

Watermelons as Food in the 22 Century

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Watermelons *Citrullus lanatus* (Thumb.) Mansf. were reported to be growing in Africa, Middle East, Central Asia, Mediterranean Coasts, Europe and America in the late 1500s. Growth spread to Japan from South China and Southeast Asia. Fruits were basic food for people and animals in these countries, however the fruits bore little resemblance to current cultivars in size, shape, color and internal food qualities. Since reproduction in watermelon and other species of cucurbits is monoecious, which means they are largely cross-pollinated, populations developed that were very heterozygous. Selective plant breeding was not in practice at that time so germ plasm was highly diverse.

When world travel by traders became more common seeds were distributed as a food crop, especially in warmer climates. Watermelons were reportedly being grown in the USA in the 1600s. In the warmer climates they are grown on lighter soils as warm season crops as dessert fruits and the rinds were used for making pickles and preserves. Also, some types were used as animal feed. As they became more commercialized, plant selection and breeding began to develop in the 19th century. As cultivation spread diseases became more of a problem, especially Fusarium wilt which is a soil borne disease. In 1908 Orton, a USDA scientist released Conqueror as the first wilt resistant variety using a stock citron as a source of resistance. Between 1932 and 1938 Porter, Wilson and Younkin released 6 wilt resistant varieties from Iowa State College. By that time Florida and California were breeding wilt resistant varieties. However, during this period, market acceptance, edible quality and long distance shipping had not become the primary focus of breeding programs.

By the 1940s breeders became focused toward shipping quality, consumer acceptance and anthracnose resistance. In 1946 C.F. Andrus, an USDA breeder had developed and released Congo with combined Fusarium wilt and anthracnose resistance, but in many cases the fruits were badly misshapen. He later released Fairfax and in 1953 Charleston Gray which broke the barrier for shipping, grower acceptance, and more universal consumer acceptance. One disadvantage of Charleston Gray was that fruit flesh color developed before they were fully ripe and growers in many cases were harvested prematurely, which reduced consumer demand.

During that period 6 varieties were released from Iowa, 4 from California, 1 from Georgia and 1 from Tennessee. V.M. Watts developed and released White Hope and Hope Diamond from the University of Arkansas. Recently, USDA nutritional scientists reported that the red pigment of watermelon, lycopene, has inhibiting qualities to some forms of cancer and is a source of vitamin A, C, B6 and potassium This means that watermelon fruits have become recognized more for their nutritional qualities when previously were considered as dessert or for salad components.

KANSAS STATE UNIVERSITY BREEDING PROGRAM

The program initiated in 1953 by Charles V. Hall involved screening of germ plasm sources among commercial varieties, and making a series of crosses in the greenhouse during the winter. One obvious lacking among the commercial varieties was a round striped type with good internal qualities. The best prospect was Early Kansas (Photo below).



The primary goals of the breeding program were development of new varieties with the following characteristics:

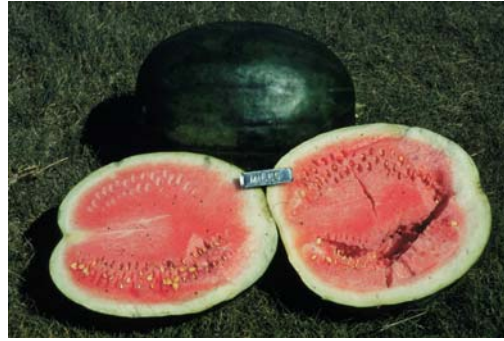
1. Improved consumer quality, which involves maximum sugar content, excellent flavor, and firm flesh with deep red color (high lycopene content) small dark and dark seed.
2. Grower acceptance, which includes high yields, resistance to Fusarium wilt, Anthracnose and adapted to long-range shipping.
3. A wide range of geographic adaptability that includes soils, temperatures and moisture conditions.
4. Demand by wholesale and retail buyers on a national scale.
5. Good shelf or storage life.

Accomplishment of the goals requires the selection of potential parents, which possessed genes, which controlled these qualities and the ability to transfer or combine them into the desired progeny. This process always requires hybridization, selfing, backcrossing and selection of desired individuals. In this program 7 years was required to produce a potentially acceptable selection.

When the program was initiated in 1953 there were no commercial varieties available with round shape and an attractive light/dark rind color, high quality edible characteristics and multiple disease resistance. (See Early Kansas photo above)

Therefore, selection for the above qualities was sought in the breeding and selection process. The photos below illustrate the 10-year sequence from the successful first cross to the successful release of Crimson Sweet in 1963.

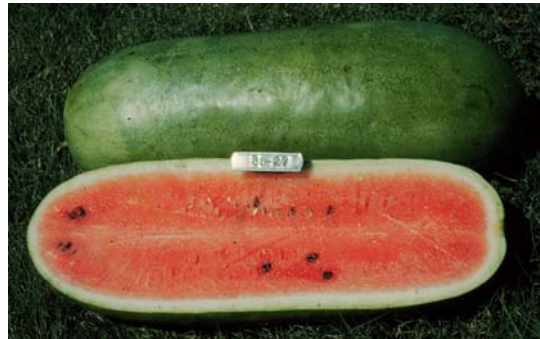
P 1 (Peacock) X P 2 (Miles)



P 1 P 2



F 1



P 3 (Charleston Gray)

The original hybrids were made in the greenhouse. Inbreeding and field, selection from segregating populations until the final uniform selection was made in 1960. The selection 60-6 that was increased and released as Crimson Sweet is a distinct contrast to Early Kansas that is shown in the first photo. This selection was mass produced (mound of uniform melons in photo) from which seed were harvested and released as Crimson Sweet in 1963.



Seed producers, Commercial growers, and markets throughout the US readily accepted Crimson Sweet. Currently this variety is grown in over 50 countries and continues to spread.

From this original gene pool Petite Sweet and Super Sweet were released in 1968 and Allsweet in 1971 (photos below). Currently, Crimson Sweet and Allsweet are leading commercial varieties and serve as parents for many commercial hybrids, both seeded and seedless. Calsweet, originated and released by the late Duke Layton, was derived from the breeding line shown in the labeled photo.



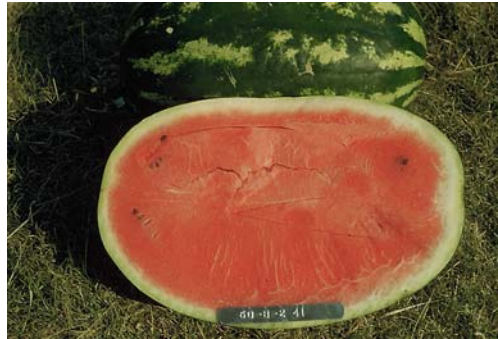
Petite Sweet



Super Sweet



Allsweet



Calsweet

The breeding program was continued at Iowa State University and has resulted in release of Crimson Beauty and other genetic lines that are currently as parents of a number of hybrids. Development of these and similar varieties adapted for long-range shipping and extended storage or shelf life has resulted in watermelons being available in markets throughout the year rather than during the local harvest season.

FUTURE POTENTIAL AND CHALLENGES

Watermelon plants are among the most efficient in the higher plant kingdom for utilization of the natural environmental factors in growth and in metabolic processes. Under normal conditions a single plant will grow, flower, set fruit and mature up to 80 to 100 lbs. (36 to 45 kg) of ripe melons containing 10 to 12% total solids in 85-90 days from seeding. Few cultivated herbaceous species can assimilate light, water, CO₂ and soil nutrients into the quantity and quality of delicious edible product in that time period. Considering the current information regarding the health benefits from eating watermelon, there is a great potential for expanding these benefits. One immediate benefit to consumers would be to grow or purchase red fleshed melons. Little is known about nutritional qualities of yellow-pigmented types. Perhaps similar or equal qualities exist and should researched.

Little or no data are available on the nutritional qualities of the vegetative tissues or watermelon vines as a human food source. As the world population increases it may become necessary to explore more non-traditional food sources. Watermelons are prolific vegetative producers in addition to the production of delicious and nutrient rich fruits. It

is known that the vines are rich in a broad range of amino acids as well as cucurbitacens.

One commercial trend in the US has been to produce smaller fruit type hybrids as demanded by small families. It remains to be determined if this trend will become internationally universal. However, the use of F1 hybrids has become more universal by commercial companies in order to retain identity of germ plasm. This trend prevents growers from saving seed from one year to another. This trend will become more competitive as biotechnological methods and techniques become more universally adapted and practiced by companies. This means that governments must place higher priorities on research and development of food production in the future. The basic research required is expensive and requires highly trained scientists. Food resources are critical in many developing countries today and will become more severe as populations increase. Malnutrition is rampant in many countries today. What role can watermelons become a nutrition source in countries where they were originally indigenous. Modern varieties have the potential of being a much greater resource if made available. In addition, they were a source of liquid since fruits are over 90% water and plants are very efficient in extracting water from the soil.

Based on data regarding the level of Fusarium wilt resistance of Crimson sweet cultivar, which has continued to have the highest level of resistance since its release in 1963, the genetic mechanism should be identified. Fusarium wilt prevails as an economically important disease in many of the warmer climatic regions of the world. The pathogen is soil born and disrupts the vascular tissues from absorbing and transporting water and nutrients to the upper plant parts, thus, starving the plant. Once the organism is in the soil it remains there for many years. Normal plant growth depends on genetic mechanisms of the host plant regardless of species. The Fusarium genus is host specific and is different for watermelon, tomato, and cotton and for many other crops. It is possible that the basic mechanism is similar if identified and with contemporary gene transfer methods could be incorporated from watermelon to other species. No doubt, the mechanism is chemical in nature and should be identifiable.

New biochemical technological methods will not replace basic plant breeding and improvement programs, which lead to consumer acceptable products. This was proven in watermelons when the main focus was on resistance to a specific disease. Plants are complex multigenic systems and the transfer of one or specific gene does not produce a commercially acceptable variety. Therefore, as indicated previously, governments must fund broad-based research and plant improvement programs to feed world populations.

The overemphasis and publicity of the term “genetic engineering” or genetic engineered crops has led to widespread resistance to the acceptance of these crop products. In many cases only single genes injected into commercially grown and accepted varieties have made minor changes in the overall crop. Typical examples are for resistance to a specific insect, herbicide, or disease. These changes make tremendous economic benefits to growers and consumers. In addition, the change has a tremendous positive effect on the environment. Therefore, it is important that there be an integration of traditional plant improvements with the new technology if the long-range effects are to be successful.

Biotechnology is a relatively new term but not a new practice. Bio- means living system, and technology means a practice or techniques applied to a living thing or system. The cultivation, manipulation, and improvement of living systems from Gregory Mendel today involve biotechnology. Over use and publicity results in public skepticism which means that leaders who do not understand and the citizens suffer as a result. Environmentalists without knowledge of the biological implications over publicize products causing fear of positive improvements to our overall food productions systems.

WATERMELONS AS A FUTURE FOOD SOURCE

Since watermelons were reported to being growing over widespread regions of the world as indigenous populations and used as human and animal food hundreds of years ago, adaptation to soils and climate is not a problem. Current varieties have been developed to be more specific to regions of the world.

Future priorities and needs involve the suitable training and funding for scientists who are knowledgeable in the crop, overall plant improvement systems as well as modern gene transfer systems. Currently, research-funding systems has been directed toward laboratory research and have diminished drastically in overall plant breeding. Therefore, most newly trained scientists have little knowledge of crops and plant breeding systems. This means that they must gain this knowledge while working for commercial companies, which is a long process. The other option is to become affiliated with colleges and universities in the knowledge to train students in the basic crop technology required in overall crop improvement systems. Finished varieties cannot be produced in the laboratory.

Governments and public institutions must increase funding for the basic research essential for long- term plant development. Currently, more emphasis is being placed on nutritional quality of many fruits and vegetables, which is and should be a high priority. This approach requires a team approach since no one scientist can possess the knowledge in nutrition research and plant culture. Based on current knowledge of watermelons, there is great potential as a basic food source and a contribution to human health during this century. Much is to be done to improve genetic disease resistance in the tropical and sub-tropical regions of the world.

This international conference (Vegetables for Sustainable Food and Nutritional Security in the New Millennium, November 11-14, 2002, Bangalore, India) will be an important beginning for looking for solutions to world food problems. There are many communication gaps in crop production knowledge as well as in plant improvement. This is especially true with what is considered as minor crops, which make an important contribution to human food and nutrition in the world.

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