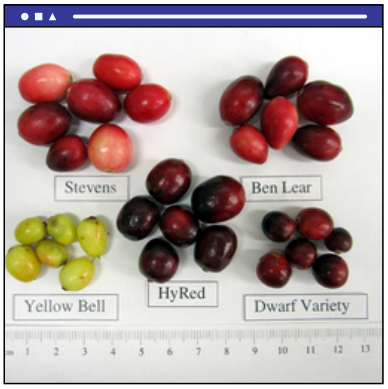
VacTrait

Color in Cranberries

WHY IS THIS TRAIT IMPORTANT?

Since the beginning of cranberry domestication, fruit color has been a top horticultural trait. Fruit color was one of the first traits selected to produce cultivars. Color is used by farmers to determine the best timing for cranberry harvesting, and cultivars have been selected to span early-, mid-, and late-harvesting.

Additionally, cranberries are considered a "super fruit" with spectacular nutritional qualities, in part due to anthocyanins. The red color in cranberries is due to anthocyanins and were a driver to help increase consumer demand for cranberry products [e.g., juices and sweeten-dried-cranberry (SDC)].



Date: 4/5/2022

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

Fruit color is due to anthocyanins, a parameter of quality in cranberry products, which has received considerable attention and study. There is much variation in cranberry germplasm for anthocyanin profiles, as well as in the chemical components of anthocyanins. There is also fruit color variation, like mutants, which lack fruit color and do not accumulate anthocyanins. Genetic studies using digital color, digital color variation, and anthocyanin content (TAcy) for genetic mapping have detected several genes controlling TAcy, color intensity, and color variation. A major gene was recently discovered that is involved in cranberry pigment accumulation.

DID YOU KNOW?

Cranberry drinks are mostly consumed as 'cranberry cocktail' made from concentrate and contain approximately 27% cranberry juice. Fruit color is important because concentrates vary in anthocyanin content, and juices are blended/formulated to specific color hues.

In the 1990s, SDC became the most popular cranberry product, which changed industry fruit quality requirements. SDCs require high and consistent color; white or blotchy berries cannot be processed. Emphasis is now on developing new cultivars with increased anthocyanins and uniform coloring.

HOW DO WE PHENOTYPE THIS TRAIT?

The industry typically measured total anthocyanins in fruit, spectrophotometrically, as milligrams of anthocyanins /100g of fresh weight. Anthocyanins are principally located in the cranberry fruit epidermis, and the content is typically measured on whole berry samples, where epidermis and flesh are not analyzed separately. Thus, berry size, or fruit weight, is generally negatively correlated with anthocyanin content in germplasm.

The need for new approaches to massively acquire color data for cranberry breeding led to development of a software package for digital color data collection. This accurate and high-throughput tool was recently adopted by the industry and has largely replaced spectrophotometrically measured anthocyanins during cranberry processing. Research has shown that the correlations between anthocyanin and digital color are high, and the mapping of genetic regions governing these traits showed mostly overlapping genetic information.

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

Growing consumer demand for SDC has increased the need for new, high quality cranberry cultivars that produce large, round, firm, and uniformly shaped and colored fruit. That requires greater berry-to-berry uniformity in fruit traits (e.g., size and color). An issue with the most widely grown cultivar Stevens is that a relatively high percentage of fruit does not develop anthocyanins (i.e., white berries), resulting in heterogeneously colored fruit. VacCAP is working to understand how and when the color of cranberries is formed, and how it interacts with other important parameters such as fruit size/weight, shape, and firmness.

We have developed cranberry accurate and high-throughput phenotyping methods for color and color variation data and tested the correlation of these traits with anthocyanin and other important traits such as fruit size/weight, shape, and firmness. The development of high-throughput genotyping and phenotyping methods in cranberry will allow for the continuation of gene mapping and make it possible to conduct genome-wide association studies for anthocyanin and color.

Additionally, advances in molecular resources and phenotyping techniques in cranberry make the application of marker-assisted selection increasingly feasible and cost-effective for these traits. In the future, based on these resources, cranberry breeders and other allied scientists will develop marker assisted selection strategies targeting large effect and consistent genes (e.g., fruit color/anthocyanin content and fruit size/weight).

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

USDA
United States Department of Agriculture
National Institue of Food and Agriculture
Award #: 2019-51181-30015

VacCAP
IMPROVING FRUIT QUALITY

www.vacciniumcap.org • @VacciniumCAP • VacCAP Project

AUTHOR
Juan Zalapa, Co-PD, University of Wisconsin-Madison

DESIGN
Josie Russo, University of Wisconsin-Madison

IN COLLABORATION WITH
North Carolina State University • University of Wisconsin-Madison • USDA-ARS • Michigan State University
Washington State University • University of Florida • Rutgers University • Mississippi State University • Plant and Food Research Ltd
Fondazione Edmund Mach • University of Georgia • Cedar Lake Research Group