Breeding for processing tomato quality

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Outline

• 1 Background and context
• 2 Fruit quality selection objectives
• 3 A (brief) attempt working with high pigment genes
• 4 High anthocyanin tomatoes for processing
• 5 Flavour
1 Background and Context
1 Background and Context

• pre-breeding program
• breeding lines are licensed to private sector seed companies

• overarching goal is to increase genetic diversity using introgressed material
1 Background and Context

• Vaino Poysa – tomato breeder at AAFC Harrow, from 1984 - 2002
• breeding goal to increase genetic diversity
• transferred most of his germplasm to Ridgetown in 2002

1 Background and Context

He crossed cultivated tomato with, “every wild species that is reasonably easy to cross”

- *S. pimpinellifolium*
- *S. cheesmaniae*
- *S. galapagense*
- *S. chmielewskii*
- *S. habrochaites*
- *S. pennellii*
1 Background and Context

He developed a bridge line to facilitate gene transfer between *S. lycopersicum* and *S. peruvianum* (and *S. chilense*).

(Theor Appl Genet 1990. 79:187-192.)

- *S. chilense*
- *S. arcanum*
- *S. peruvianum*
- *S. corneliomulleri*

(updated taxonomy of Peralta et al., 2008. *Systematic Botany Monographs 84.*)
1 Background and Context

• We use backcrossing and phenotypic selection to tame this semi-wild material
• Breeding lines resemble cultivated tomato, but retain variation from wild species
• Currently working to combine multiple wild species in the recent pedigrees of adapted lines
PCA of 384 SNP marker data from the SolCAP processing tomato panel and a collection of Ridgetown breeding lines

SolCAP processing panel
(141 genotypes)

Ridgetown breeding lines
(26 genotypes)

(Manuscript in preparation)
2 Fruit quality selection objectives

- Fruit size (& uniformity of size)
- Fruit shape (& uniformity of shape)
- External fruit colour ( . . . )
- Peeled fruit colour ( . . . )
- Internal fruit colour
- Concentration of maturity
- Field-holding ability
- Firmness
- Flavour
- NTSS, acidity
- Freedom from defects (cracking, BER, roughness, sunscald, . . .)
- Small stem scar, small core, ease of peel removal,
3 A (brief) attempt with high pigment genes

• Many breeders have worked with $hp-1$, $hp-2$, $hp-2^{dg}$
• Increase: lycopene, β-carotene, vitamin C
• Associated with: low germination rate, delayed maturity, low yield, brittle stems
### Yield trial of *hp-1* breeding lines, 2017

<table>
<thead>
<tr>
<th>Entry</th>
<th>Days to 80% red</th>
<th>Red ripe</th>
<th>Breakers</th>
<th>Proc green</th>
<th>Grass green</th>
<th>Limited use</th>
<th>Potential Yield</th>
<th>NTSS</th>
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<tr>
<td><strong>Y024AABAA</strong></td>
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<td>2.9 ab</td>
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<td>0.8 b</td>
<td>0.3 d</td>
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<td>100.5 cd</td>
<td>15.1</td>
<td>1.8 b</td>
<td>0.6</td>
<td>1.1 b</td>
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<td>4.05 ab</td>
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<tr>
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<td>19.3</td>
<td>2.7 ab</td>
<td>1.1</td>
<td>1.8 b</td>
<td>0.6 d</td>
<td>25.5</td>
<td>4.00 ab</td>
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<td>15.6</td>
<td>3.4 ab</td>
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<td>1.2 bcd</td>
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<td>4.60 a</td>
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<td>32.3</td>
<td>4.2 ab</td>
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<td>0.5 b</td>
<td>0.7 d</td>
<td>38.3</td>
<td>4.08 ab</td>
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<td>0.9 b</td>
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<td>22.9</td>
<td>8.6 a</td>
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<td>2.2 b</td>
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<td>3.90 b</td>
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<td>28.0</td>
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<td><strong>Pr (&gt;F)</strong></td>
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</table>

Trial conducted 2017, 1 location, 4 replications (RCBD)
Means are based on samples of 5 plants per plot.
Means followed by the same letter are not different (Tukey's HSD, $\alpha = 0.05$)
3 A (brief) attempt with high pigment genes

- Some progress on earliness
- Poor progress on yield
  - only 1 year on yield trial, variability was high
  - may be confounded partly by external appearance of fruit and way trials are graded
- Need to clean up material further ($u^+$)
4 High anthocyanin tomatoes for processing

- *Aft, atv*
- both parents processing types
4 High anthocyanin tomatoes for processing


- acylglycosides of petunidin and malvidin
- mainly in the hydrophilic extract
- ORAC-H value 2-fold higher than San Marzano
4 High anthocyanin tomatoes for processing

Li et al., 2012. Microwave-assisted extraction of phenolics with maximal antioxidant activities in tomatoes. Food Chem. 130:928-936.

- CEM MAE microwave system
- aqueous ethanol solvent, freeze-dried tomato powder
- mixture heated and cooled, centrifuged
- residue re-extracted in same conditions
- filtered through PTFE membrane
- reduced time in first solvent step to 2 minutes (from overnight)
4 High anthocyanin tomatoes for processing

Li et al., 2013. Carotenoid compositions of coloured tomato cultivars and contribution to antioxidant activities and protection against H$_2$O$_2$-induced cell death in H9c2. Food Chem. 136:878-888.

- H9c2 rat heart muscle cells
- total carotenoid content was slightly lower in high anthocyanin line compared to red accessions
- higher lycopene showed greatest protective effect against H$_2$O$_2$ induced cell death
4 High anthocyanin tomatoes for processing


- role of anthocyanins in *in vitro* tests were not significant
- but *in vivo* tests showed reduction of oxidative stress and increased protective enzyme activity
- tomato extract had a significant and dose dependent anti-inflammatory effect on *in vivo* rat paw oedema
5 Reflections on tomato flavour

• Every field selection is tasted

• to avoid off-flavours from wild backgrounds

• to detect any unusual flavours
5 Reflections on tomato flavour

• Despite how much I’ve thought about, and learned about tomato flavour over 30+ years, why do I feel like I always lose when discussing this topic?

• How can we explain to consumers that we really do care about tomato flavour, and that we’re working to improve it?
5 Reflections on tomato flavour

• For many years tomato flavour has been a symbol for everything that people dislike about modern agriculture.
5 Reflections on tomato flavour

- Many conversations begin with tomato flavour.
- But pay attention to where the discussion topic goes from there.
- romanticized and nostalgic memories of eating a home-grown tomato

(e.g. Pawlick, 2006. The end of food. Fort Lee, NJ: Barricade Books)
5 Reflections on tomato flavour

• Is the symbolism of tomato flavour moderating?
  – urbanization
  – production agriculture is making some changes in response to the range of criticisms.

• Will it become easier to keep the discussions on topic?

• Will fresh tomato harvest practices continue to make these discussions difficult?
Collaborators

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Thank you for your attention