Highbush Blueberries

Available Year Round

Courtesy of Research
by
North Carolina State University
with the
United States Department of Agriculture, Agricultural Research Service (ARS)
and assisted by
North Carolina Blueberry Growers

An historic overview of the industry in North Carolina.
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Today, fresh high-quality highbush blueberries (*Vaccinium corymbosum L.*) are available almost year-round. This was not possible some years ago when highbush blueberry harvests in the United States were available mainly from farms in New Jersey, North Carolina, and Michigan from mid-May to mid-August. They were sent to local and distant markets in or near the eastern United States.

A big problem was in trying to market berries that were often over-ripe and over-heated. Thus, they tended to have a short shelf life and could not be marketed long distances.

Relief came around 1965 when the North Carolina Legislature found that the entire horticulture industry in North Carolina was expanding rapidly. Approximately $500,000 dollars was given to North Carolina State University to assist it. Additional researchers in the College of Agriculture and Life Sciences were being accepted by departments.

The Department of Horticultural Science acquired several who were assigned to research and to improve the situation of the N.C. blueberry industry. One was a postharvest physiologist who had experience with blueberry research at Michigan State University. He had grown up on a family fruit and vegetable farm in Southern New Jersey, near blueberry farms. A second was a seasoned postharvest physiologist who was assigned to the Department of Horticultural Science by the United States Department of Agriculture (ARS) at Beltsville, Maryland. A third was a blueberry breeder who had just graduated from the University of California at Davis. He had extensive training in genetics, and grew-up on a family blueberry farm in southern New Jersey.

Also available were research assistants and three graduate students who chose to do research on blueberries as part of their degree requirements. Finally, an extremely capable laboratory technician who had a degree in biology was added. In addition, a Horticultural Research Station was located near the blueberry farms. The Department of Horticultural Science had a research faculty member stationed there to assist blueberry farmers and researchers.

To start the new blueberry program, extensive visits were made by the researchers to many blueberry growers, their fields, packing houses, and operations. Immediately the growers offered to help the research program in any way possible, including the extensive use of their blueberry bushes and fruit of <u>any</u> quantity that was needed for experiments.

Returning to Raleigh, the researchers met with faculty in other departments who had interests in blueberry research, such as Biological and Agricultural Engineering, Plant Pathology, Food Science, Genetics, Economics and Experimental Statistic. Researchers in those departments were thereafter sought for advice and cooperation.

Next, they sought to become acquainted with the characteristics of the blueberry fruit by conducting research as follows:

- Relationship of nutrition and fruit quality
- Factors affecting firmness
- Sorting berries for quantity by vibration
- Relationship of size and color intensity to quality and shelf life
- Study of blueberry anthocyanins- extraction and composition versus ripeness.

Next, visits were made to blueberry farms at harvest time to become familiar with harvest systems such as how blueberries were harvested by hand, taken to the packing building, and sorted by hand to remove small numbers of "green" and "damaged" berries, placed in one-pint boxes covered with cellophane with 12 boxes per shipping crate, placed on pallets at the truck-loading dock, and finally loaded in large, enclosed trucks for shipment to markets. The researchers found that harvest time was a warm time of the year. Berries were warm when harvested, taken to the packing building, sorted and packed in warm containers, sat on warm loading docks, and later loaded in a truck. Some trucks were "cooled" by ice bunkers, others by refrigeration units. Problem: when loaded in the truck, the berries were too warm (approximately

70-90 F) to retain good quality for more than 2 to 3 days. On the way to the market, the berries cooled rather slowly to only 15 to 20 F below the field temperature.

According to the growers, these trucks would take the berries to towns in North Carolina, or as far as Boston, Massachusetts. In the market, their warm berries often lost quality quickly. Decay often appeared within a few days. One grower said that an entire load of berries had to be dumped upon arrival in Boston for lack of salability.

Back in the NCSU laboratory, the researchers found that harvested berries varied in ripeness, which was a great problem. Pickers in the field could not readily tell an overripe berry from one that had just ripened on the bush. Both were all blue.

Back in the laboratory, the researchers found that, during ripening, a blueberry's sugar content increased. Therefore, they were pleased to find that a valid means of measuring ripeness in blueberries was the soluble-solids/acids ratio (SS/AC).

They continued research by analyzing anthocyanin contents of the epidermis ("skin") of blueberries. Fifteen anthocyanins (ACY) were identified. The ACYs as a whole, however, increased in total content as the berries ripened.

All of this research advanced greatly upon learning that Drs. Birth & Norris at Beltsville (USDA-ARS) had heard about a method of dual wavelength spectrophotometry that had been used in the measurement of intrinsic properties of intact agricultural products. They and fellow researchers Dekazos and Birth had developed an instrument called the "Difference Meter" (often referred to as the "Light Transmittance Difference Meter" (LTDM). It provided the stimulation for undertaking the development of an automatic sorter for small fruit. However, while the LTDM was capable of providing optical data, its construction did not lend itself to automation.

Consequently, both the USDA-ARS and NCSU researchers became involved in the development. The LTDM was borrowed by NCSU and was used to continue development of an automatic blueberry ripeness sorter.

Back at NCSU, two valuable members of the Biological and Agricultural Engineering Department began the development of two blueberry ripeness sorters that could continually sort berries automatically. They utilized "fibre optics" that could be used to collect valid measurements of light transmitted through the berries, so that they could be transmitted via a rotating round disc, to one of five containers at the rear of the sorter. Each one collected only berries of a given ripeness. The sorter had sorting rates of 8, 16, 32, and 64 blueberries per minute, respectively.

Researchers at NCSU and the USDA thus had developed an important blueberry-ripeness sorter based on the optical density of anthocyanins in the epidermis ("skin") as the fruit ripened.

Using this machine, now named the "BERRYMATIC," they could easily sort over 10,000 berries on a given day. Over 20,000 were sorted to set up a cold storage blueberry test.

Thus, highbush blueberries sorted with transmitted light, according to their anthocyanin (ACY) content were reasonably well separated for quality as expressed by pH, titratable acid (AC), soluble solids (SS), and SS/AC ratio.

HOWEVER, this sorter was not meant to be a commercial sorter. It only showed that commercial blueberry sorters were feasible for mass-handling in the future.

Next, one of the engineers at NCSU, who helped develop the Berrymatic, developed an "in-line" sorter that separated unripe, ripe, and overripe berries. Indeed, today countless types of sorters are in use.

Finally, the relationship of holding temperature and stage of ripeness to decay development of blueberries was determined, comparing six sets of five ripeness classes (light-sorted; 740-800 nm) stored at 34°F, 50°F, and 70°F. On each of six dates, one set (3 temperatures x 5 ripenesses x 4 replications) was removed from storage and sorted for decay. Regardless of cultivar or stage of ripeness, all berries stored at 70°F decayed rapidly (within 5 days). Only when the berries were held at 34°F did the time and expense of light-sorting appear economically

justifiable. At 34°F, overripe berries required about 12 days while just-ripe blue fruits required about 32 days to develop 20% decay.

Therefore, overripe blueberries should be sent to a processor, **NOT** to fresh market!!!

THUS, an important finding: blueberries should be kept continuously at 34°F. Even under these conditions, however, overripe berries should never be sent to market, but instead be sent to a processor as soon as possible.

In addition to a blueberry sorter, a fast pre-cooling system was needed. Consequently, a forced-air cooling system was developed by the researchers in a cold-storage building of a grower. The cooling rate of blueberries packaged for shipment to market was increased by forcing cold air through the containers. More information on commercial forced-air coolers is available online and in extension publications.

In North Carolina today, the blueberry planting numbers are increasing. For example, extension personnel from Agricultural Engineering, Horticulture, Plant Pathology, and Economics Departments (a TEAM) held a meeting with blueberry growers to demonstrate pruning techniques on blueberry bushes. The turnout was so great that a second meeting had to be held to reach growers that had to be turned away from the first meeting.

For information on increases in blueberry production in the world, one only needs to visit a computer. In Fruit Grower Magazine (http://fruitgrowersnews.com/index.php/magazine/blueberry) the world blueberry acreage grew by 254%, from 57,122 to 144,807 acres. The projected production in North America should increase from 494 million pounds in 2012-13. "New" countries are starting to produce blueberries now: Philippines, South Korea, Japan, South Africa, Angola, the Netherlands, Ireland, Sweden, Switzerland, the United Kingdom, Mexico, and Nova Scotia.

In South America, all but four countries there are great producers. Chile alone, plus California, are considered to be the big producers in the future. These two already have facilities to handle fruits and vegetables.

All of this indicates the importance of research at the North Carolina State University and the United States Department of Agriculture, ARS.

Millions of people seeking a source of antioxidants are benefitting from this research. North Carolina is still active with this research. For example, Dr. Mary Ann Lila, Director of the NCSU Plants for Human Health Institute, located at the N.C. Research Campus in Kannapolis, NC, appeared on the Dr. OZ Show, May 5, 2011. She discussed her research under way there on the multifaceted protection from cancer and other diseases that blueberries provide. She is also a member of the Department of Food, Bioprocessing and Nutrition Science at NCSU. The blueberry genome is currently being sequenced by Dr. Allan Brown of the NCSU Plants for Human Health Institute at the N.C. Research Campus in Kannapolis. He is a member of the Department of Horticultural Science. The genome project will open new avenues of research on the blueberry.