VacTraitX

Soluble Solids Concentration

WHY IS THIS TRAIT IMPORTANT?

Developing blueberry cultivars with improved fruit quality is a high breeding priority for the industry. A major challenge for the industry is blueberry fruit quality, especially flavor, is highly variable across cultivars. US consumers often equate flavor with sweetness (soluble sugars), and soluble solids concentration (SSC) or total soluble solids (TSS) quickly and easily gauge the relative amount of sugar in a fruit. Usually, SSC values represent 70 to 80% of the soluble sugars, with amino acids, water soluble polysaccharides, organic acids, and flavonoids making up the rest. Since extracting and quantifying individual soluble sugars is time consuming and expensive, measuring SSC has become a widely used assay to estimate the field quality of produce, especially relative to harvest ripeness or possible flavor.



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WHAT DO WE KNOW ABOUT THE TRAIT IN TERMS OF DIVERSITY AND GENETICS?

Multiple studies have evaluated SSC in blueberry, largely in small germplasm collections. They indicated genetic and environmental factors affect SSC values, and that SSC is a highly hereditable trait. This implies that DNA markers or genes controlling this trait can be identified and used in blueberry breeding employing quantitative trait loci (QTL) mapping. DNA markers representing the region of the genome associated with a given phenotype are named QTL. Statistical significance can indicate if it has a major or minor effect. Major effect QTL that are stable and detected across multiple years are the most suitable for DNA assisted breeding. However, in the previous work only two QTLs with minor effect were associated with SSC 4 and these were not tested for stability.

DID YOU KNOW?

SSC or TSS is often referred to as [°]Brix. In the 1800's, Adolf Brix first developed a refractive system to compare sweetness, where I[°]Brix represents Iq sucrose in 100g water at 68°F. Since we are really looking at dissolved solids, not just sugars or sucrose, SSC or TSS are the more relevant terms for comparison of fruit. A higher SSC reading is thought to correlate with a higher amount of sugar. An adequate sugar to acid balance is important for blueberry flavor perception, with a SSC/TA ratio of between 10-33 recommended. As the dissolved solids in addition to sugars can affect actual sweetness perception, we will continue to seek a more accurate evaluation of the contribution of SSC and SSC/TA on consumer perceptions.

HOW DO WE PHENOTYPE THIS TRAIT?

SSC is easily measured using a refractometer and is expressed in [°]Brix. The refractometer, which can be pocket-sized, handheld, or bench top, uses a light beam to pass through the juice sample. The light beam bends more as the amount of dissolved solids increases. Values can be altered slightly with cold or hot temperatures—usually cold substances have higher SSC values—so temperature-compensated refractometers are preferred. Analog refractometers require a source of light and the ability to align the line of refraction, while digital refractometers have a built-in light and display the result as [°]Brix. Juice, rather than puree, should be used for this measurement. First, we calibrate the refractometer with distilled water to get a reading of zero. Then a small amount of juice is applied, just enough to cover the well. A button is pushed to read the display. A "how to video" is available on our website and provides instructions on how to measure SSC in blueberry. Obtaining juice from blueberries can be challenging. Freezing a puree at -20 C for at least 48 h, then thawing, helps release juice (Ebrahiem Babiker, USDA-ARS). Centrifuging puree at 3000 rpm for 12 min at room temperature helps release more juice from the thawed puree.

Summary of QTLs for SSC identified in blueberry

Material	Growing Location	SSC value range (°Brix)	# QTL	# Stable QTL/Years	Chr.	Reference
Diversity Panel (N=1575)*	Citra, FL	6 - 18	2	N/A	N/A	Ferrao et al., 2018
RxA (N=287)**	lvanhoe, NC	7.5 - 18	3	2 - 3 Yrs	2, 7, 10	Mengist et al., 2021
DSxJ (N=190)**	Corvallis, OR	10 - 24	2	0	8, 10	Mengist et al., 2022
* Previous study ** VacCAP study						

WHAT IS VACCAP DOING TO WORK ON, SOLVE, OR IMPROVE THIS ASPECT?

VacCAP is working to understand the relationship between SSC and sugars, how SSC contributes to flavor/taste, if it is stable during storage, and determine the genetic mechanisms controlling SSC variation in blueberry.

Two major genetic studies for SSC in blueberries have been completed that are much more comprehensive than those done before. The first study was performed in a population derived from the cross between 'Reveille' and 'Arlen'(RxA). Across 287 siblings, SSC value ranged from 7.5-18 °Brix. In total seven, major QTL associated with SSC were identified. Six of those QTL, three mapped on chromosome 7 and three mapped on chromosome 10, were detected across three years. These QTL explained phenotypic variance ranging from 7 to 28%. The study also determined that quantities of sugar molecules had a moderate (<0.2 R2) positive correlation with TSS. The second study used a population derived from the cross between Draper-44392 and "Jewel' (DSxJ). Among 190 siblings, SSC value ranged from 10-24 °Brix. Two major QTL associated with TSS were identified, one in chromosome 8 and one in chromosome 10. However, none of these QTL were stable across years indicating that environmental factors likely had a stronger influence over the phenotype than genetic effects.

VacCAP plans to conduct additional genetic studies and experiments to better understand the contribution of SSC to consumer preferences and its correlation with sugar content. Advances in molecular resources and improved phenotyping techniques for SSC will be evaluated to make the development and application of marker-assisted selection increasingly feasible and cost-effective. In the future, blueberry breeders can use these resources to select blueberry cultivars that have much higher and more consistent fruit quality.





OTHER RESOURCE AND REFERENCES:

- An excellent resource with more details on using a refractometer can be found <u>here</u>.
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The Vaccinium Coordinated Agricultural Project (VacCAP) is a nationwide coordinated transdisciplinary project focused on addressing major bottlenecks limiting the growth of the U.S. Vaccinium industry by developing and implementing marker assisted selection (MAS) capacity in breeding programs. This will enable breeders to select and pyramid fruit characteristics that positively contribute to fruit quality and market value. Long term, the scientific resources developed will increase production of fruit with improved characteristics that meet ever-changing industry, market, and consumer



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