FACTORS AFFECTING TOMATO SOLIDS

PRESENTATION AVAILABLE ON OUR WEBSITE:

WWW.TOMATOSOLUTIONS.CA

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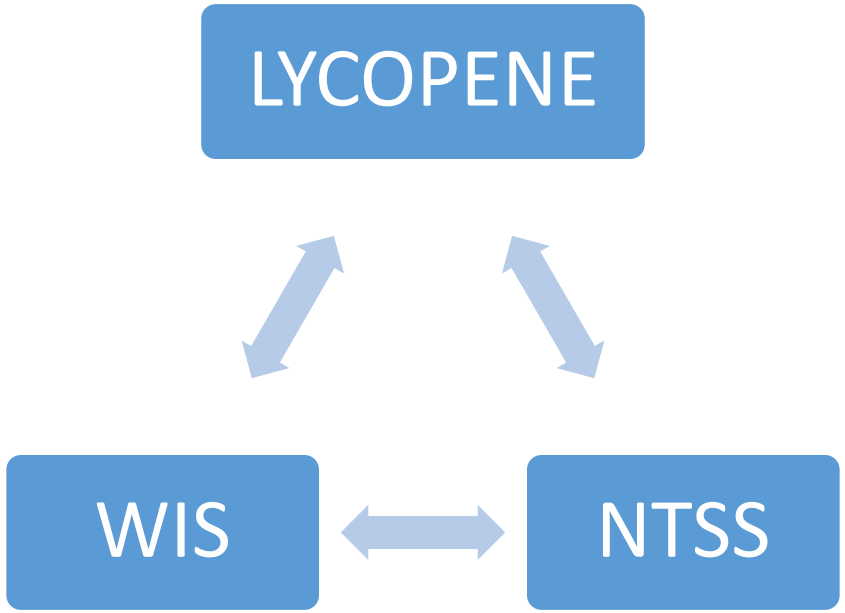
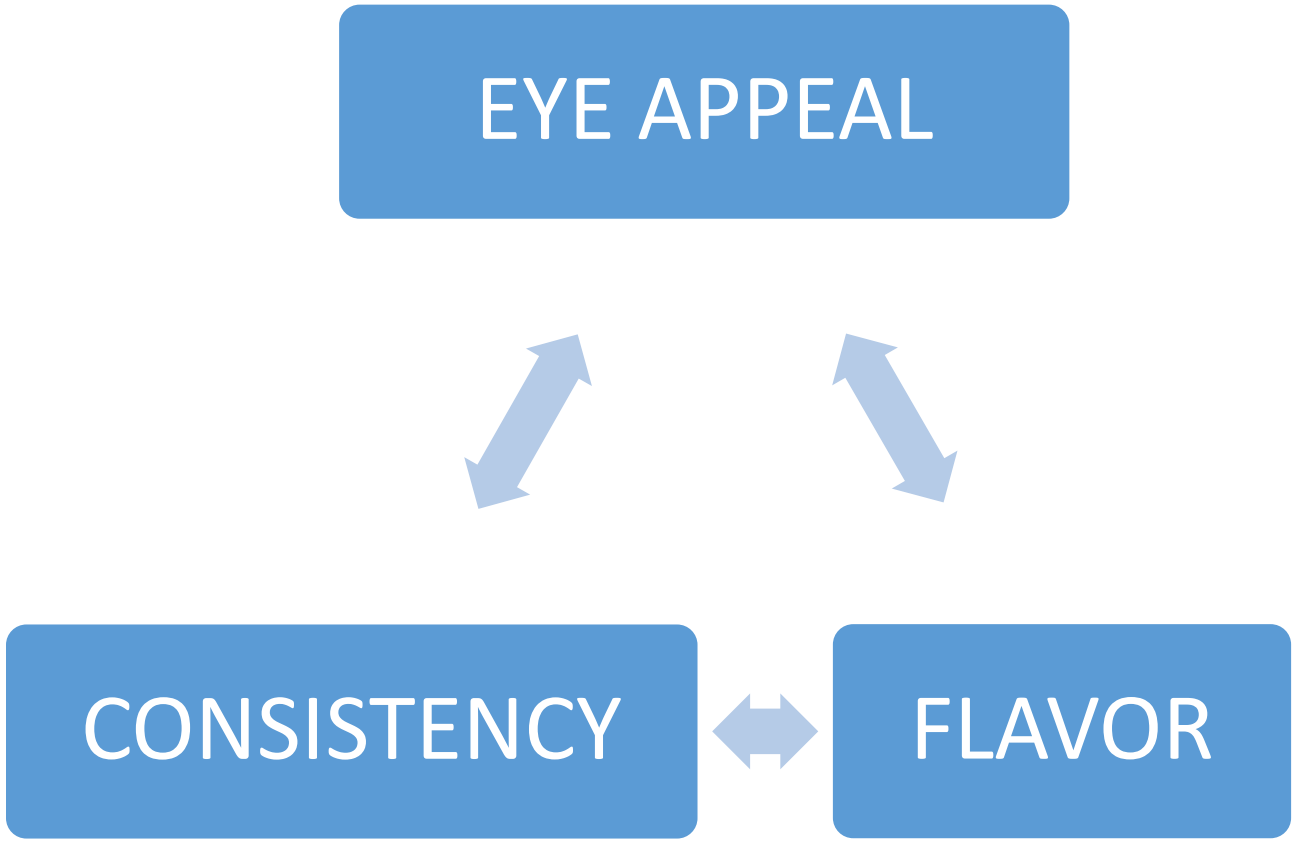
MARCH 2, 2018

TOMATO DAY, LEAMINGTON, ONTARIO, CANADA

TOMATO PULP
--MEASURABLE FACTORS--



TOMATO JUICE, SAUCE, ETC.
--CONSUMER PERCEPTION--



% SOLUBLE SOLIDS FOR A TYPICAL PROCESSOR ONTARIO, CANADA, 2013 - 2017

YEAR	2013	2014	2015	2016	2017
LOWEST GROWER	4.0	4.0	4.3	4.0	4.4
HIGHEST GROWER	4.6	4.4	5.0	4.6	5.0
AVERAGE OF ALL GROWERS	4.3	4.2	4.5	4.3	4.9

AVERAGE DIFFERENCE BETWEEN LOWEST & HIGHEST GROWER= 0.6

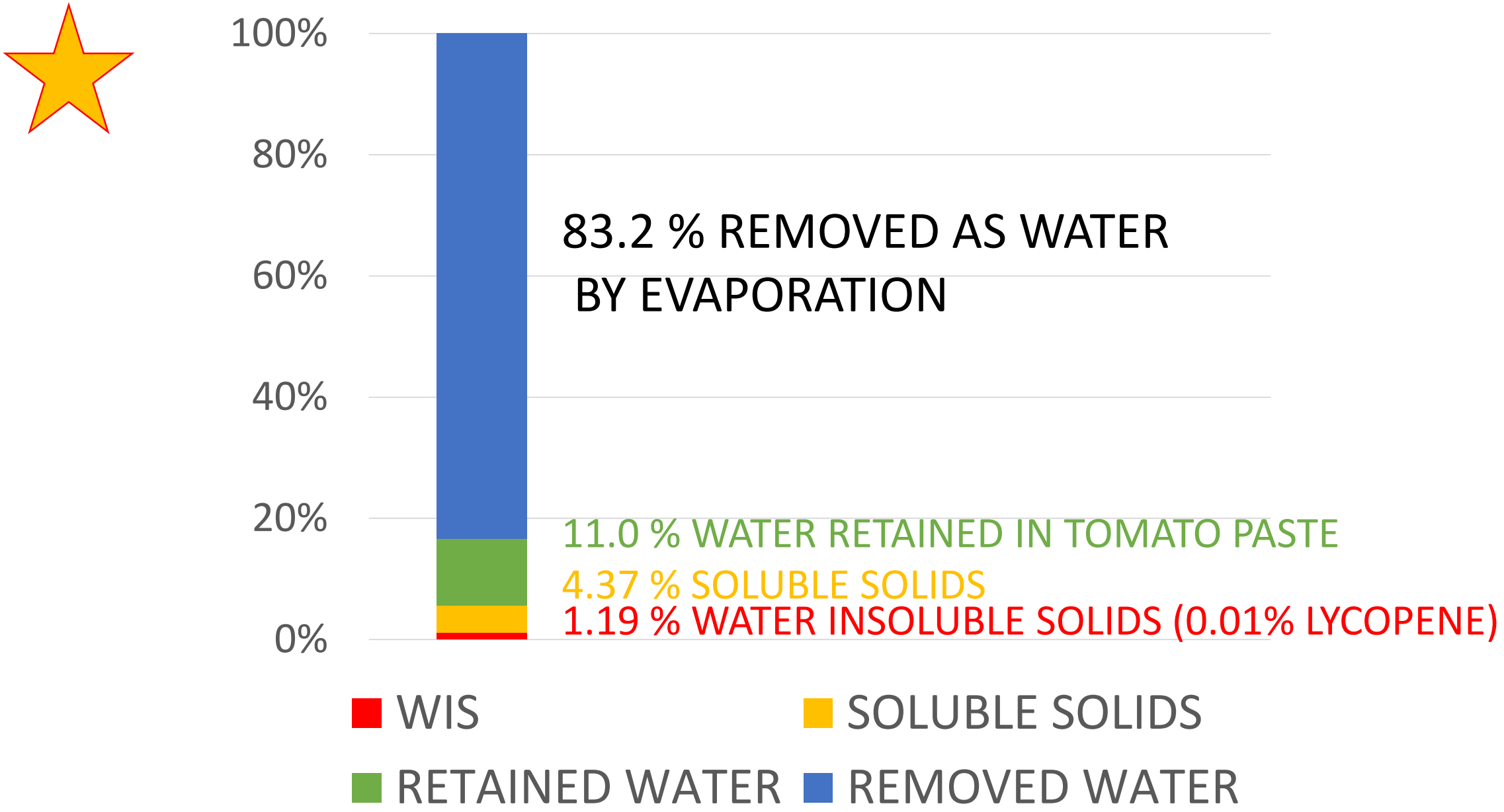
DIFFERENCE FROM LOWEST TO HIGHEST YEAR = 0.7

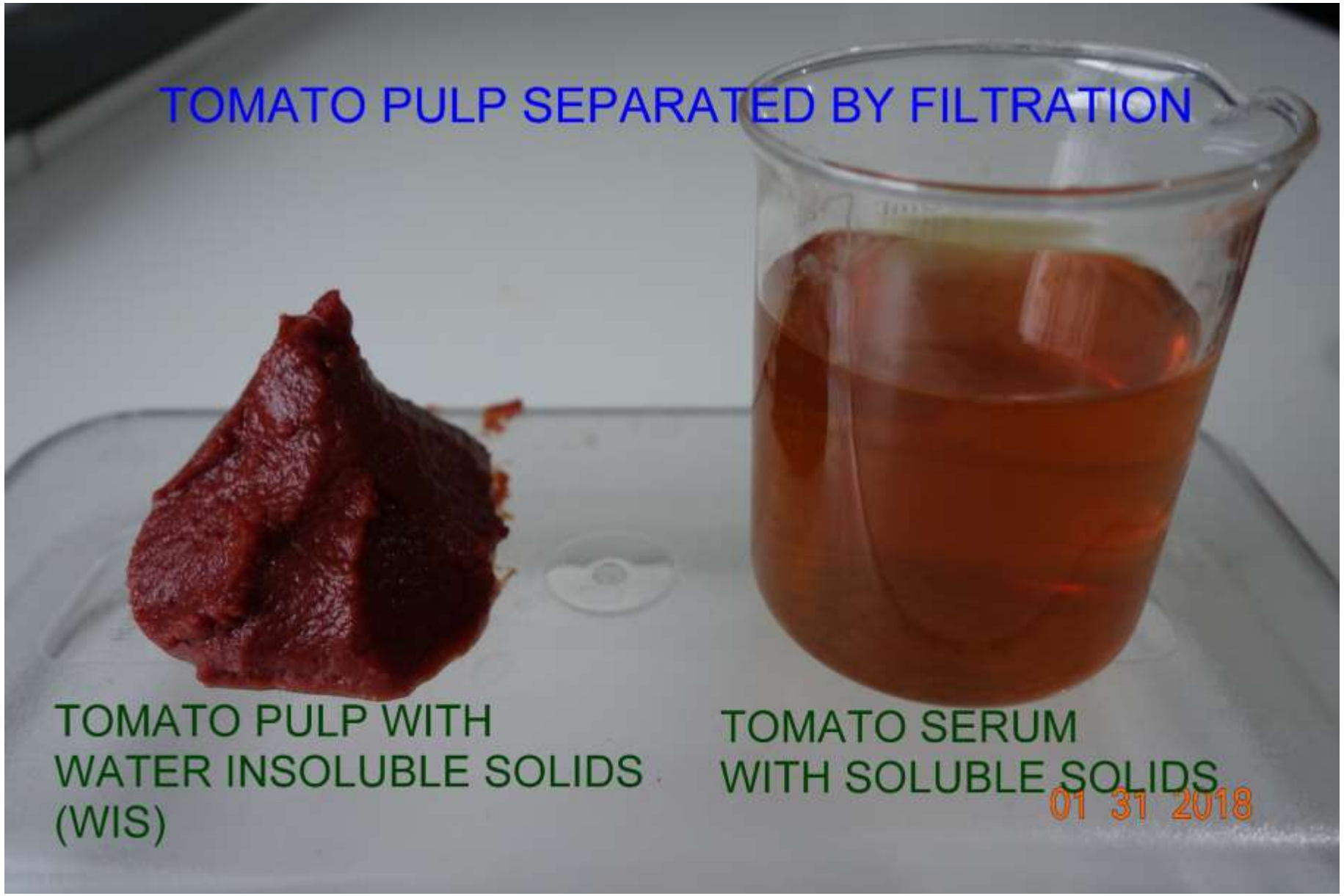
COMPONENTS OF A PROCESSING TOMATO	%
SOLUBLE SOLIDS (°BRIX, NTSS)	4.37
WATER INSOLUBLE SOLIDS (WIS)	1.44
(WIS here includes ~0.25% seeds & skin)*	
TOTAL SOLIDS (TS) = % DRY WEIGHT OF PULP	5.81
WATER	94.19

Adapted from "Analysis of a tomato processing variety, VF145B-7879 grown in California".
(J. Amer. Soc. Hort. Sci. 118 (2): 286-292. 1993)

*NOTE: ACTUAL WIS~1.19% (1.44-0.25)

TOMATO PULP COMPOSITION FOR 26°BRIX PASTE




TOMATO PULP SEPARATED BY FILTRATION
TOMATO PULP WITH WATER INSOLUBLE SOLIDS (WIS)
TOMATO SERUM WITH SOLUBLE SOLIDS
01 31 2018

WATER INSOLUBLE SOLIDS (WIS) ARE A VERY IMPORTANT COMPONENT OF TOMATO PULP

-58% CELLULOSE & HEMICELLULOSE, AND 42% PECTIN

-WIS GENERALLY ONLY 1% OF PULP (VARIABLE)

-LYCOPENE INSOLUBLE IN WATER ≈ 0.01% (80-125 mg/Kg)

-PECTIN CAN BE DEGRADED BY ENZYMES (IN FIELD, PROCESSING)

-CONSISTENCY INCREASES AS WIS:TOTAL SOLIDS INCREASES

WIS CONCENTRATED IN SUB-EPIDERMAL LAYER

- LAYER REMOVED BY LYE PEELING
- 20-30 % OF TOMATO WEIGHT
- VERY HIGH IN WIS, LYCOPENE (OVER HALF OF TOTAL?)
- LYE PEEL WASTE UNUSABLE
- WASTE IS USABLE IF STEAM PEELED

PX5588

COMPONENTS OF SOLUBLE SOLIDS (NTSS, BRIX)	%
FRUCTOSE – A REDUCING SUGAR (59% OF SUGAR)	1.48
GLUCOSE – A REDUCING SUGAR (41% OF SUGAR)	1.02
TOTAL REDUCING SUGAR	2.50
TITRATABLE ACIDITY (CITRIC & MALIC)	0.47
TOTAL SOLUBLE SUGAR AND ACIDS	2.97
RESIDUAL SOLUBLE COMPONENTS (PECTINS, MINERAL SALTS ESPECIALLY POTASSIUM)	1.40
TOTAL SOLUBLE COMPONENTS	4.37

MEASURING SOLUBLE SOLIDS

METHOD 1

- CENTRIFUGE PULP TO OBTAIN CLEAR LIQUID
- DRY THIS AND CALCULATE % SOLUBLE SOLIDS
- ALSO CAN DO TOTAL SOLIDS, THEN CALCULATE WIS BY SUBTRACTING SOLUBLE SOLIDS
- VERY ACCURATE, BUT TIME CONSUMING AND COSTLY

MEASURING SOLUBLE SOLIDS, CONT'D

METHOD 2

- USE A DIGITAL REFRACTOMETER

- PLACE A SAMPLE OF CLEAR LIQUID (FILTERED OR CENTRIFUGED) ON LENS, PRESS BUTTON AND RECORD READING

- FAST, EASY, BUT NOT AS ACCURATE

REFRACTOMETER READINGS FOR DIFFERENT SUBSTANCES

SOLUTION	% BY WEIGHT	REFRACTOMER READING
DEXTROSE (PURE SUGAR)	5.0	5.0
POTASSIUM CHLORIDE	5.0	4.5
CITRIC ACID	5.0	4.4
CERTO (SUGAR, FUMARIC ACID, PECTIN)	5.0	4.9
SIMULATED SOLUTION	5.0	4.9

NOTE: SIMULATED SOLUTION CONSISTED OF 2.86% DEXTROSE (SUGAR), 0.538% CITRIC ACID, 0.801% POTASSIUM CHLORIDE, AND 0.801% CERTO (SUGAR, FUMARIC ACID AND PECTIN IN UNDISCLOSED AMOUNTS) -THIS SOLUTION WOULD BE SIMILAR TO TOMATO PULP.


ATAGO
Palette
4.9
%
PR-32α (Brix 0~32%)
REFRACTOMETER
START/OFF
ZERO
SCALE
TEMP
SAMPLE→
DIGITAL REFRACTOMETER
01 31 2018

VALUE OF SOLUBLE SOLIDS

- COMPLEX FLAVOR CHEMICALS
- ACIDS AND SUGARS
  - FOR SUGAR/ACID FLAVOR BALANCE
  - PRESERVATION AND FOOD SAFETY

BUT, -ADDS NO LYCOPENE

-ADDS NO WIS (VISCOSITY/CONSISTENCY)

WHY MEASURE SOLUBLE SOLIDS?

- PASTE PRODUCTION CONCENTRATES PULP TO °26 BRIX SO HIGH INITIAL °BRIX = LESS PULP NEEDED
  - 26/4.3=6.05 CONCENTRATION RATIO
  - 26/4.8=5.42 CONCENTRATION RATIO
  - 6.05/5.42=1.116
  - COSTS 11.6% MORE TO MAKE PASTE WITH LOW °BRIX TOMATOES
- ***BUT***…. COLOR AND WIS MUST ALSO INCREASE TO MAINTAIN PASTE COLOR AND VISCOSITY

QUALITY FACTORS FOR TOMATO PASTE

- VISCOSITY – DEPENDS ON WATER INSOLUBLE SOLIDS (WIS) and PECTIN = 1.19% OF PULP

- LYCOPENE FOR COLOR
  - 0.01% OF PULP (80-125 mg/kg)
  - 10 LB/ACRE FOR A 50 TON/ACRE CROP

- SOLUBLE SOLIDS – FLAVOR AND ACIDITY = 4.37% OF PULP

CRITERIA FOR ASSESSING PASTE QUALITY

- PASTE IS DILUTED TO 12 °BRIX

- COLOR IS MEASURED ON THE HUNTER a/b SCALE
  -SHOULD BE 1.8 OR ABOVE

- VISCOSITY (CONSISTENCY) IS MEASURED WITH THE BOSTWICK CONSISTOMETER
  -VISCOSITY REQUIREMENTS MAY VARY DEPENDING ON PRODUCT FORMULATION

BOSTWICK CONSISTOMETER

CONSISTOMETER CELL LOADED PRIOR TO TRIPPING

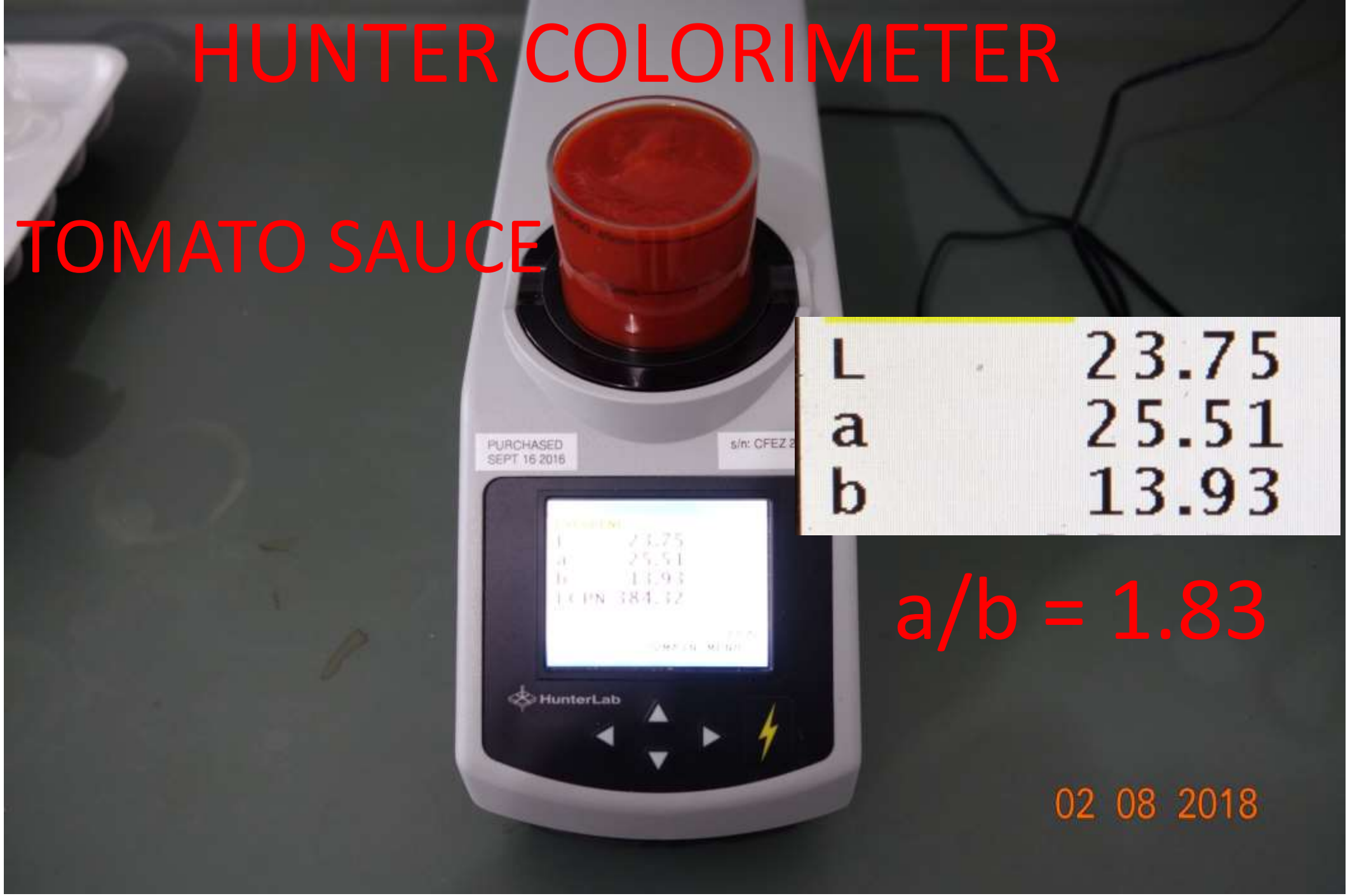

INGREDIENTS: TOMATO PUREE (WATER, TOMATO PASTE), WATER, SALT, CITRIC ACID, SPICE, COTTONSEED OIL, FLAVOUR.
9.5 CM
TOMATO SAUCE
02 08 2018

PASTA SAUCE

- CRUSHED TOMATOES
- GLUCOSE FRUCTOSE (SUBSTITUTES FOR SOLUBLE SOLIDS)
- CORN STARCH (THICKENER – SUBSTITUTES FOR WIS)

HUNTER COLORIMETER

TOMATO SAUCE



L	23.75
a	25.51
b	13.93

a/b = 1.83


PASTA
SAUCE
L 25.99
a 23.88
b 15.46
a/b = 1.54
02 08 2018
PURCHASED
SEPT 16 2016
HunterLab

LYCOPENE IMPORTANCE IN TOMATO PRODUCTS

- ARTIFICIAL COLOR CANNOT BE ADDED TO SUBSTITUTE FOR LYCOPENE
- DEPENDING ON THE PRODUCT, (EG. PASTA SAUCE) SUGAR AND THICKENING AGENTS CAN BE ADDED TO SUBSTITUTE FOR SS AND WIS
- FOR EXAMPLE,KETCHUP ADDS SUGAR BUT NO THICKENING AGENT TO DILUTED PASTE (DEPENDS ON WIS & LYCOPENE)

BANANA KETCHUP WITHOUT ANY TOMATO SOLIDS

-LOOKS AND TASTES SIMILAR TO TOMATO KETCHUP DUE TO SUGAR, VINEGAR, SPICE, AND ARTIFICIAL COLOR

IMPORTANT RELATIONSHIPS

- IF °BRIX OF RAW PRODUCT INCREASES WITHOUT AN INCREASE IN WIS, VISCOSITY OF PASTE WILL BE REDUCED

- IF °BRIX OF RAW PRODUCT INCREASES WITHOUT AN INCREASE IN LYCOPENE, PASTE COULD HAVE POOR COLOR
  (LESS THAN a/b RATIO OF 1.8 @ 12 °BRIX)

CULTIVAR SELECTION CRITERIA FOR THE AUSTRALIAN PROCESSING TOMATO INDUSTRY

PASTE	PEELING
1) VISCOSITY (WIS)	1) PEELABILITY – EASY SKIN REMOVAL
2) COLOR (LYCOPENE)	2) °BRIX – 5.0 CONSIDERED EXCELLENT
3) pH	3) COLOR – NO YELLOW SHOULDER
4) EARLINESS	4) pH – CITRIC ACID BAD FOR FLAVOR
5) °BRIX	5) FLAVOR – FULL TOMATO FLAVOR

- WANT HIGH °BRIX, BUT THIS CAN REDUCE VISCOSITY.

"HARD TO GET HIGH VISCOSITY PASTE WITH HIGH °BRIX FRUIT"

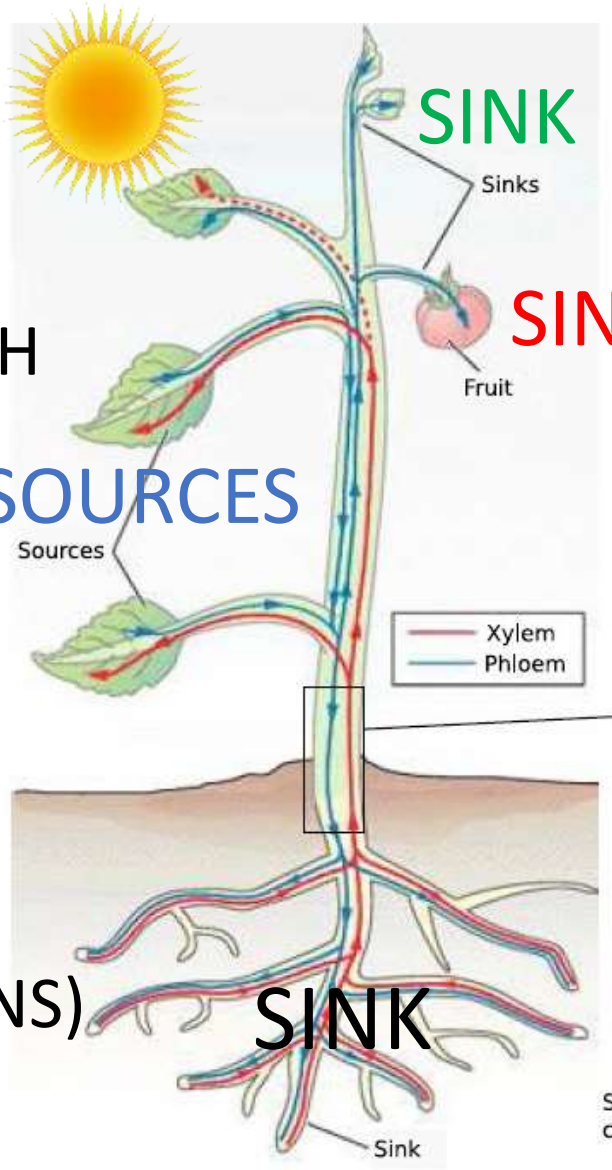
BIOLOGY OF SOLIDS PRODUCTION IN TOMATOES

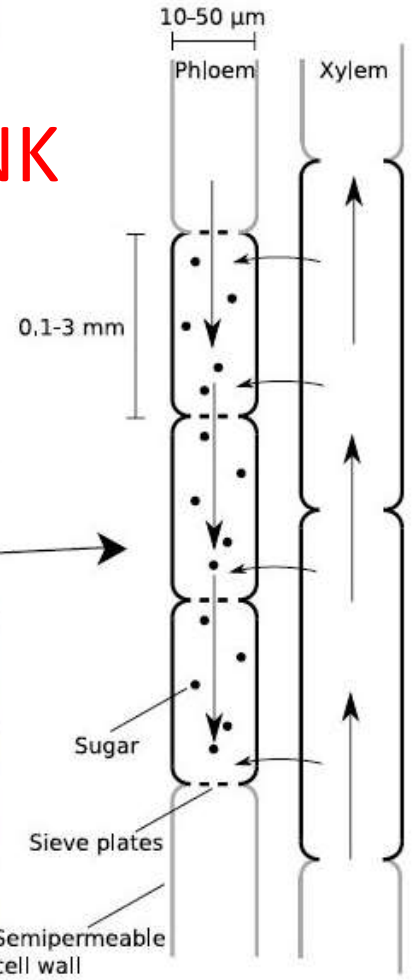
LEAVES→SUCROSE

CONVERTED TO STARCH
& WIS IN TOMATO

RIPENING→

FRUCTOSE
GLUCOSE
ACIDS
OTHER SOLUBLES (PECTINS)

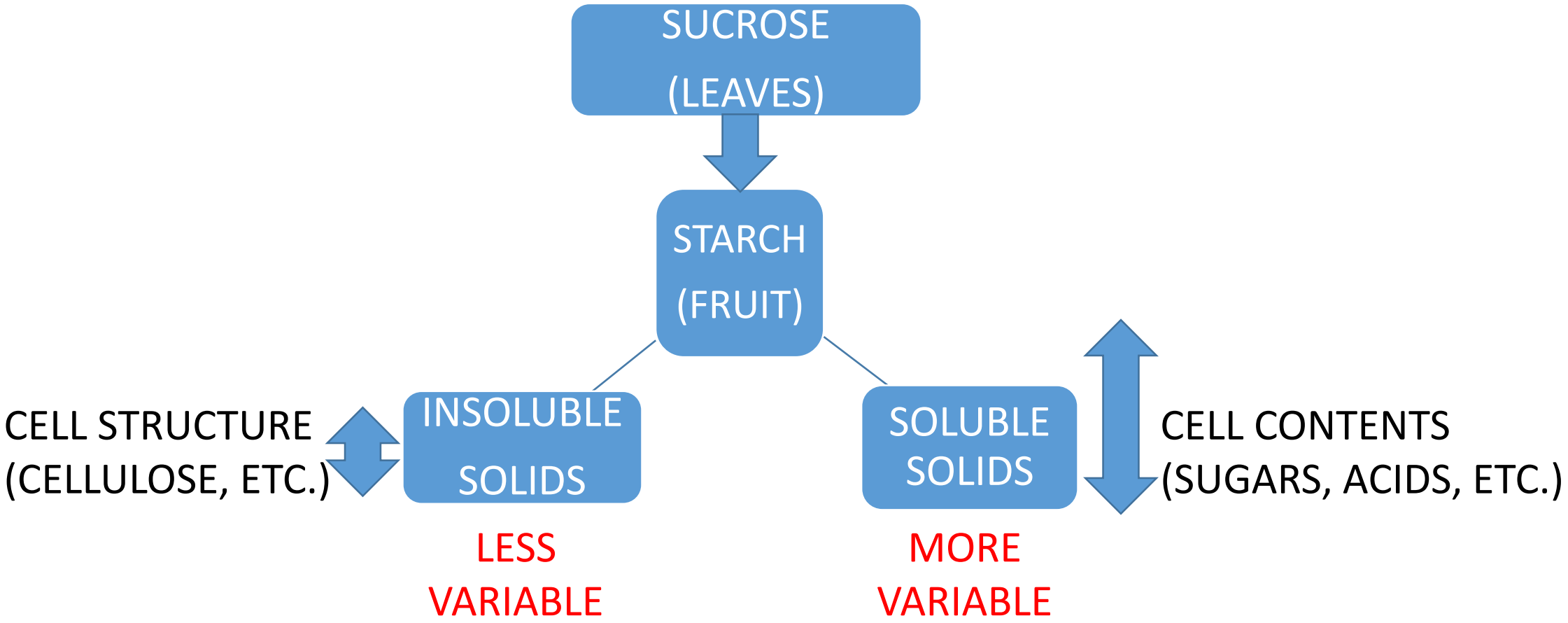




SOURCE – SINK RELATIONSHIP

- ASSUMING A FULL CANOPY OF FOLIAGE, HIGHER FRUIT LOAD (YIELD) RESULTS IN LOWER °BRIX
- REDUCTION OF °BRIX BY HIGH FRUIT LOADS CAN INDUCE YELLOW SHOULDER DISORDER (YSD)
- EXCESS N MAKES LEAVES AN UNPRODUCTIVE SINK
- INFLUENCED BY VARIETY AND CULTURAL CONDITIONS

RELATIVE DISTRIBUTION OF SOLIDS IN TOMATO FRUIT



AGRONOMIC PRACTICES TO IMPROVE PASTE RECOVERY FROM RAW PRODUCT

1) USE HYBRIDS WITH HIGHER SOLUBLE SOLIDS PROVIDING WIS (VISCOSITY) AND COLOR ALSO INCREASE

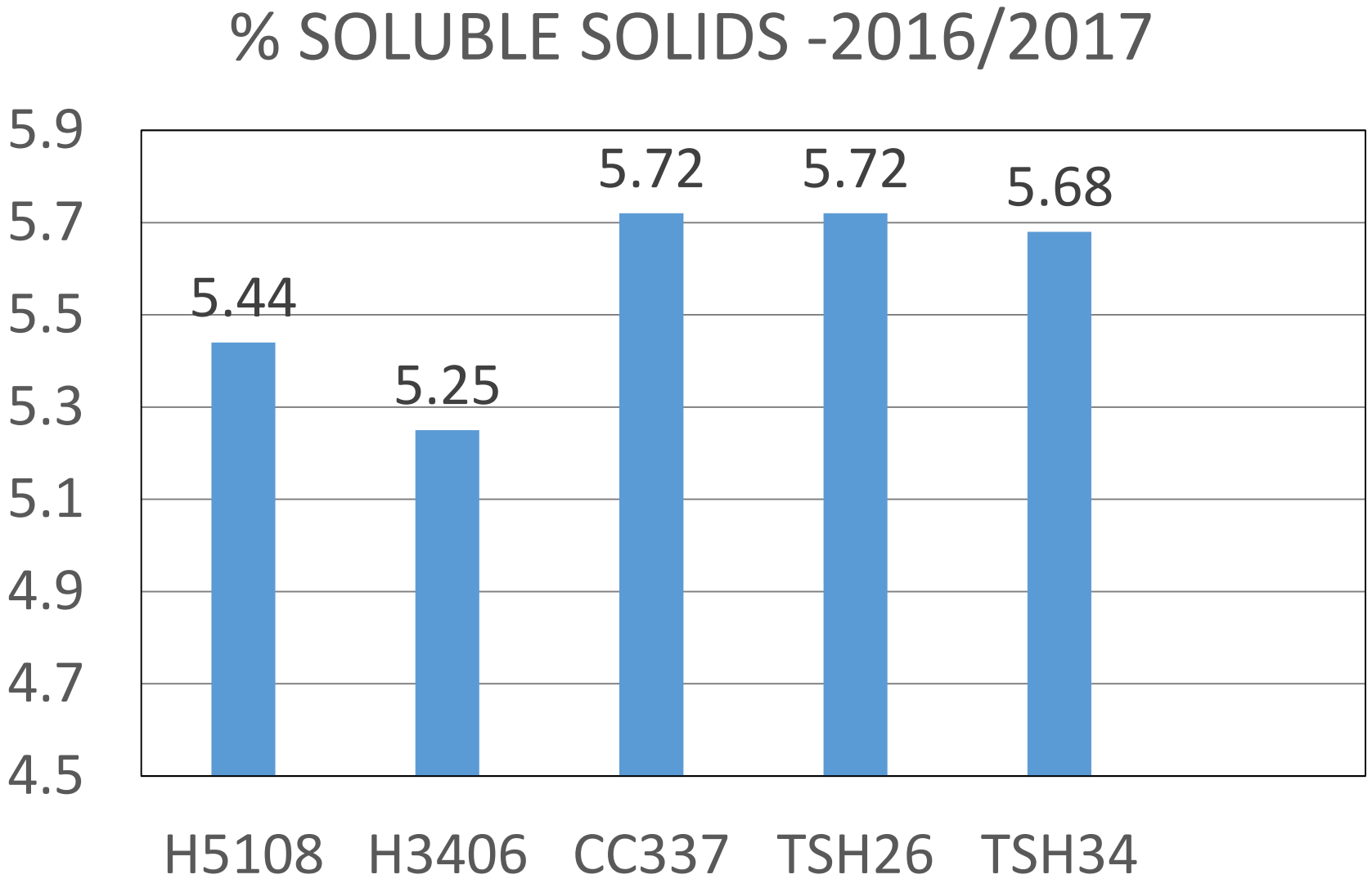
2) PRACTICES THAT ENHANCE OR MAINTAIN PHOTOSYNTHETIC EFFICIENCY OF LEAVES (RISKS REDUCTION IN VISCOSITY)

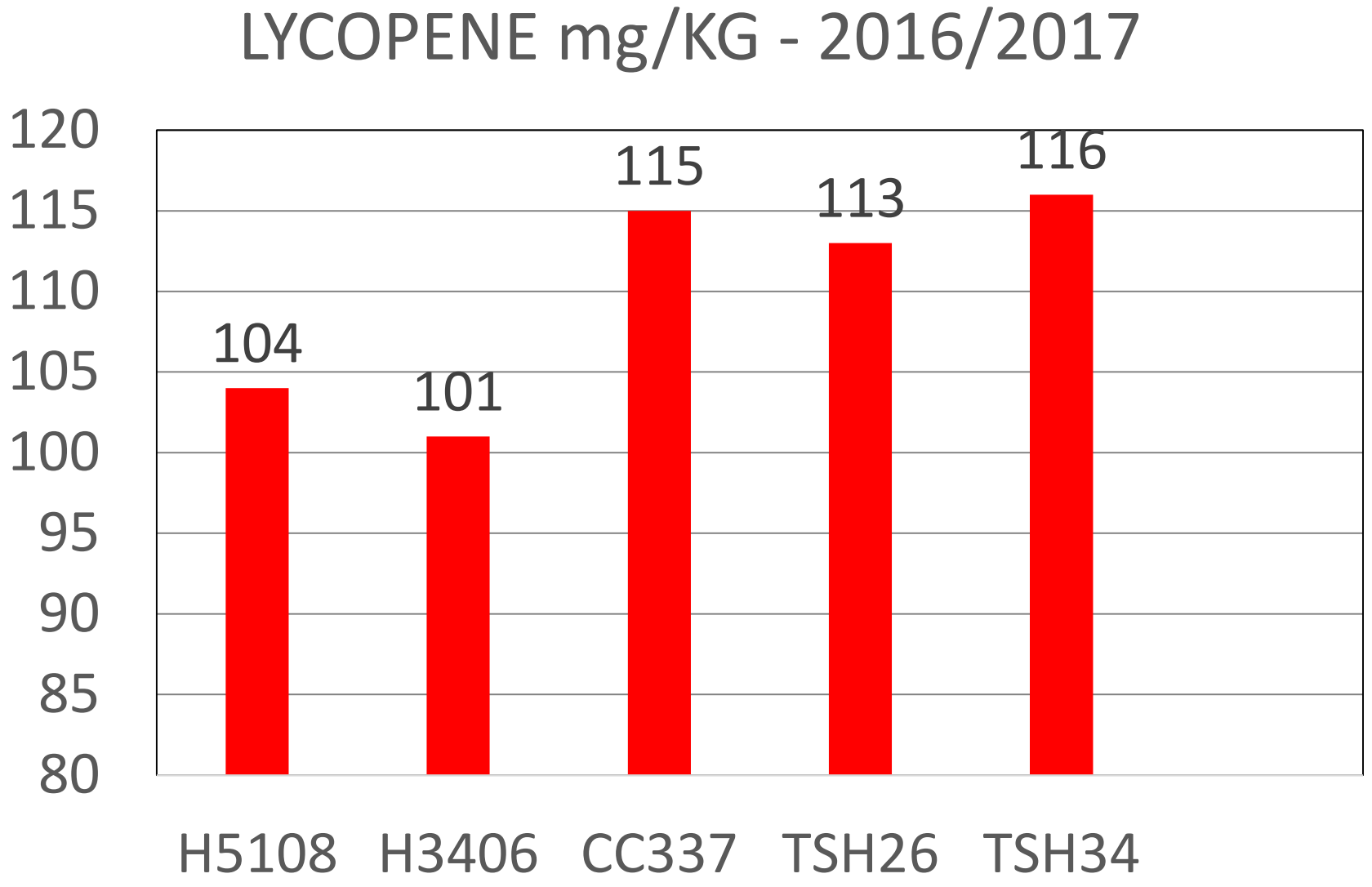
3) HARVEST ON TIME TO PREVENT LOSS OF SOLIDS

4) PRACTICES THAT RESTRICT WATER AVAILABILITY TO ROOTS (RISKS REDUCED YIELD)

TOMATO HYBRID DIFFERENCES AFFECTING PASTE QUALITY

(USING TOMATO SOLUTIONS DATA)

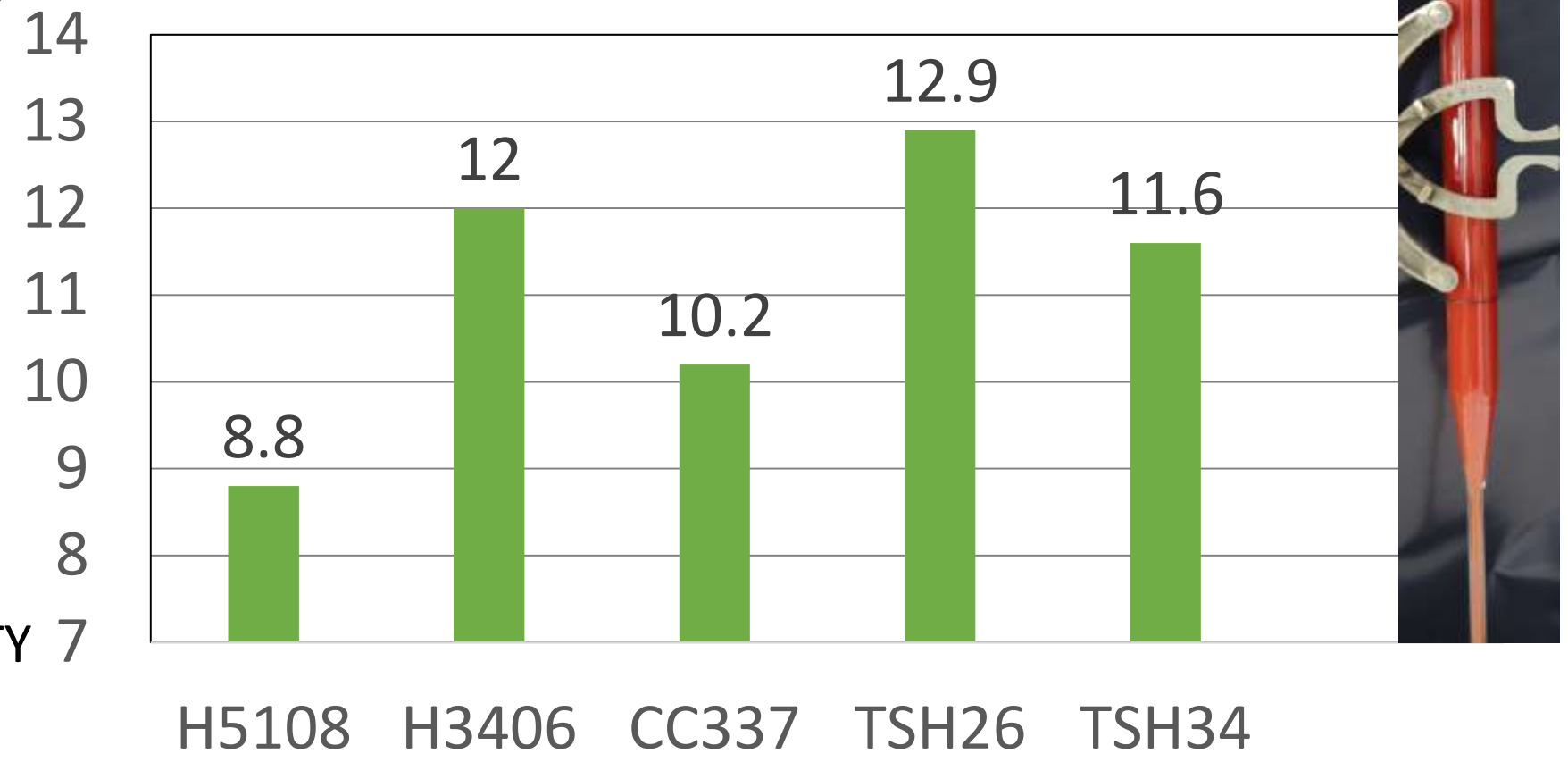

% SOLUBLE SOLIDS -2016/2017
5.9
5.7
5.5
5.3
5.1
4.9
4.7
4.5
5.44
5.25
5.72
5.72
5.68
H5108
H3406
CC337
TSH26
TSH34


LYCOPENE mg/KG - 2016/2017
120
115
110
105
100
95
90
85
80
104
101
115
113
116
H5108
H3406
CC337
TSH26
TSH34

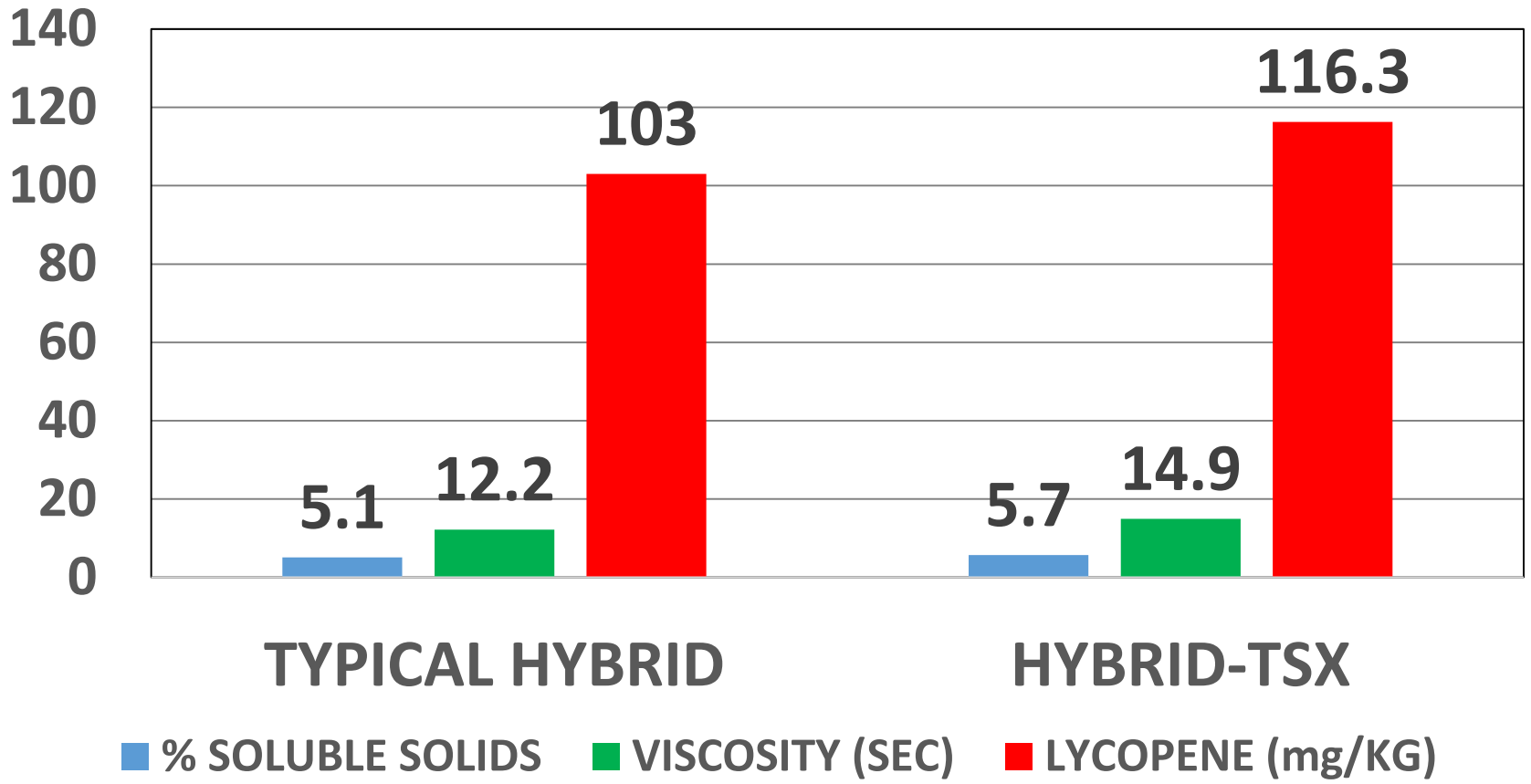
VISCOSITY (SECONDS) – 2016/2017 (CORRELATES WITH WIS)

HIGH VISCOSITY

LOW VISCOSITY



FUTURE HYBRID DEVELOPMENT (FROM ACTUAL DATA)



BREEDING CONSIDERATIONS:

- SELECTION FOR RESISTANCE TO YELLOW SHOULDER DISORDER (YSD) FOR HIGH PEEL QUALITY USUALLY ASSSOCIATED WITH HIGHER SOLUBLE SOLIDS

- HIGHER VISCOSITY ASSOCIATED WITH THICK WALLS AND FIRMNESS, ALSO NEEDED FOR PEEL QUALITY

- HIGHER LYCOPENE ENHANCES VISUAL QUALITY FOR BOTH PASTE AND PEEL PRODUCT

BREEDING CHALLENGES:

- SELECTION FOR HIGH YIELD ASSOCIATED WITH DECREASED °BRIX AND YELLOW SHOULDER (POOR PEEL QUALITY)

- SELECTION FOR VERY HIGH °BRIX CAN CAUSE BLOSSOM END ROT & HIGH MOULD COUNTS

FACTORS AFFECTING BREEDING FOR HIGHER BRIX

1) HIGHER RATIO OF LEAVES TO FRUIT

- MORE SUGAR FOR LESS FRUIT = HIGHER °BRIX

2) ROOT SYSTEM RESTRICTED IN ABILITY TO ABSORB AND TRANSLOCATE WATER TO FRUIT

- CONCENTRATES SOLIDS IN FRUIT

- LESS CALCIUM TRANSLOCATED TO FRUIT
  = HIGHER INCIDENCE OF BLOSSOM END ROT

BREEDING OPPORTUNITIES:

- INCREASED LYCOPENE USING “OLD GOLD CRIMSON” (OGC)

- INCREASED FIRMNESS AND VISCOSITY USING:

  → FRUIT WITH THICKER FIRMER WALLS
  (MULTIGENIC INHERITANCE)
  → SINGLE GENES WITH SPECIFIC EFFECTS ON WIS

IMPROVED FRUIT FIRMNESS ESSENTIAL FOR HARVESTING AND PROCESSING, AND ENHANCES HOLDABILITY IN FIELD.

INCREASING LYCOPENE CONTENT

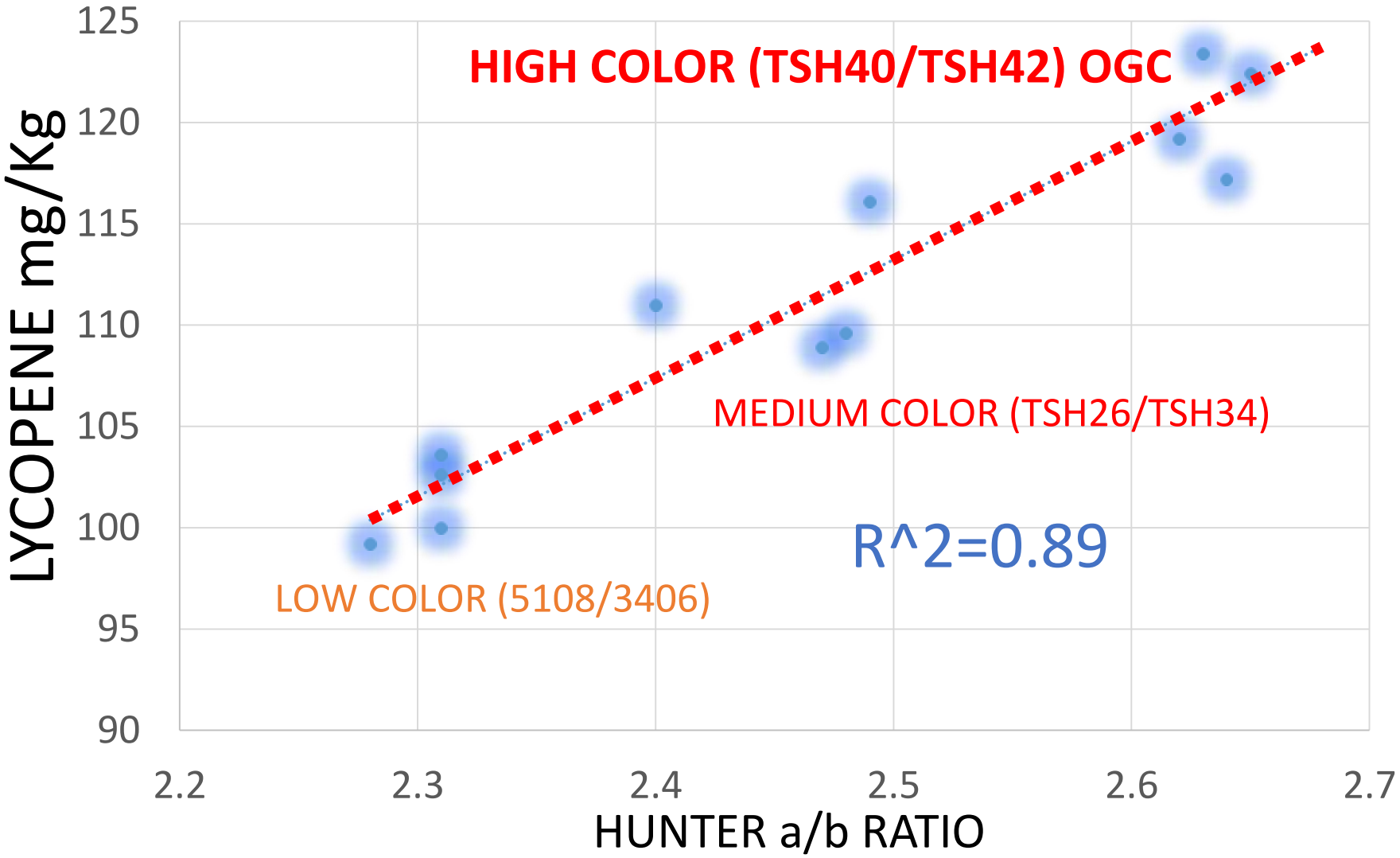
- CONVENTIONAL SELECTION FOR BETTER PEELED COLOR IS ASSOCIATED WITH HIGHER LYCOPENE AND SOLUBLE SOLIDS

- THIS MULTIGENIC IMPROVEMENT IN COLOR MAY BE DEPENDENT ON HIGHER SOLIDS (+ 0.30 %)

- THE CRIMSON GENE (OGC) CAN INCREASE LYCOPENE BY 18% COMPARED TO LOW SOLIDS HYBRIDS & IS PHOTOSYNTHETICALLY EFFICIENT WITH NO IMPACT ON YIELD

- BOTH HIGHER SOLIDS GENETICS AND THE CRIMSON GENE SHOULD BE USED FOR THE BEST PEEL AND PASTE COLOR

LYCOPENE VS HUNTER a/b RATIO FOR COLOR TOMATO SOLUTIONS PLOTS, 2016



PRODUCTION PRACTICES TO ENHANCE OR MAINTAIN PHOTOSYNTHETIC EFFICIENCY (PROBABLY RELATIVELY MINOR EFFECTS)

1) CONTROL FOLIAR FUNGAL DISEASES
(MOST GROWERS HAVE A GOOD PROGRAM)

2) INCREASE OR MAINTAIN SOIL K @200 PPM
-VERY IMPORTANT FOR PEEL PRODUCT

3) BALANCED N/K RATIOS (NO EXCESSIVE FOLIAGE)

EFFECT OF FUNGICIDES ON LATE BLIGHT RESISTANT HYBRIDS
HARVESTED 109 DAYS FROM PLANTING
AVERAGE OF 9 HYBRIDS - TOMATO SOLUTIONS PLOTS - 2017

	YIELD (T/AC)	°BRIX	VISCOSITY (SECONDS)	LYCOPENE mg/Kg
NOT SPRAYED	39.8	5.7	8.6	114
SPRAYED	44.8	6.0	10.4	114
IMPROVEMENT	+12%	+5%	+21%*	0%

* UNSPRAYED PLOTS WERE OVER-RIPE, SO PECTINS WERE LOWER

TYPICAL LATE BLIGHT RESISTANT HYBRID

NO SPRAY

SPRAYED

NO ETHREL

PRODUCTION PRACTICES TO PREVENT LOSS OF SOLIDS ONCE PRODUCED

- SOLIDS CAN BE LOST AFTER PEAK RIPENESS
- ACIDITY DECREASES ↓ pH INCREASES ↑ → SPROUTS
- PECTINS DEGRADED → SOFT FRUIT → VISCOSITY ↓
- PLANTING AND HARVESTING SCHEDULE ESSENTIAL
  -- OFTEN DISRUPTED BY WEATHER

PRODUCTION PRACTICES TO RESTRICT WATER AVAILABILITY TO ROOTS

- DROUGHT PRONE SAND AND CLAY SOIL → HIGHER °BRIX
- ***BUT,*** LACK OF ADEQUATE MOISTURE CAN RESULT IN BLOSSOM END ROT CAUSING HIGH MOULD COUNTS IN JUICE & PASTE
- EXCESSIVE FOLIAGE PRODUCTION DUE TO FERTIGATION OR IRRIGATION MAY DIVERT SOLIDS FROM FRUIT TO LEAVES
- EXTENSIVE RESEARCH IN CALIFORNIA SHOWS THAT °BRIX IS REDUCED AS YIELDS ARE INCREASED BY IRRIGATION

“°BRIX VERSUS YIELD RELATIONSHIP”

- ARTICLE PUBLISHED IN THE CALIFORNIA TOMATO GROWER
- 5 PAGES LONG
- DETAILS INVERSE RELATIONSHIP
- READ THE COMPLETE ARTICLE AT:

WWW.TOMATOLAND.COM/DOCUMENTS/182.PDF

FACTORS CAUSING DIFFERENCES IN SS AMONG FIELDS

(OBSERVATIONAL/SPECULATIVE)

- SOIL COMPACTION – RESTRICTED WATER UPTAKE ⬆
- EXCESSIVE N APPLICATION – LEAVES BECOME SINK ⬇
- FOLIAR DISEASES (BACTERIAL SPOT) ⬇
- POOR ROTATION→ROOT DISEASES→POOR WATER UPTAKE ⬆
- LOW POTASSIUM LEVELS ⬇
- SOIL TYPE – WATER HOLDING CAPACITY POOR ⬆

FACTORS BEYOND YOUR CONTROL

- RAINFALL
- SOLAR RADIATION
- TEMPERATURE
- DISEASE

→ YEAR TO YEAR VARIABILITY IN SOLUBLE SOLIDS
-ACCOUNTS FOR OVER HALF OF TOTAL VARIABILITY
WORST = WET, CLOUDY, COLD + LEAF DISEASES

→ ***BUT***, WIS WILL NOT VARY AS MUCH

SUMMARY

1) SS IMPORTANT FOR FLAVOR AND ACIDITY
2) WIS AND LYCOPENE IMPORTANT FOR RECOVERY WHEN RE-CONSTITUTED (AS SAUCE, ETC)
3) RESTRICTED WATER UPTAKE WILL INCREASE SS AS WELL AS WIS, IMPROVING PASTE RECOVERY
4) HIGHER SUGAR PRODUCTION IN LEAVES WILL INCREASE SS, BUT LESS FOR WIS (LOW VISCOSITY)
5) LYCOPENE INFLUENCED BY HYBRID & MATURITY

COMMENTS

- MOST TOMATO PROCESSORS IN ONTARIO (AND EASTERN U.S.) HAVE A HIGH PRIORITY FOR PRODUCING PEELED TOMATOES

- THE SAME FACTORS THAT RESULT IN HIGH PEEL RECOVERY WILL ALSO ENHANCE PASTE RECOVERY & QUALITY

REFERENCES AND SOURCES

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