Presentation Summaries
American Cranberry Growers Association
2018 Summer Field Day
Friday August 17, 2018
Rutgers University

P.E. Marucci Center for Blueberry & Cranberry Research & Extension,
Chatsworth, NJ

Parking will be available at the Center’s shop (across cranberry bogs).
Transportation for tours will be provided at the Center.
Restrooms located at the Center, adjacent to Conference Room.

CRANBERRY BOGS:

8:30–8:45 **Opening Remarks**
*Shawn Cutts, President, American Cranberry Growers Association*

8:45–9:10 **Crop Phytotoxicity and Weed Control with Prospective Pre-emergence Herbicides for Cranberry (Bog 3)**
*Thierry Besancon and Baylee L. Carr, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ*

9:10–9:35 **Mitigation of the Ill Effects of Liquid Fertilizer with Lime Applications: Preliminary Results (Bog 5)**
*Nicholi Vorsa and Jennifer Johnson-Cicalese, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ*

9:35-10:00 **New fungicides and cultural methods for improving fruit quality (Bog 7)**
*Peter Oudemans, Timothy Waller, Dave Jones, Jacob Armitage, John Jensen, Dan Flath and Chris Constantelos. P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ*

10:00–10:25 **Evaluation of Fungicide Treatments on Fruit Rot Resistant Cranberry Selections (Bog 11)**
*Jennifer Johnson-Cicalese, Timothy Waller, Peter Oudemans, and Nicholi Vorsa, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ*

10:25–10:50 **On-going Research on Sucking Insect Pests (Bog 19)**
*Cesar Rodriguez-Saona, Department of Entomology, Rutgers University; Vera Kryzenko-Roth, P.E. Marucci Center; and Robert Holdcraft, P.E. Marucci Center, Chatsworth, NJ*
CONFERENCE ROOM:

11:10-11-20 Cranberry Statistics
  Bruce A Eklund, State Statistician, U.S. Department of Agriculture | National Agricultural Statistics Service

11:20–11:40 Advances in Cranberry Genomics
  James Polashock, Research Plant Pathologist, USDA-ARS

11:40–12:00 Cranberry Fruit Chemistry and Potential Effects on Disease
  Nicholi Vorsa, Jennifer Johnson-Cicalese, Karen DeStefano and Susan Vancho, P.E.
  Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

POLE BARN:

12:00–1:00 LUNCH

CONFERENCE ROOM:

1:00-3:00 Lab Tours (Optional)
On-Going Research on New Preemergence Herbicide for Cranberry

Thierry Besancon, Rebecca Hemstead, Tim Jensen & Baylee Carr
P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth

The number of currently labeled herbicides registered for use in cranberry remains extremely limited. Screening and evaluating herbicides already registered on other minor crops, and that can provide efficient control of perennial weeds, is ranked as a research priority by both the ACGA and the Cranberry Institute.

Weed Control Efficacy with Various Preemergence Herbicides

Field studies were conducted in 2018 to test the weed control efficacy and crop tolerance of three non-registered herbicides. Trials were laid out in a ‘Demoranville’ cranberry bog at the P.E. Marucci Center in Chatsworth, NJ, and in an ‘Early Black’ cranberry bed at Theodore H Budd and Sons Farm in Southampton, NJ. Similar studies were also conducted in Wisconsin and Massachusetts.

Treatments consisted in 3 new herbicide compounds applied prior to weed emergence at 2 different rates (low and high rate) and at 2 different timings (white bud and cabbage head cranberry stages). A non-treated weedy check was included in each study. Plots were sprayed on May 2nd and 8th at the Marucci Center and on May 2nd and May 9th at Budd Farm. All treatments were applied with a CO2-backpack sprayer delivering 30 GPA at 35 psi. Weeds and crop were rated 2, 4, and 8 weeks after treatment (WAT).

Weeds were not present at the Marucci center. Earth loosetrife (*Lysimachia terrestris*) was the dominant weed species at Budd Farm.

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<th>Percentage loosestrife cont</th>
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<tr>
<td><strong>Compound X</strong></td>
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<tr>
<td>low rate</td>
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<tr>
<td>White bud</td>
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<td><strong>Compound Y</strong></td>
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<tr>
<td>White bud</td>
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<td>low rate</td>
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<td><strong>Compound Z</strong></td>
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Limited control of earth loosestrife was noted with compound Z regardless of application rate or timing. Compound X provided over 90% control at the low and high rate when applied at the cabbage head stage. Earth loosestrife control reached 80% 8 weeks after application with compound Y applied at a high rate at the white
bud stage or at the cabbage head stage regardless of application rate.

**Cranberry Tolerance with Various Preemergence Herbicides**

Damages to cranberry terminal bud were observed with compounds X and Y but not with Z. These herbicides caused severe reduction of the development of the terminal upright and, in some cases, necrosis of the terminal bud. The number of nonbearing axillary uprights significantly increased when these herbicides were applied at the late application timing and at the high rate.

![Aerial view of the trial at Budd Farm](image)

![Terminal bud damages](image)
Mitigation of the Ill Effects of Liquid Fertilizer with Lime Applications: Preliminary Results
Nicholi Vorsa and Jennifer Johnson-Cicalese, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

In 2008, we began applying liquid fertilizer to Bogs 1 through 20 in an effort to get more uniform applications of nutrients. Bogs ‘Lower 5’ and ‘Upper 5’ continued to receive granular fertilizer because the dimensions of these beds allowed the use of a ground applied granular spreader. Over time (about 5 years), we began to notice the health of vines in Bogs 1-20 declining, and we were seeing a difference between the beds receiving liquid versus granular applications. Mullica Queen, in particular, exhibited an ‘orange’ coloration on the leaves in August. During the 2016 and 2017 seasons, the liquid fertilizer beds looked very stressed and unhealthy, with reduced growth and yield, and a “burnt” appearance. At the same time, we were having problems with toad bugs, which can cause similar symptoms. A closer examination of the liquid fertilizer formulation revealed potassium chloride, a salt which could cause burning of the plant tissue. Thus, one possible cause of the stress could be the potassium being a chloride salt. In 2017, the formulation was changed to potassium sulfate.

When tissue analysis was done in September 2017, however, calcium, magnesium, and manganese levels were found to be deficient in beds (all half-acre beds) receiving liquid fertilizer, while beds receiving granular had levels in the normal/sufficient range. For example, Bog 5 calcium was 0.25%, and Lower 5 was 0.66% (normal range is 0.50-0.91). To help mitigate this deficiency, we began liquid applications in Bogs 1-20 of calcium-magnesium in May and July 2017, and monthly, May through August, in 2018.

To see if pelletized lime might further improve the health of the cranberry beds, we set up a trial in the Mullica Queen bed (Bog 5) with four liming treatments: 1) no lime, 2) ½ ton/acre, 3) 1 ton/acre, and 4) 2 ton/acre, applied on May 9, 2018. Plots are 20’ x 50’, with three replications (Figure 1). From visual evaluations in July/early August, we observed greener, healthier growth on the lime-treated plots. Samples for tissue analysis were collected on August 6 for comparisons between the four treatments, and with last year’s samples.

These tissue analysis results showed higher levels of calcium and magnesium in the lime-treated plots compared to the no lime treatment, but no differences between the ½ ton, 1 ton, and 2 ton rates of lime (Fig. 2-left).

We also compared Bog 5 with Bog 9 (a Crimson Queen bed that has been receiving liquid fertilizer for the last 10 years) and with Upper 5 and Lower 5 (breeding program beds receiving granular fertilizer). Bog 9 also had deficient levels of Ca and Mg, while Upper 5 and Lower 5 were in the normal to high range (Fig. 2-right).

When compared to last year’s samples, Bog 5 Ca increased from 0.25% to 0.80%, and Mg increased from 0.10% to 0.21%. This increase is also due to the monthly liquid Ca/Mg applications that were made in 2018. For example, Bog 9 did not receive lime, but its Ca increased from 0.16% to 0.40%. We will harvest fruit samples from these lime treatment plots in September to evaluate possible effect on yield and fruit size. However, it typically takes a full year for lime to dissolve completely, so the effects may be more apparent next year.
Figure 1. Lime applications on May 9, 2018 on Bed 5, Mullica Queen.

Figure 2 (left). Lime treatments (left). Calcium and magnesium levels in leaf tissue analyzed Aug 6, 2018 from Bog 5 - 4 liming treatments; blue shaded area is normal range

Figure 2 (right). Fertilizer type no lime & liquid fertilizer; and Upper & Lower 5 bogs – no lime & granular fertilizer; blue shaded area is normal range
Management for berry quality begins early in the season. Heat stress can occur under a variety of conditions. Berry scald and overheating (cooking) develop during hot dry conditions. Our results show that berry temperatures and canopy temperatures become uncoupled and the canopy temperatures is misleading because berry temperatures are driven by solar radiation. Our research is aimed at managing berry and canopy (leaf) temperatures throughout the season to determine at what timing these tissues become uncoupled. In addition, various treatments are being investigated to determine how temperature of canopy and fruit can be controlled.
Evaluation of Fungicide Treatments on Fruit Rot Resistant Cranberry Selections
Jennifer Johnson-Cicalese, Timothy Waller, Peter Oudemans, and Nicholi Vorsa, P.E.
Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

Managing the fruit rot disease complex is becoming increasingly difficult due to climate stress, a widening distribution of the disease, and increasing restrictions on fungicide inputs. Since 2003, an intensive effort has been made by Rutgers cranberry breeding program to develop commercially viable cultivars with enhanced resistance to fruit rot. We believe considerable progress has been made. Multiple sources of fruit rot resistance were identified in our germplasm collection, hundreds of crosses have been made, and over 5000 progeny are being screened for resistance. In addition, 19 genetic markers associated with fruit-rot-resistance (FRR) have been identified which may prove useful for accelerating the screening process.

From our evaluations of over 1600 individuals in the 1st and 2nd breeding cycle of crosses, we selected the top dozen progeny based on FRR, yield, and berry quality. Most of the top selections had Budd’s Blues as a parent, a variety that has long been known to exhibit excellent FRR, but unfortunately has very low yields. In these crosses, however, we were able to recover Budd’s Blues progeny with resistance and good yields. Other sources of resistance in these top selections include US89-3 (highly resistant, but small-fruited), and Cumberland (high yielding, but just moderately resistant) (Fig.1). These top selections were planted in 2014 in replicated 5’ x 5’ plots (four replications of each), for further evaluations. Data from 2016 and 2017 indicate that some selections continue to perform well under severe fruit rot pressure (minimal fungicide applications). For example, CNJ06-22-10 had mean yield of 234g/ft² and only 13% rotted fruit, and CNJ05-64-9 had a yield of 348g/ft² and 22% rot (as compared to Stevens with 265g/ft² and 57% rot in this trial). On the other hand, CNJ06-30-2 and CNJ06-30-21 succumbed to severe Colletotrichum sp. infections of the leaves and stems, so we are no longer interested in these selections.

In 2015, these same top selections were planted in Bog 11 in large plots (10’ x 20’, 5 reps, Figure 1). Crimson Queen was included as a high yielding, but susceptible control. Now that this bed is established, we can begin evaluating these FRR selections under reduced fungicide inputs to determine minimum number of fungicide applications needed, and optimal timing and formulation. In 2018, plots were divided into 5’ x 10’ subplots and received four fungicide regimens: 1) no fungicides, 2) two Indar/Abound applications during bloom, 3) two Bravo applications after bloom, and 4) standard fungicide treatments (I/A, I/A, Bravo, Bravo) (Fig.1). It is too soon to evaluate fruit rot incidence but initial observations indicate differences between selections in plot cover, fruit set, and fruit size, with CNJ06-22-10, CNJ05-64-9, and CNJ05-64-14 looking particularly good. Plots will be harvested in September and October to determine % rotted fruit, yield, berry weight, and fruit chemistry.

These selections were also planted in trials in Wisconsin and British Colombia. We are hopeful that at least one of them will consistently perform well enough to be released as a FRR cultivar. This fungicide trial is designed to establish the optimal timing for fungicide use on resistant varieties including the role of pre and/or post-bloom fungicide applications.
Figure 1. 2018 fungicide treatments on 9 fruit rot resistant selections and a susceptible, high yielding control, Crimson Queen, planted in Bog 11 in July 2015, 10’ x 20’ variety plots, and 10’ x 5’ fungicide treatment plots. Treatments on Rep 5 are shown below, selections and treatments are repeated in a randomized order in Reps 1-4.

*Resistant parents: BB – Budd’s Blues, CU – Cumberland, 86-46 – (Stevens x US89-3) progeny; Susceptible, high yielding parents: CQ - Crimson Queen, MQ – Mullica Queen, DE – Demoranville

**I/A = Indar/Abound
On-going Research on Sucking Insect Pests

Cesar Rodriguez-Saona, Department of Entomology, Rutgers University; Vera Kyryczenko-Roth, P.E. Marucci Center; Robert Holdcraft, P.E. Marucci Center

There is concern among cranberry growers of a potential increase in secondary pests, such as the blunt-nosed leafhopper (Fig. 1), because of recent changes in pest management strategies (e.g., adoption of new reduced-risk products and decreased applications of broad-spectrum insecticides). Blunt-nosed leafhoppers are the vectors of cranberry false blossom, an important disease of cranberries caused by a phytoplasma that decreases the crop’s productivity. False-blossom diseased cranberries show abnormality in plant morphology such as witches’ broom where several branches appear at the internode, and the color of infested plants is noticeable red. Flowers are also replaced by a whorl of leaves (phyllody) in severely infected plants. Although, blunt-nosed leafhoppers are often found in high densities in cranberry false-blossom infected bogs, there are no studies on the effects of the cranberry false-blossom phytoplasma on the preference and performance of blunt-nosed leafhoppers.

This summer we conducted studies to investigate new products for controlling leafhoppers.

Methods

Evaluate the efficacy of various insecticides against leafhoppers

Semi-field experiments were conducted in May and July to determine the toxicity of registered and non-registered insecticides against nymphs and adults of blunt-nosed leafhoppers, (Fig. 1-2) respectively. The following 10 insecticides were evaluated: Cormoran, Sevin, Assail, Closer, Lorsban, Movento, Agri-Mek, Beleaf, an unregistered pyrethroid, and an unregistered diamide. Foliar applications of these registered and unregistered insecticides will be applied to small (1m-by-1m) cranberry plots (Fig. 3). Toxicity of different insecticides was evaluated by placing leafhoppers (nymphs or adults) on field-weathered foliage residues collected a day after treatment. For this, five insecticide-treated uprights were inserted in florists’ water picks, enclosed
in a ventilated 40-dram plastic vial, and secured on water-filled trays (Fig. 4). Each replicate consisted of five vials per treatment. Five nymphs or adults were placed individually in a vial. Plants and insects were placed in the laboratory at 25°C. Mortality was assessed 24 and 48 hrs after transfer. Number of insects alive, dead, or missing was recorded. Results will be presented at the 2019 ACGA winter meeting.

**Acknowledgment.** This work was funded by the NJ Blueberry and Cranberry Research Council, the Cape Cod Cranberry Growers’ Association, the Cranberry Institute, and Ocean Spray.
USDA’s National Agricultural Statistics released the 2017 Non-citrus Fruits and Nuts Final Summary noon June 26, 2018. New Jersey acres harvested and production decreased from 2016. These decreases were also the case nationally. New Jersey growers were again second nationally in barrels per acre, and average price received.

https://www.nass.usda.gov/Publications/Reports_By_Date/index.php

NASS released (will release as I write) the production forecast for the 2018 crop August 10. This cranberry forecast is included in the Crop Production report. This includes the National and State level forecasts.

NASS released the most recent Cost of Pollination Survey results December 21, 2017. Cranberries had the highest total value of pollination of crops reported in Region 1 (includes New Jersey) during 2017. The price per colony for cranberries increased slightly to 78.0 dollars per colony in 2017. The price per acre decreased 3 percent to 162 dollars per acre.

Also look for Census results in February 2019.

You can get State and Regional customized reports:


Look under ‘I want to’ on the left.
All of the genetic material in a living cell comprises the genome. Genomics is the branch of molecular biology that studies the structure, function, evolution, and mapping of genomes. The genome is made up of DNA (deoxyribonucleic acid), or nucleotides at the most basic unit. Sequences of the 4 different nucleotides (Adenine, Cytosine, Thymine, and Guanine - abbreviated A, C, T, G) are organized into large units called chromosomes. Chromosomes contain the molecular ‘blueprint’ for the organism. The ‘blueprint’ consists of genes and gene regulators between 1 and 10 thousand nucleotides long. Every organism, including individuals in the same species, have distinct ‘blueprints’, through variations in the nucleotide sequence.

While the ‘blueprint’ is the organisms’ genotype, the phenotype is the observable characteristics of an individual resulting from the interaction of its unique genome with the environment. Our goal is to study the cranberry genome and apply that information to predict the phenotype(s) of offspring in the breeding program. The first step in this process is to determine the genome sequence of a representative cranberry. This not an easy task, but we have made great strides since we started the program.

**Genome sequencing and assembly statistics**

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<tr>
<th><strong>First draft</strong> (2014)</th>
<th><strong>Current draft</strong> (2018)</th>
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<tbody>
<tr>
<td>Short-read data</td>
<td>Long + short-read data</td>
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<tr>
<td>Assembled size 420 Mb</td>
<td>Assembled size 480 Mb</td>
</tr>
<tr>
<td>Fragments 229,745</td>
<td>Fragments 1635</td>
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<tr>
<td>Average fragment size 4,237 bp</td>
<td>Average fragment size 712,946 bp</td>
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<tr>
<td>Longest fragment 0.15 Mb</td>
<td>Longest fragment over 4 Mb</td>
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<tr>
<td>Genes predicted 36,364</td>
<td>Genes predicted 36,000</td>
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Although successful, conventional breeding is somewhat blind. Parents are crossed in the hopes that some of the offspring will exhibit the desired phenotype. To determine the phenotype, offspring are planted in the field and monitored for years. This is ‘expensive’ in terms of time, field space and labor. Molecular breeding utilizes our knowledge of the genome to predict the outcome of crossing and to select offspring that are likely to carry the gene(s) for the desired phenotype. Only those offspring that carry the desired genes are planted in the field for testing. This can dramatically speed the breeding process by reducing the time, space and labor required for selection.

We are targeting fruit quality traits (e.g. size, shape, color), disease resistance, stress tolerance, and other horticultural traits such as yield, flowering time, ripening time, growth habit, etc. We ‘find’ the genes that control expression of the desired traits by placing thousands of ‘markers’ across the genome to make a map. A population of plants is then phenotyped for the desired trait. Finally, a statistical procedure is applied to
determine which markers are associated with the desired trait. Those markers are then used for Marker-Assisted-Selection (MAS).

The example below is a map of chromosomes of a cross between Budd’s Blues (chromosomes in black) and Crimson Queen (chromosomes in light blue). The small horizontal bars on each chromosome represent marker locations. Those markers associated with traits of interest are indicated (red = percent rot or rot rating, green = yield, purple = berry weight). Note that there are several markers associated with disease resistance and most are on the Budd’s Blues chromosomes. The lines between the Budd’s Blues and Crimson Queen chromosomes indicate identical markers.

Cranberry juice is high in organic acids. This requires the addition of sugar to the juice to make it more palatable. To reduce the required amount of ‘added sugar’, we are developing a variety that is low in acid. Plants with a low acid phenotype were crossed to create a population that has a range of acids from low to normal. We identified markers associated with the low malic acid and low citric acid phenotypes. These markers reliably identify plants that have low acid fruit. A search of genes around the markers suggest that the low malic acid phenotype is associated with a gene coding for malate dehydrogenase.

Cranberry juice is also high in antioxidants. The antioxidant activity is primarily associated with the fruit pigments called anthocyanins. Unfortunately, most of the anthocyanins are not well absorbed in the human gut, so the antioxidant benefits are lost. A cross between American cranberry and small-fruited cranberry (Vaccinium oxycoccus) resulted in plants with anthocyanins that are readily absorbed. We have developed a marker that identifies plants that will have the desired fruit anthocyanins. The markers are associated with a gene that encodes an anthocyanidin glucosyltransferase.

The markers we have developed for MAS will help identify seedlings that carry the genes for the desired traits, thereby speeding the breeding process to produce new cranberry varieties that are disease resistant, low in acid (suitable for reduced-sugar beverages), have increased antioxidant activity, and other desired traits.
Cranberry Fruit Chemistry and Potential Effects on Disease
Nicholi Vorsa, Jennifer Johnson-Cicalese, Stephanie Fong, Karen DeStefano and Susan Vancho, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

In many plant species, fruit serves as a vehicle for seed dissemination for procreation of the species. In the cranberry and blueberry genus *Vaccinium*, seed dispersal mechanisms appear to have diverged. In blueberry, the seed are largely animal dispersed, whereas cranberry appears to have evolved to utilize water as a vehicle as well. As a consequence, both the chemistry and morphology of blueberry and cranberry fruit have taken divergent paths. The evolutionary influences for seed dispersal have likely led to the fruit of the cranberry being a rich source of phenolic compounds, especially the flavonoids. Many of the cranberry flavonoids have been recognized as having benefit to human health. Three major *Vaccinium* flavonoid classes, anthocyanins, proanthocyanidins and flavonols, are recognized as potent anti-oxidants, and may provide benefit to cardiovascular, urinary tract, and cognitive health, as well as having anti-aging properties. Cranberry has a higher content of proanthocyanidins and flavonol glycosides than blueberry and most other fruit species.

Cranberry’s proanthocyanidins, which have been shown to be beneficial to urinary tract health, are referred to as A-type proanthocyanidins, whereas in blueberry and other species, e.g., grape and cocoa, they are principally B-type. Also, in contrast to other fruits, cranberry is an especially rich source of the flavonol ‘aglycones’ quercetin and myricetin. In cranberry, as in most plants, these flavonol aglycones are attached to sugars. In cranberry, the sugar galactose is the principal sugar conjugate for both anthocyanins and flavonols. Other sugar conjugates include arabinosides, rhamnosides and xylosides. The specific sugar that the flavonol or anthocyanidin is attached to may play a role in absorption, metabolism and excretion when consumed, which would be important for human health.

Cranberry also has a higher level of organic acids, including citric, malic, and quinic acids, than other fruit crops including blueberry. Cranberry is also unique in having about 0.1% benzoic acid. Cranberry’s titratable acidity (TA) is about 2.3-2.5 citric acid equivalents, whereas, other fruits such as Honey Crisp apple has a TA of 0.5%, about one fifth of that of cranberry. Thus to obtain a sugar:acid ratio that is palatable, cranberry requires substantial ‘added-sugar’ for palatability. There is opportunity to reduce the acid level significantly in cranberry fruit through breeding. Genes have been found for both citric and malic acids which may provide for cranberry varieties having TA < 1. Malic, quinic and benzoic acids may also play a role in fruit rot resistance.

The cranberry also contrasts with other fruit in fruit volatiles. ‘Fruity’ crops such as blueberry have ‘fruity’ aldehyde, ketone and alcohol volatiles, e.g., linolool, whereas cranberry’s principal volatile is 1-α terpineol, which is considered to be anti-microbial.