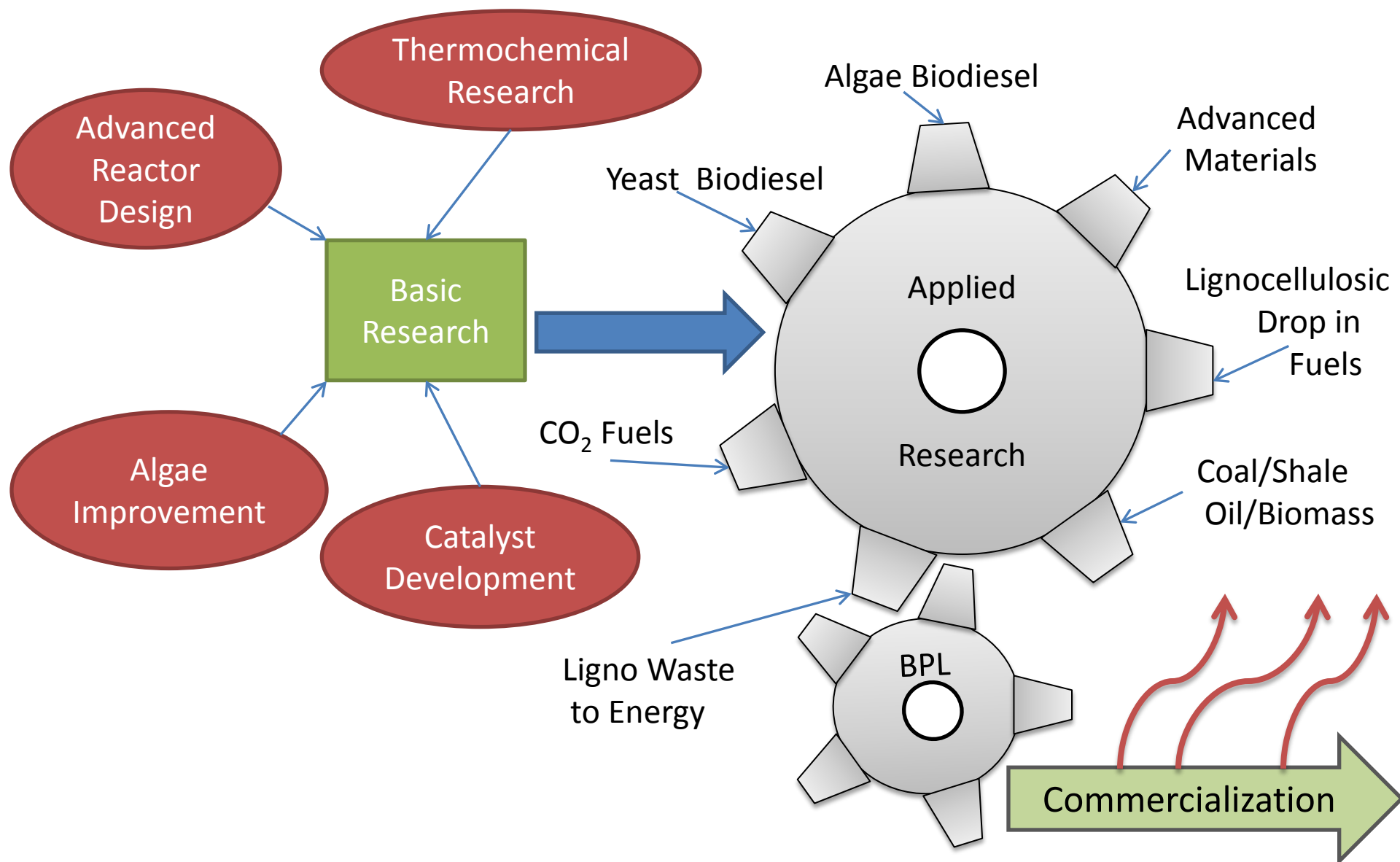


Advances in biobased products and fuels development at USTAR Bioenergy Center

Foster A Agblevor
Biological Engineering
Utah State University, Logan UT
foster.agblevor@usu.edu

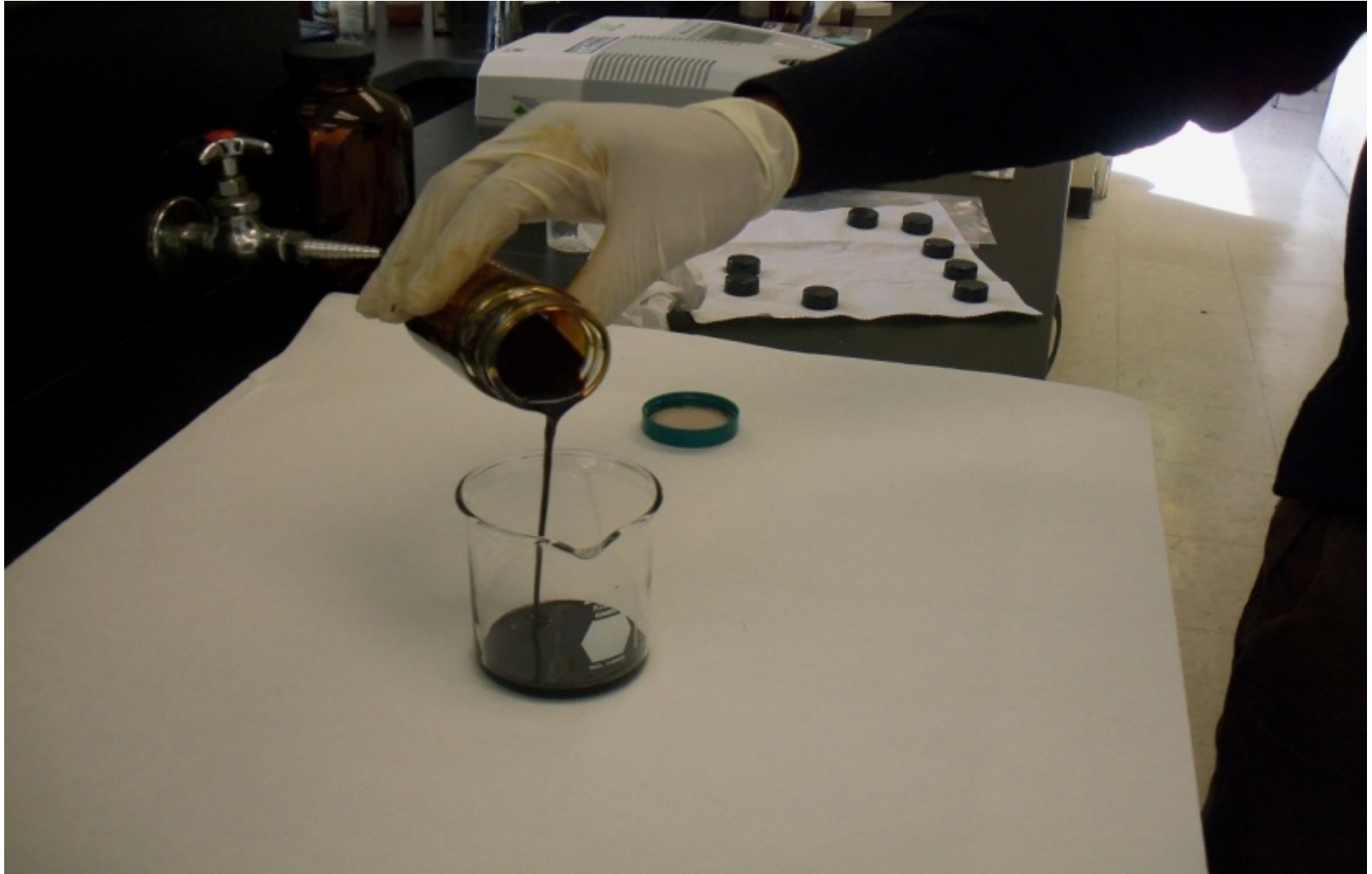
USTAR BioEnergy Center



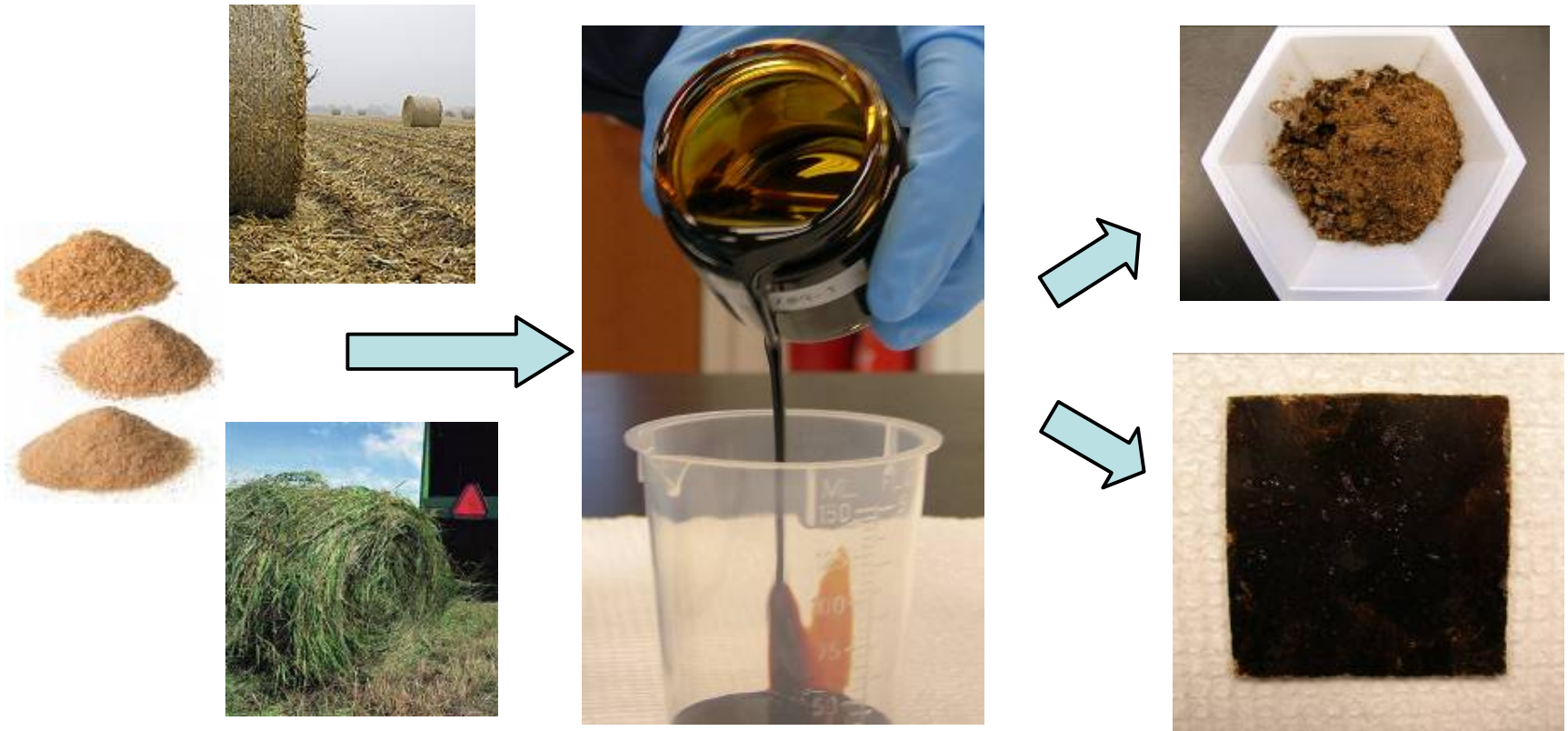
Pilot plant for biooil production



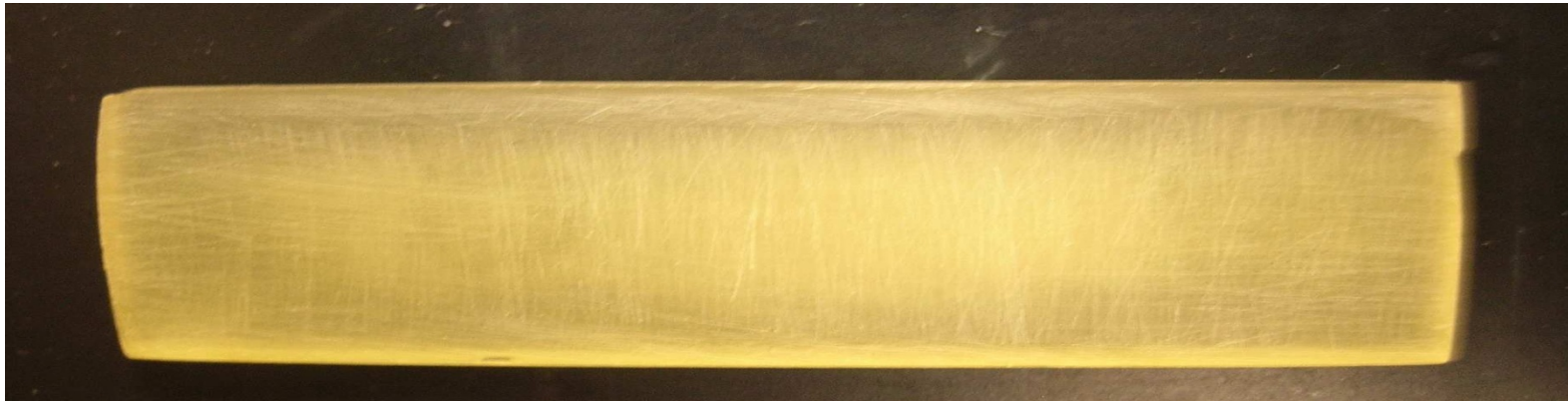
Hybrid poplar FCP oil



Production of biobased materials



**Epoxy Novolac clear castings from various Phenol/biocrude oils.
All samples were cured with AEP**



phenol



Poplar



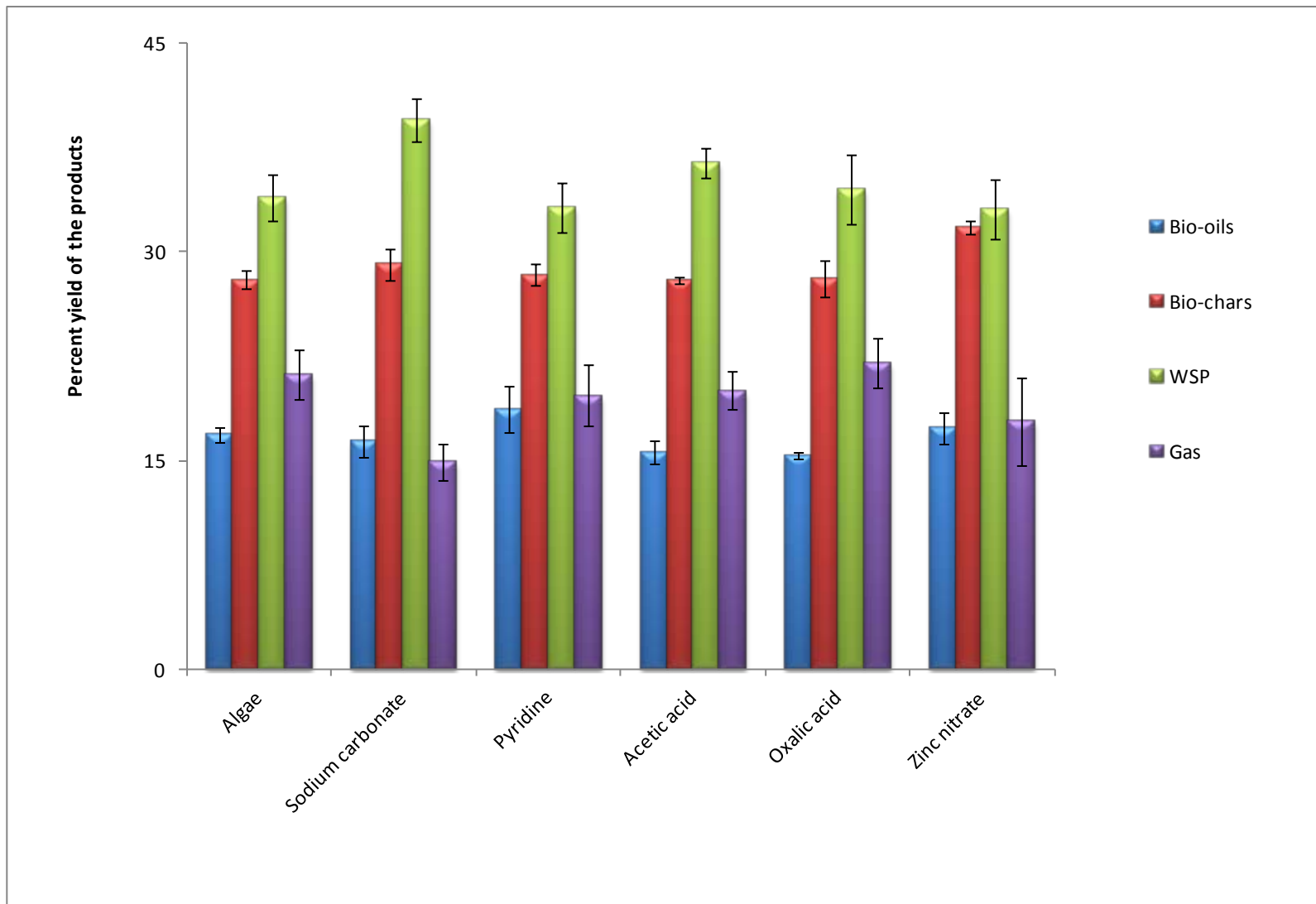
Pine

Biofoam from levoglucosan



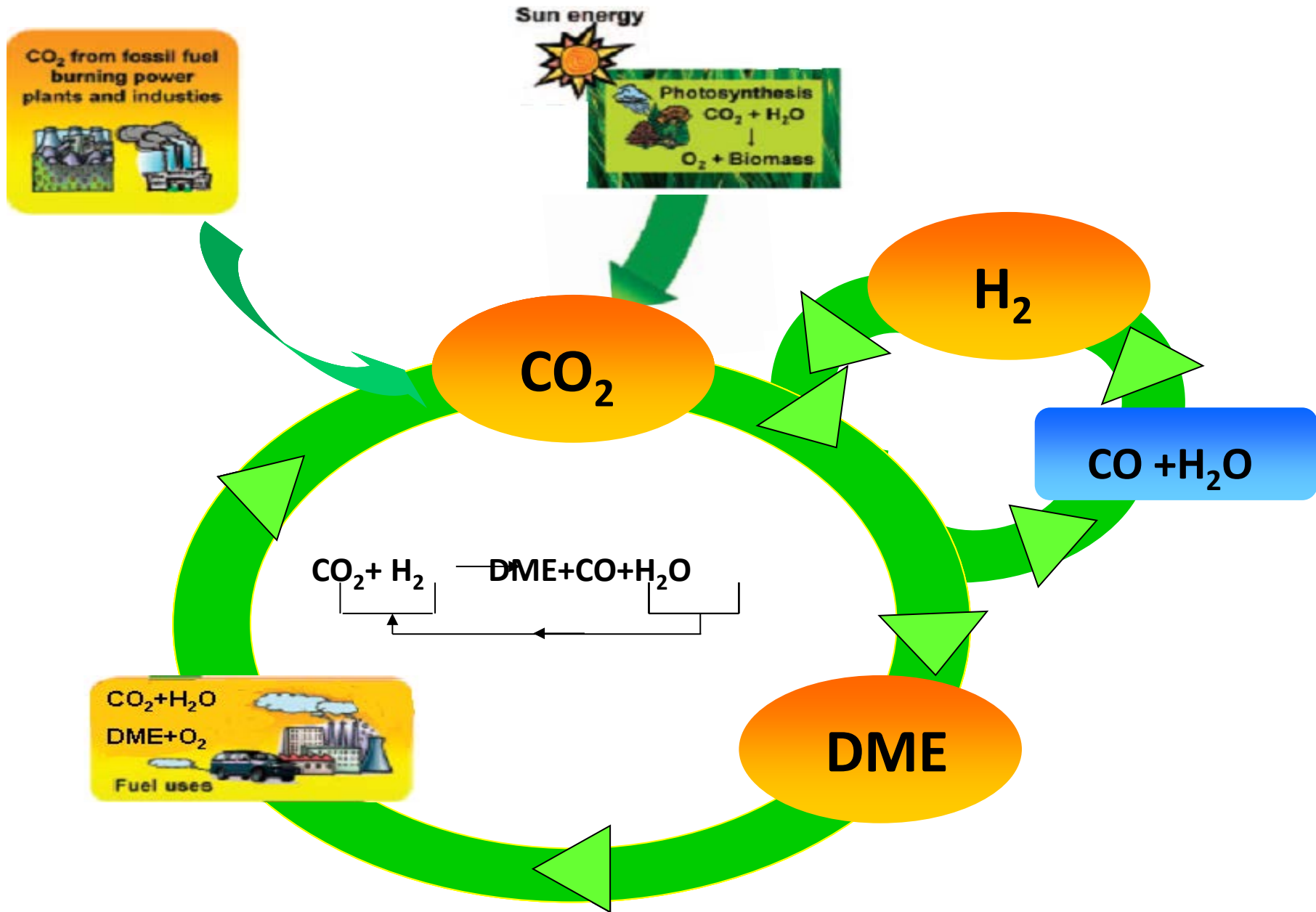
Thermochemical conversion of algae to biofuels

- Hydrothermal catalytic conversion of wet algae to biofuels
- Catalytic pyrolysis of algae to biofuels
- Supercritical fluid separation of thermochemical algae biofuels



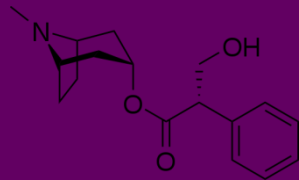
Effect of the catalysts on the algae hydrothermolysis product distribution

Catalytic conversion of CO₂ to DME

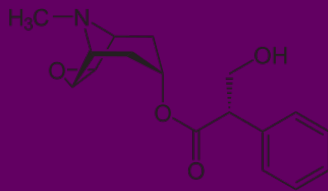


Extracellular tropane alkaloids production by hairy roots

Pharmaceutical applications of tropane alkaloids



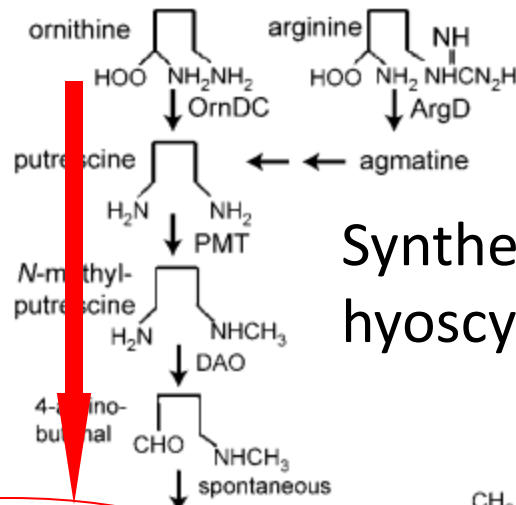
hyoscyamine



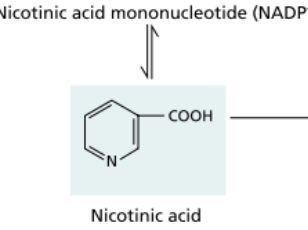
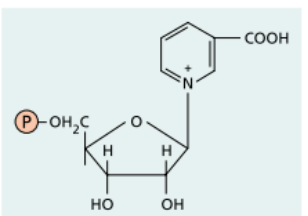
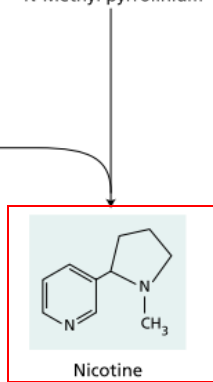
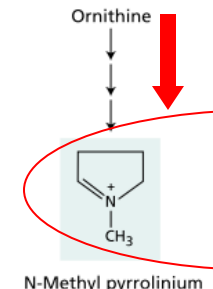
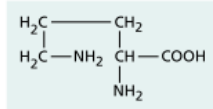
scopolamine

- Gastrointestinal disorders
- Heart problems
- Parkinson's disease
- Palliative care

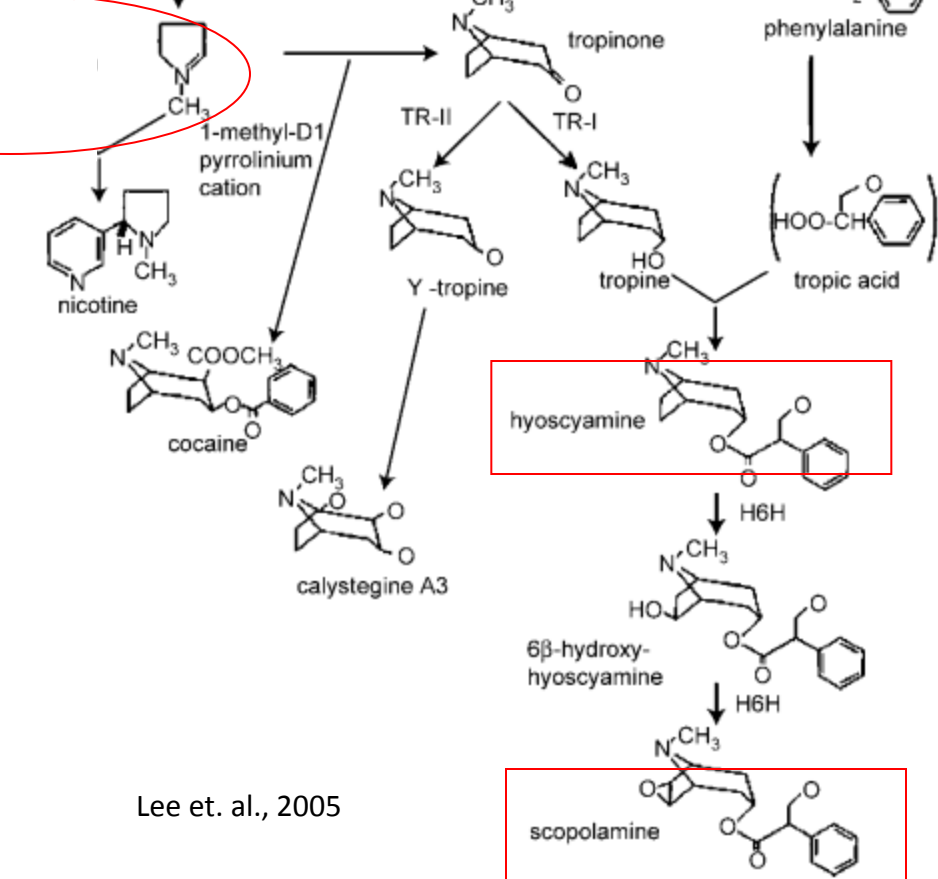
- Nausea
- Motion sickness
- Intestinal cramping
- Ophthalmic purposes
- Adjunct to narcotic painkillers



Synthetic pathways of nicotine, hyoscyamine, and scopolamine

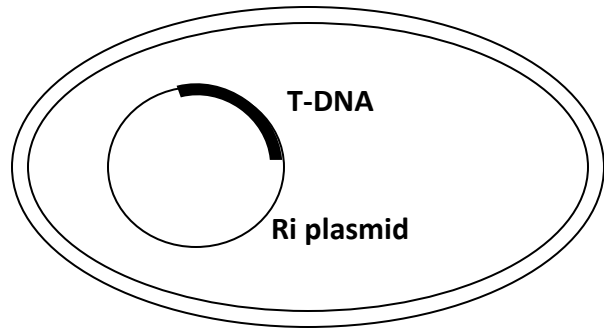


Taiz and Zeiger 2002

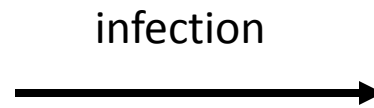


Lee et. al., 2005

Induction of hairy root



Agrobacterium rhizogenes



wounded higher plant



emerging root at the wounding sites



hairy root

Tobacco hairy root lines

wild-type line

Xanthi-105



Xanthi-105

transgenic line

T13-8-101

homozygous (nicotine uptake permease) *NUP1-RNAi* reduced expression line

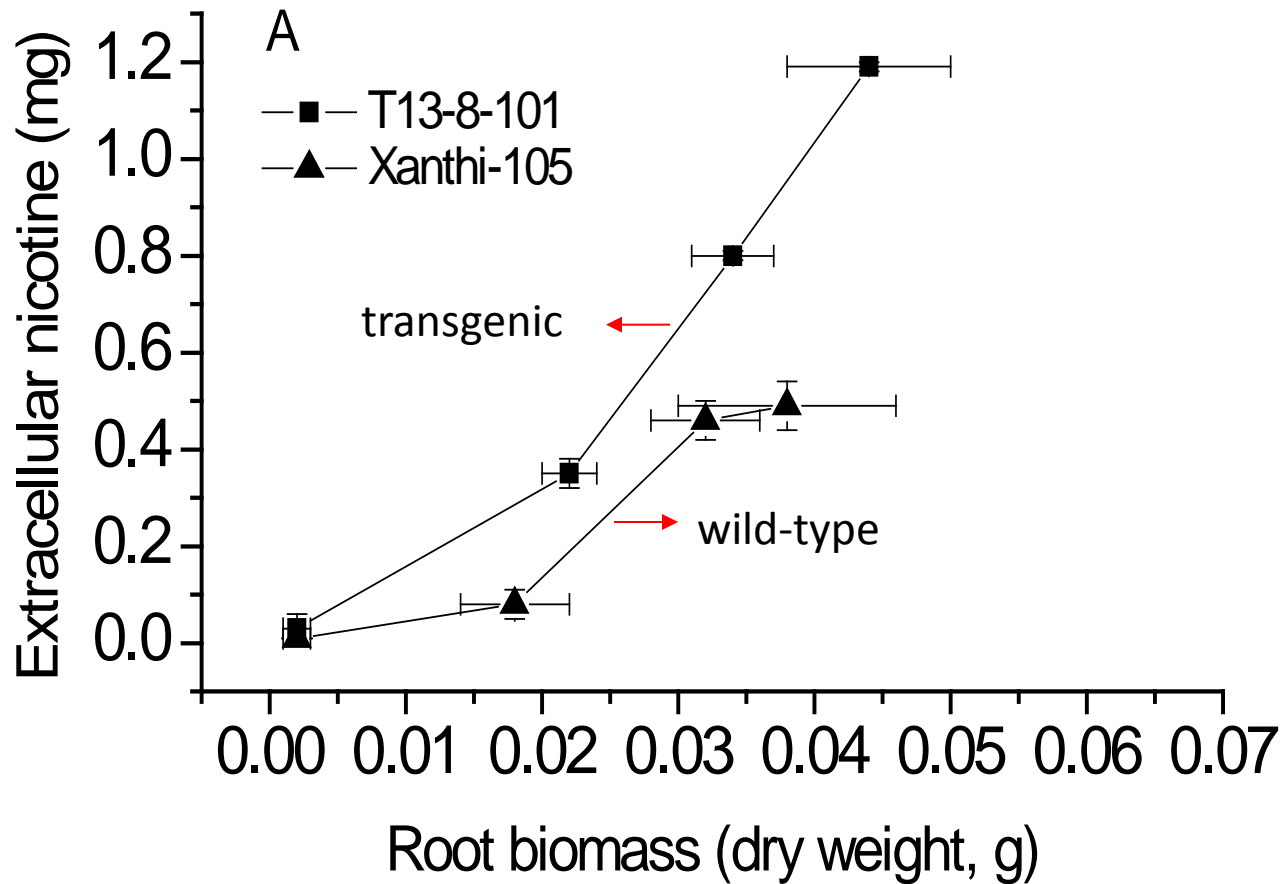
generated by inoculating sterile leaves (in the case of T13-8-101, homozygous T3-generation T13-8 transgenic leaves) with *Agrobacterium rhizogenes* ATCC15384

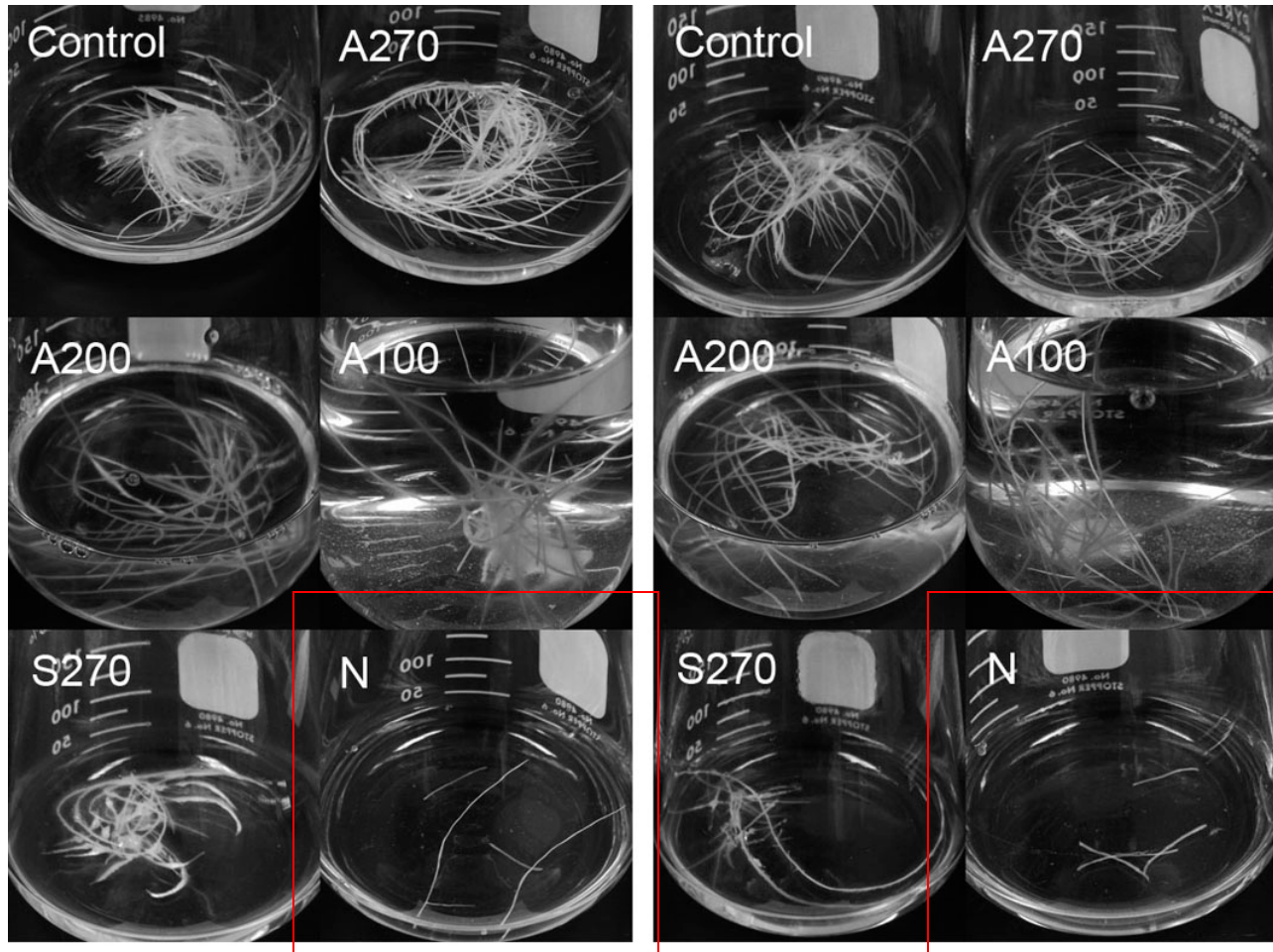


T13-8-101

Kindly provided by Dr. John G. Jelesko
Department of Plant Pathology, Physiology, and Weed Science, Virginia
Tech

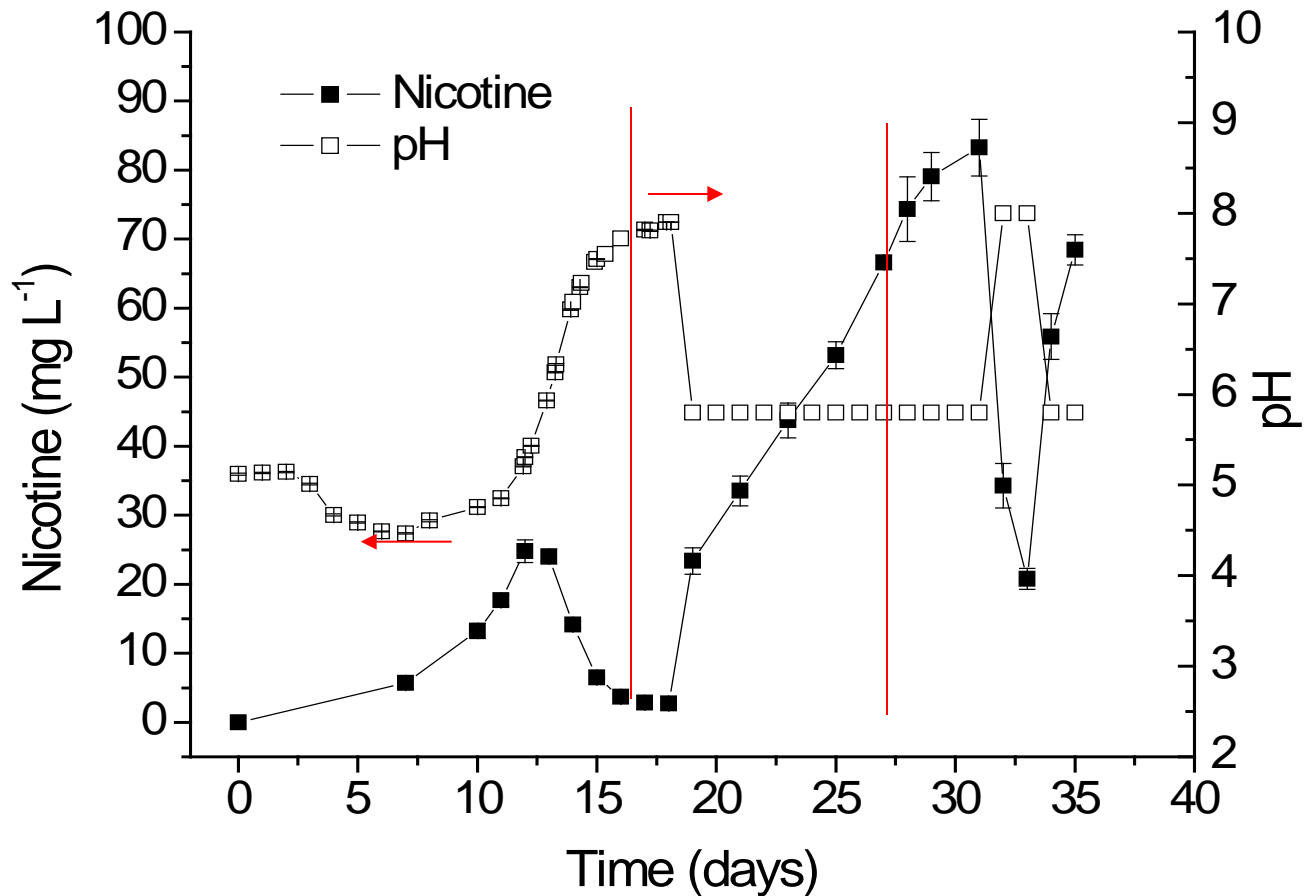
Nicotine Versus Root Biomass





T13-8-101

Xanthi-105



Microbubble dispersion (MBD) – an efficient method to improve oxygen mass transfer

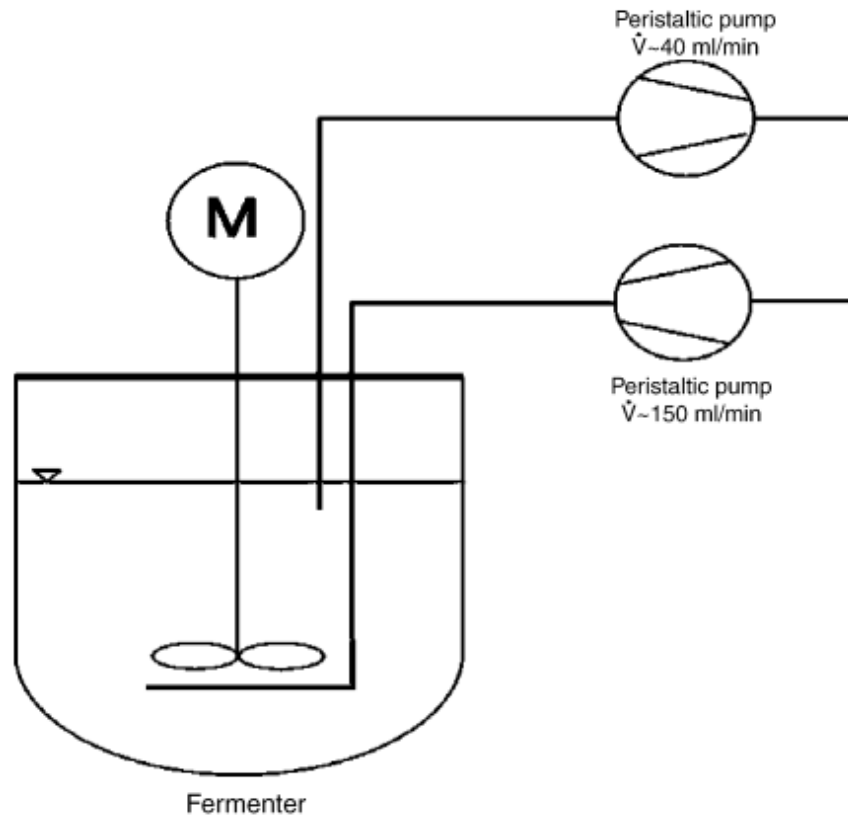


Fig. 2. The schematic of experimental setup of fermenter and MBD generator (M: motor).

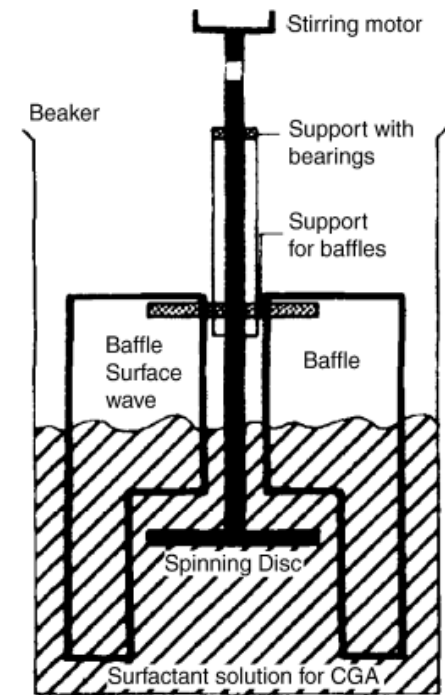
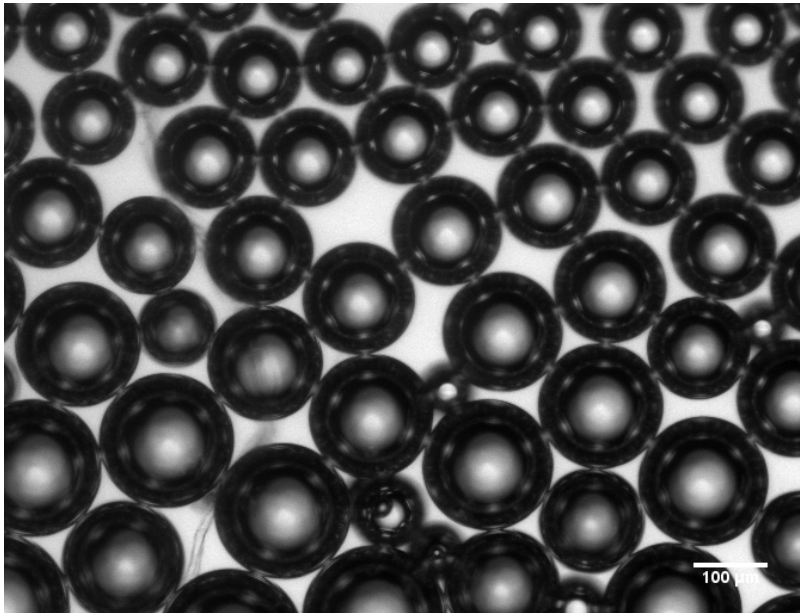


Fig. 1. The schematic diagram of a spinning-disc MBD generator.

Microbubble dispersion generation



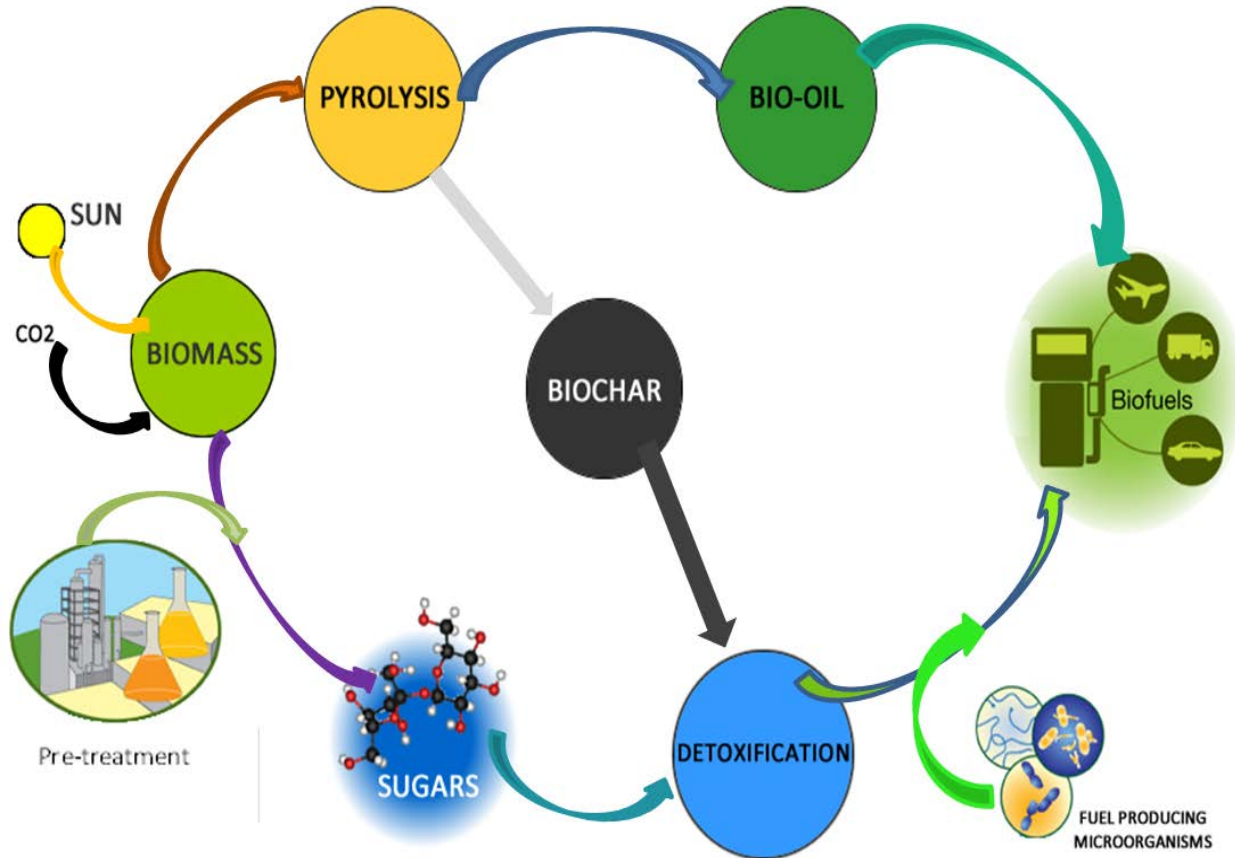
100 um

Microscope image of microbubbles

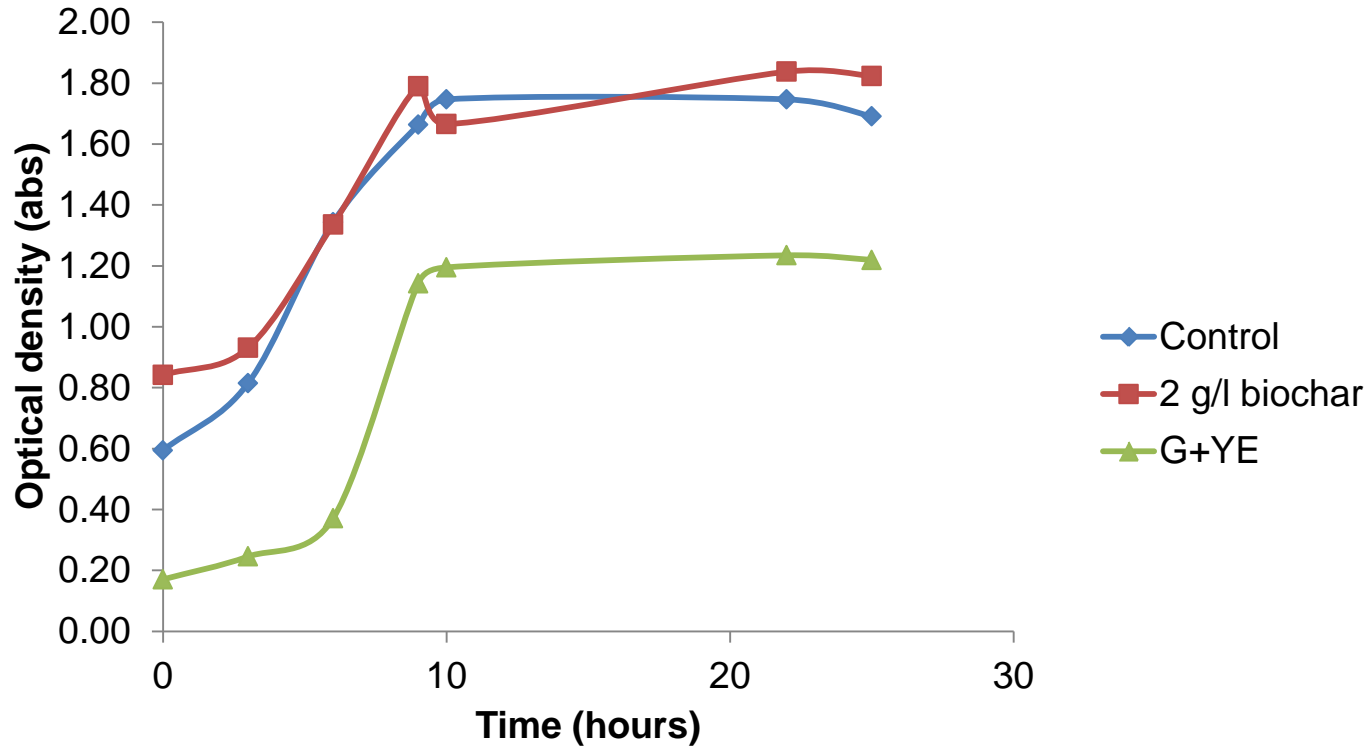


Microbubbles in generator

Influence of biochar on pretreated biomass



Effect of biochar on the growth of *S. cerevisiae*



Thanks

- Questions?

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1. Objective

2. Introduction

3. Materials

4. Aeration improved extracellular alkaloid production

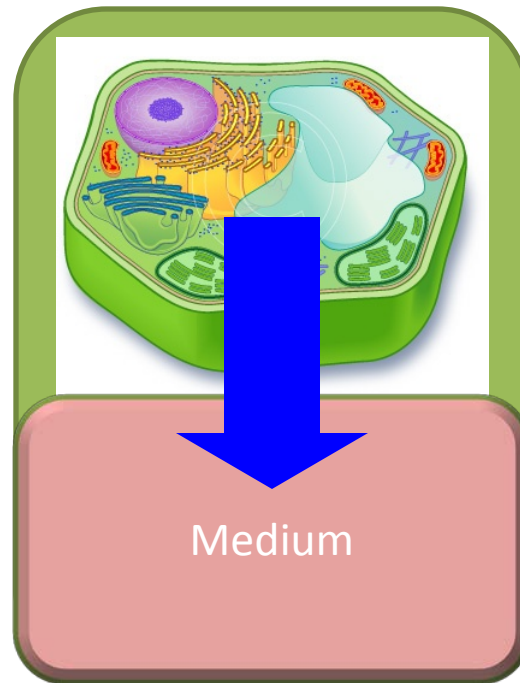
5. Decline in alkaloid release can be avoided by neutralizing the medium

6. Conclusions

Conclusions

1. Aeration showed linear positive effect on hairy root growth.
2. Aeration improved extracellular nicotine production.
3. Basic culture medium caused the absorption of extracellular nicotine.
4. By controlling the media pH, extracellular nicotine production was significantly enhanced.

Extracellular production of phytochemicals by hairy root



- Downstream processes
- Product feedback inhibition
- Continuous

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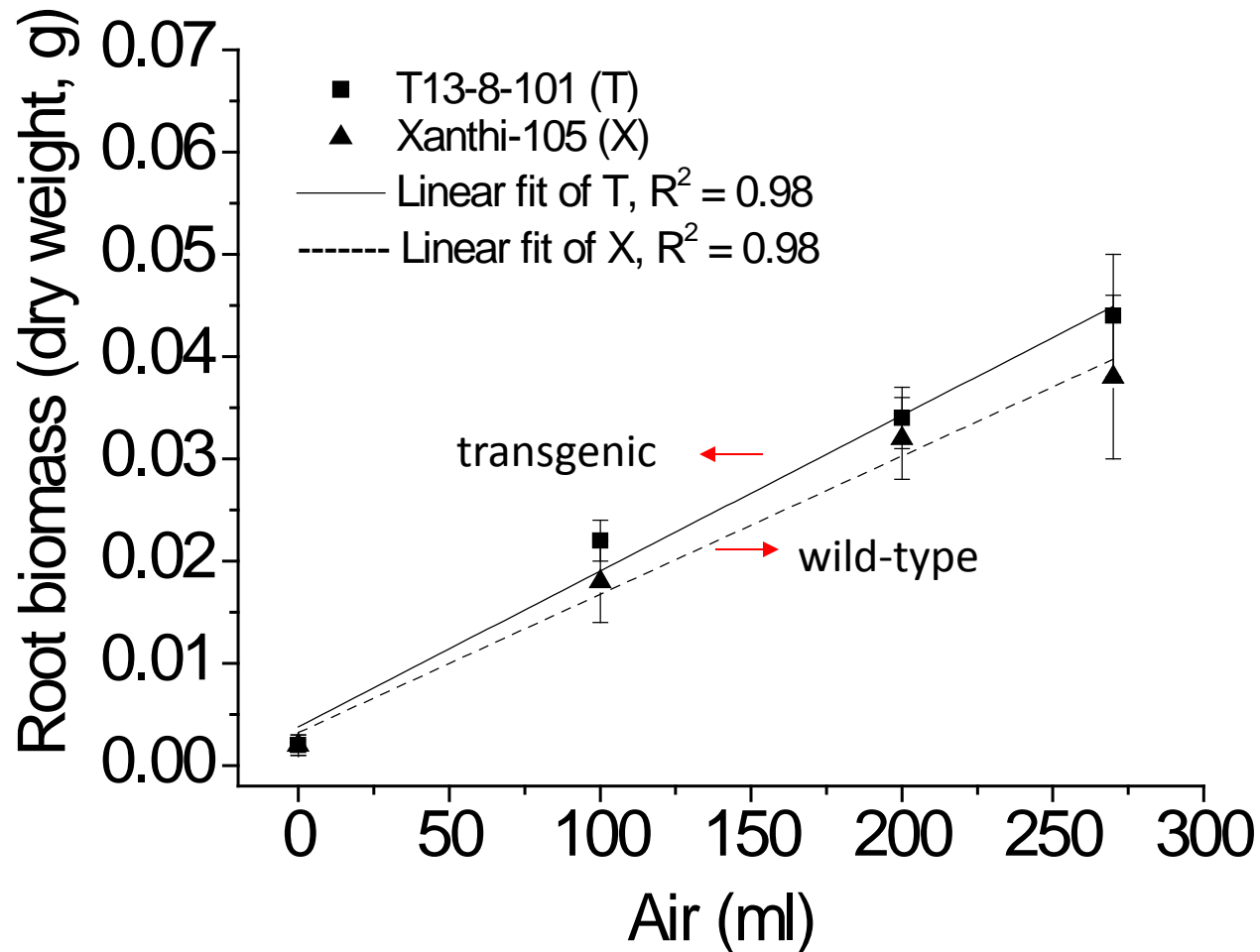
6. Conclusions

Extracellular tropane alkaloids production by hairy roots

Aeration conditions in flask culture

Code	Medium volume (ml)	Shaking speed (rpm)	Closure	Gas phase	Air volume (ml)
Control	30	100	filter paper	air	270
A270	30	100	screw cap	air	270
A200	100	100	screw cap	air	200
A100	200	100	screw cap	air	100
S270	30	0	screw cap	air	270
N	30	100	screw cap	N ₂	0

Root Biomass Versus Air Volume



Phytochemicals production systems

Properties	Whole plant	Plant suspension cell culture	Hairy root
Growth	Slow	Fast	Fast
Control	Limited	Yes	Yes
Stability	High	Low	High
Regulators	No	Required	No
Immobilization	—	Possible	Self-immobilized

challenges – entangled root matrix

Mass transfer

Inoculation

Tissue distribution

Direct growth measurement

Harvest