Yeast-insect interactions in the Queensland fruit fly (*Bactrocera tryoni*)

Alexander Piper
PhD Candidate
What do we know about Qfly host selection?

- Generalist Pest
- Prefers ripe fruit on tree
- Female flies attracted to “ripening odours”
What is a fruit odour?
Acetate esters

Ethyl acetate
\[ \text{H}_3\text{C} - \text{O} - \text{O} - \text{CH}_3 \]

Isoamyl acetate
\[ \text{H}_3\text{C} - \text{O} - \text{O} - \text{CH}_3 - \text{CH}_3 \]

2-phenylethyl acetate
\[ \text{CH}_3 - \text{O} - \text{O} - \text{C} - \text{H}_3 \]
Acetate ester production by yeasts

- Deletion of ATF1 gene has no fitness effects on the lab yeast
- So why did yeasts evolve to produce these?
Insects as vectors

- Yeasts are “Sticky”
- Don’t produce spores that can be dispersed by air
- Require insects to be transported to new environments

The Fungal Aroma Gene ATF1 Promotes Dispersal of Yeast Cells through Insect Vectors

Joaquin F. Christiaens,1,2,9 Luis M. Franco,3,4,9 Tanne L. Cools,1,2 Luc De Meester,6 Jan Michiels,1 Tom Wenseleers,1,9 Bassem A. Hassan,3,4,9 Emre Yaks1,6,7,8,10,9 and Kevin J. Verstrepen1,2,10,9

1Laboratory for Genetics and Genomics, Centre of Microbial and Plant Genetics (CMPG), Department of Microbial and Molecular Systems
Benefits to the insect

- **Nutrition**
  - Protein, vitamin B, steroids

- **Protection against entomopathogenic microbes**
  - Antifungal volatiles, killer toxins, antimicrobial peptides

- **Digestion of polymeric substrates**
  - Starch, pectin, inulin, cellulose, hemicellulose, lignin

- **Volatile organic compounds as Indication of substrate quality**
Hypothesis

- We now know that many fruit odours are actually yeast odours.
- Does Qfly respond to volatile chemical cues given off by yeasts?
Yeast sampling

- 48 x larvae collected
- Larvae surface sterilized, crushed to release gut contents then streaked on SDA agar plates
- Yeasts identified by sequencing of ITS and D1/D2 barcoding regions
Yeasts associated with Qfly Larvae

- Budding yeasts - “Saccharomycotina”
- Most common genera: Pichia and Hanseniaspora
Both associated with and highly attractive to Drosophila spp.
Larval Development Bioassays

- 20x surface sterilized eggs on Orange juice agar
- Inoculated with *H. uvarum, P. kluyveri* or sterile control
- Measured:
  1. Time to pupation
  2. Survival to adulthood

8 day old larvae developing on orange agar inoculated with *H. uvarum*
Larval Development Bioassays

c. Larval development time

d. Survival to adulthood
Olfaction trap bioassays

- 30 flies in each cage,
- 20x Reps of Mated flies (12 day old)
- 20x Reps of Virgin flies (5 day old)

Oviposition pot bioassays

- 10x 16 day old mated flies in each cage
- 20x Reps
Olfactory & Oviposition response

- No response from Virgin flies
- Yeast volatiles are not an oviposition cue
Hanseniaspora uvarum, beneficial deterrent?
Volatile sampling
1. Ethyl acetate; 2. Ethyl propionate; 3. 2-Methyl-butanol; 4. Isobutyl acetate; 5. 1-Hexanol; 6. Isoamyl acetate; 7. Hexyl acetate; 8. 2-Phenylethyl alcohol; 9. 2-Phenylethyl acetate; IS1. n-Octane (internal standard 1); IS2. Nonyl acetate (internal standard 2).
Summary

- Qfly larvae are closely associated with yeasts of the genera *Hanseniaspora* and *Pichia*
- Yeast volatiles modify the behaviour of mated females through quantitative differences in similar volatiles
- Deterrence of mated females by *H. uvarum* may be adaptive
Future Directions

- Ecological reason Pichia kluyveri attracts the flies?
- Attractant development
  - Field trials for yeast esters are continuing this season
- Metabolic pathways of volatile production
  - Will knockout of odour producing genes change fly response?

Better understanding of QFF host selection = Developing better trapping and control methods
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