46TH TOMATO BREEDERS ROUNDTABLE

Tomato breeding for good taste
Brief review from breeder's viewpoint

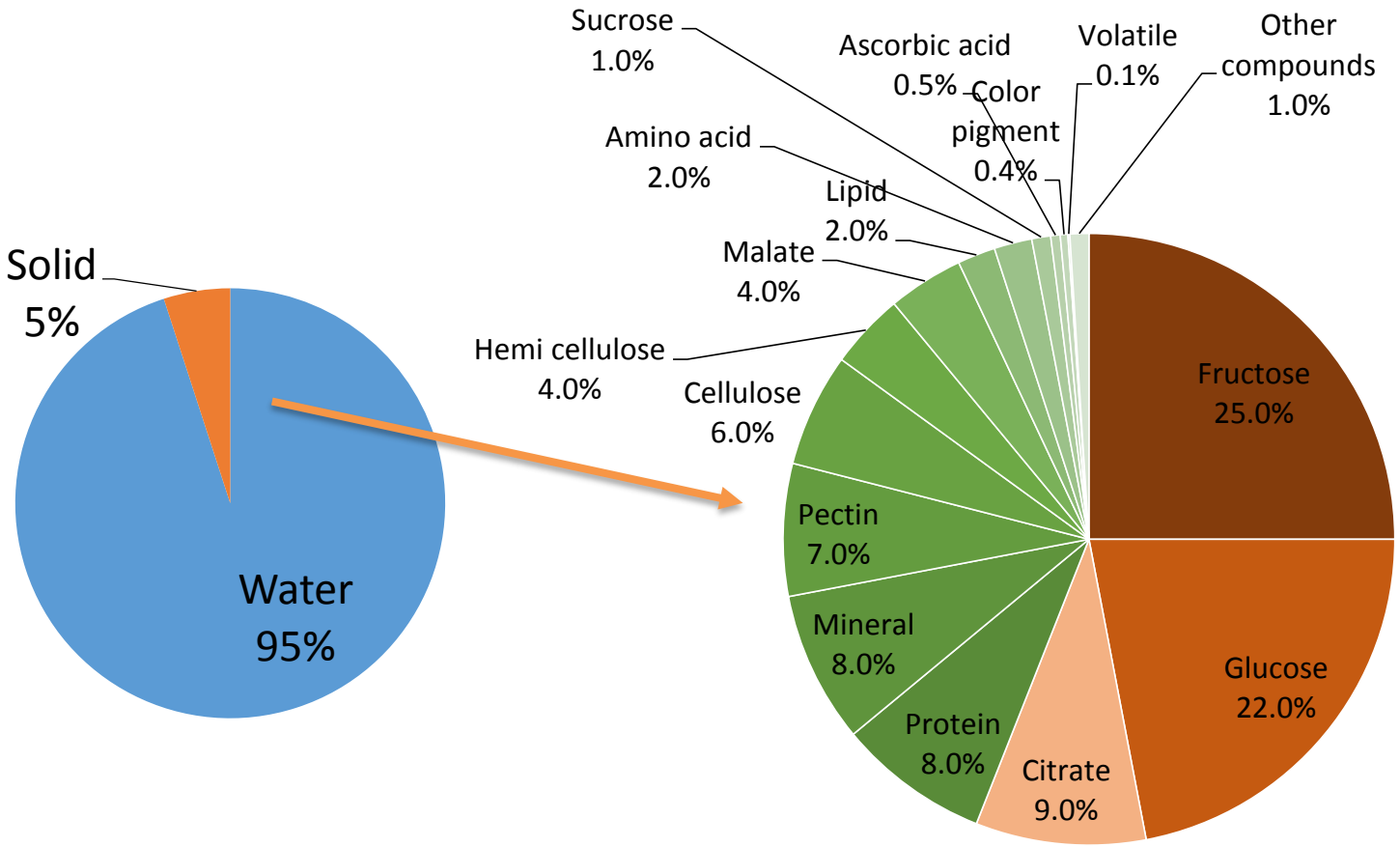
United Genetics Seeds Co.

Junji Kimbara

True to nature, the flavor of KAGOME

UNITED GENETICS

Composition of tomato fruit



From Davies and Hobson (1981)

*Three compounds occupy more than 50% of solid

*But we cannot synthesize artificial “tomato taste”

How much do we understand it?

Metabolites in tomato fruits

Total number of metabolites	?
Identified metabolites	~2,000?
Annotated metabolites	869

Iijima et al, 2008

We don't need to know everything, but two questions should be addressed;

1. How much these metabolites affect the taste? What makes good or bad taste?

*Contribution of sugars, organic acids, amino acids is well explained for years

*Volatile is currently hot area, because it is supposed to be "no cost" for plant

*Elucidation of preference will be long way

2. How can we breed "good taste tomato"?

*We made some progress since pre-historic ages

Ex. Tomatine (Courtney and Lambeth 1977), Acetate Ester (Goulet et al., 2012)

*Reducing negatives and/or increasing positives?

Classification of volatiles in tomato fruit

Key players in volatile land

Source	Example	Character
Fatty acid	hexanol, hexenal*	Green, leaf, grass, "tomato"
Phenylalanine	Phenylethanol, benzaldehyde	Floral
Phenylalanine	Methyl salicylate, guaiacol, eugenol	Pharmaceutical, smoky
Leucine, isoleucine	2-methylbutanal, 3-methylbutanol, and 2-isobutylthiazole*	Stem, leaf, wood, "tomato"
Terpenoids	limonene, linalool	Lemon
Carotenoids	β-ionone, β-damascenone, Methylheptenone	Fruit, carrot

*"Campari" is rich in hexenal and isobutylthiazole (Ties and Barringer, 2012)

Rambla et al, 2014

*A few sources can produce various compounds
*Recently, phenylalanine-derived compounds are deeply investigated
-> Possible to modify these compounds by MAS
(Tieman et al., 2006, Tikunov et al., 2013)

How scientists describe tomato taste?

Causse et al. 2010

Tieman et al. 2012

	Causse et al. 2010	Tieman et al. 2012
Taste / Aftertaste	Sweet, Acid, Salty, Astringent, Bitter, Chemical, Fresh, Rough	Sweetness, Sourness, Salty, Bitter, Umami
Aroma	Tomato, Green, Earthy, Watermelon, Sweet, Fruity, Herbaceous, Spicy, Sharp, Smokey	Tomato Flavor Intensity
Texture	Juicy, Crunchy, Mealy, Melting, Firm, Skin thickness	Texture liking

Correlation between these perceptions and compounds?

An example of connection between metabolite and human perception

Compound	Spicy	Watery	Smoky	Sour	Bitter	Tomato	Total
1) Methylbutanal	O					O	2
(2) Penten3one	O						1
(3) 3-Methylbutanol		O		O			2
(4) 2-Methylbutanol					O	O	2
(5) Cis3hexenal							0
(6) Hexanal					O	O	2
(7) Trans2hexenal		O					1
(8) Cis3hexenol							0
(9) Trans2heptenal	O	O					2
(10) Methyl5hepten2one	O						1
(11) Isobutylthiazol				O		O	2
(12) Phenylacetaldehyde	O	O					2
(13) Methoxyphenol			O		O		2
(14) Phenylethanol	O	O			O		3
(15) Methylsalicylate			O				1
(16) Betadamascenone			O			O	2
(17) Betaionone		O		O			2
(18) Glucose							0
(19) Sucrose	O		O		O		3
(20) Fructose	O	O					2
(21) Myoinositol	O	O					2
(22) Malic acid							0
(23) Citric acid	O	O	O	O			4
(24) Aspartic acid	O						1
(25) Glutamic acid				O			1

Patricia et al., 2012

*One compound tends to confer multiple perceptions, makes it more complex

*Some compounds don't contribute anything in tomato context?

One more story…

*Japanese bell pepper (“pea-man” in Japanese) has to be bitter
*This bitterness comes from following combination;

Astringency (quercetin) + bell pepper aroma (pyrazine)

*Human feel bitterness if these compounds are together

Press release by Takii, 2012

It suggests that combination of specific compounds can give you different taste. Further study should be done in this area.

Breeding good taste tomato

- Strategy A
  - Reduce “Negative component”
  - Most of people can agree on negative taste
  - Ex: “Smoky flavor”
- Strategy B
  - Increase “Positive component”
  - More challenging due to variation in personal preference
  - Preferences are different between market segments

So, what is positive / negative anyway?

A few studies about consumer preference

Dutch market (Causse et al., 2010)

Segment 1: sweet, juicy, tomato-like and spicy taste, highly educated
Segment 2: price-driven, prefer beef tomato
Segment 3: fruit size and firmness, medium level education
Segment 4: price and origin, sour, astringent taste

French market (Causse et al., 2010)

Segment 1: old people, no tendency for specific taste, prefer open market
Segment 2: don't like old-ribbed-soft beef type, prefer large round
Segment 3: don't like mealy texture , prefer small and juicy fruits with intense flavor
Segment 4: sweetness, ancient cultivars with soft melting fruits, thick peel is OK

Italian market (Sinesio et al., 2009)

Segment 1: don't like salty, pulp-thickness, firmness
Segment 2: like higher pulp-thickness, firmness, juiciness, water
Segment 3: like juiciness, fruity odor, fruity flavor, sweet taste,
don't like skin thickness, acidic taste, watermelon flavor, green flavor

In conclusion: Flavor is important in some markets, not in others.
You need to know your market

Thank you!!