E. c(oil)i: The Lean, Green, Fat-Producing SynBio Machine

Manchester iGEM Team
Palm Oil

- Soaps and cosmetics
- Emulsifying agents
- Oil paints
- Varnishes
- Detergents
- Shaving cream
- Lubricants
- Food
- Biofuel
What Is Palm Oil?

- **Palmitic Acid**: 44% C16
- **Stearic Acid**: 4.5% C18
- **Oleic Acid**: 39.2% C18:1
- **Linoleic Acid**: 10.1% C18:2
Effects of Palm Oil Cultivation

58 Bn Tons of CO$_2$

Over the next 15 years
EXPERIMENTAL

Rob, Lorna, Tan, Tim, Divita, Marco
Aim: Palm Oil Production in *E. coli*

- Increase native palm oil acids in *E. coli* (palmitic and stearic acid)
- Introduction of non-native palm oil acid synthesis pathways in *E. coli* (oleic and linoleic acid)
Overproduction of Native Fatty Acids

Production of Non-Native Fatty Acids

Synechocystis sp.
PCC 603

BBa_K1027001

BBa_K1027002
Production Batches

**BATCH 1**
FAS Module

- **INPUT:** ‘FAS MEDIUM’
- **OUTPUT:** PALMITIC ACID
- **OUTPUT:** STEARIC ACID
Characterisation

Samples → Orbitrap UHPLC-FTMS

Increase in linoleic acid production between wildtype and Δ12 expressing E.coli

Analysis of desired phospholipids

Identification of metabolites of interests

Data showing metabolite profile of sample

Relative abundance of Linoleic Acid (log)

WT
Δ12

4X
2X

Very high
High
Moderate
Low
Very Low

Metabolites
• 43 reactions
• 60 metabolites
• 267 parameters
Uncertainty Analysis

1. Information collected + Prior knowledge

2. Distribution for each parameter

3. Creation of a collection of models

4. Analysis of each model

5. Distribution of results

Species Accumulation over 100 seconds (mM)

- Dark Red: >4
- Pink: > 2
- Light red: >1
- White: 1-0.01
- Light yellow: <0.01
- Dark yellow: <0.0001
Uncertainty Analysis:

Results

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• **Potentials**
  – Gives ability to model complex and poorly experimentally measured systems
  – Creates unbiased models
  – Opportunities for different types of data analysis
  – Pinpoints areas for further study

• **Limitations**
  – Potential inability to reach steady state
• β-hydroxy acyl-ACP dehydrase
• Carried out in GROMACS
• Less Dynamic N-Terminals are more appropriate for His-tag addition.
HUMAN PRACTICES

Matt, Tan, Lorna, Rob, Elsa
Environmental Impact

Models created using Vortex
The cost of crude palm oil (CPO) more than doubled in the period 2005-2013.
Economic Impact

Modelling shift of demand on price of crude palm oil
Impact Analysis

• Palm oil has detrimental effects in many areas.
• Synthetic palm oil is not a viable solution on its own.
• Natural palm oil and synthetic palm oil can coexist.
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