



Alaska Agriculture in the Classroom

AITC Lesson Plan

Title: Genetically Modified Crops versus Other Methods of Changing Food

Author: Barbara Ross

Grade Level(s): 6-8

Class Time Suggested to Complete: 4 days

Lesson Focus: Where does our food come from? What does it mean to be genetically modified? What are other ways foods can be modified? Why would we want to modify our food?

Standards Covered: Processes of Science; Genetics; Scientific Knowledge and Technology

Rationale: Students will learn about the reasons for modifying food for human consumption. They will learn how this is done and explore if it is a good idea or not.

Assessment: There is a Pre-Test, which is also the Post Test.

Prior Knowledge: Students will have a general understanding of genetics.

Student Learning Objectives: Students will be more aware of the sources of the food they eat.

Materials/ Preparation for Teaching: See attached pages.

<https://search.yahoo.com/yhs/search?p=youtube+gmo+foods&ei=UTF-8&hspart=mozilla&hsimp=yhs-001> (You Tube video about genetically modified foods; about 7 minutes)

<https://search.yahoo.com/yhs/search?p=youtube+gmo+foods&ei=UTF-8&hspart=mozilla&hsimp=yhs-001> (You Tube video; The Eyes of Nye: Genetically Modified Foods; by Bill Nye; about 25 minutes)

<https://search.yahoo.com/yhs/search?p=youtube+gmo+foods&ei=UTF-8&hspar=mozilla&hsimp=yhs-001> (You Tube video: What is a Genetically Modified Food; Instant Egghead #45; Scientific American; a little over 3 minutes)

Differentiated Instruction: The material provided is for 6-8 use as appropriate.

Lessons:

1. Pre-Test
2. Play the game: **Farm to Cart** (Note: this game was created for lower elementary students but middle school students should do OK with it.) This is an overview as to where our food comes from.
3. Watch the 3 You Tube videos for an introduction to GMO's.
4. Discuss why farmers have tried to change the foods we eat over time. Use the articles on Golden Rice, the Arctic Apple, Transgenic Salmon, Seedless Watermelon and Seedless Oranges. Which of these are not genetically modified? How do you know? What are the concerns?
5. Discuss Traditional Plant Breeding vs. Genetic Engineering using the chart:

Traditional Plant Breeding	Genetic Engineering
Combine DNA from plants of the same species	Can combine DNA from different species
Select plants that have desirable traits and cross them	Select a desirable trait from another species and isolate the gene
Large parts of genome changed	Can select a single gene
Genes introduced via pollination	Genes introduced via a plasmid

6. Look up and discuss other genetically modified foods. In pairs, students will look up a GMO and report back to the class on their findings. They should include pros and cons for their particular organism.
7. Take Post Test

References:

<http://www.agfoundation.org/resources/farm-to-cart-a-downloadable-board-game>
<http://pioneerio.hubpages.com/hub/geneticallymodifiedfood>
<http://www.healthline.com/health/gmos-pros-and-cons#1>
<http://www.geneticallymodifiedfoods.co.uk/what-are-common-gm-foods.html>
<http://www.foodpyramid.com/what-is-golden-rice/>
www.arcticapples.com/arctic-apples-story/how-we-keep-apples-from-turning-brown
http://www.nature.com/polopoly_fs/1.129031/menu/main/topColumns/topLeftColumn/pdf/497017a.pdf
<http://www.washingtonpost.com/wp-dyn/content/article/2010/08/31/AR2010083102643.html>
http://www.ehow.com/info_8058700_oranges-seedless.html

Vocabulary

Agrobacterium: A bacteria that is a natural plant pathogen, able to transfer genes to plants by invading through wounds and inserting DNA into the chromosomes. This is used in genetic engineering to get the gene of interest into the target organism

Backcross: The process of breeding genetically modified plants that contain the gene of interest with plants that have other desirable traits, such as high yields.

cisgenic: Transferring genes from the same organism or a plant containing no foreign genes.

Clone: To isolate and make copies of a single gene, such as the gene for Cry protein.

Enzyme: Protein that catalyzes a biochemical reaction. In genetic engineering, enzymes are used to cut DNA, allowing scientists to isolate the gene they would like to insert into another organism.

Gene: A region of the DNA that encodes a protein or part of a protein.

Genetic Engineering (GE)/ Genetic Modification (GM): The process of directly modifying an organism's genes using biotechnology to produce desired traits.

GMO: Genetically modified organism

Grafting: Horticulture.

1. a bud, shoot, or scion of a plant inserted in a groove, slit, or the like in a stem or stock of another plant in which it continues to grow.
2. the plant resulting from such an operation; the united stock and scion.

Herbicide: a substance or preparation for killing plants, especially weeds.

Hybrid: the offspring of two animals or plants of different breeds, varieties, species, or genera, especially as produced through human manipulation for specific genetic characteristics.

Plasmid: a segment of DNA independent of the chromosomes and capable of replication, occurring in bacteria and yeast: used in recombinant DNA procedures to transfer genetic material from one cell to another.

Pesticide: a chemical preparation for destroying plant, fungal, or animal pests.

Scion: a shoot or twig, especially one cut for grafting or planting; a cutting.

Transformation: When foreign DNA is inserted into the host, such as the Bt Cry protein gene into the corn DNA.

Transgenic: Containing a gene that has been transferred from one organism to another. A synonym for genetically modified.

Pre/Post Test

1. What is a GMO?
2. What is a hybrid?
3. What has been added to tomato plants to keep them from freezing?
4. What is an Arctic Apple?
5. Why would you want a seedless watermelon?
6. For what reason would scientists want to genetically engineer a salmon?
7. Golden Rice is a fairly new product. What gives it the golden color? Why has it been added?
8. How do we get seedless oranges?
9. Name 3 genetically modified foods.
10. What is the difference between transgenic and cisgenic?

Pre/Post Test (KEY)

1. What is a GMO?
A GMO IS AN ORGANISM THAT HAS BEEN GENETICALLY MODIFIED.
2. What is a hybrid?
A hybrid is the offspring of two animals or plants of different breeds, varieties, species, or genera, especially as produced through human manipulation for specific genetic characteristics.
3. What has been added to tomato plants to keep them from freezing?
Genes from an arctic fish have been added.
4. What is an Arctic Apple?
It is a variety of apple that does not brown quickly when cut. It also does not bruise easily.
5. Why would you want a seedless watermelon?
They are easier to eat. Also there is less chance of children choking to death on the seeds.
6. For what reason would scientists want to genetically engineer a salmon?
They do this so the salmon could grow twice as fast as salmon in the wild.
7. Golden Rice is a fairly new product. What gives it the golden color? Why has it been added?
Genes from a daffodil plant give it the yellow color. This has been added for the Vitamin A, which helps prevent blindness in those with a Vitamin A deficiency.
8. How do we get seedless oranges?
We get seedless oranges by grafting.
9. Name 3 genetically modified foods.
Some examples of genetically modified foods are corn, tomatoes, golden rice, salmon, soybeans, sugar beets, potatoes and squash.
10. What is the difference between transgenic and cisgenic?
Transgenic transfers genes from one organism to another while cisgenic means the organism has no foreign genes.

Golden Rice:

<http://www.foodpyramid.com/what-is-golden-rice/>

What is Golden Rice?



Image of Golden rice

Golden rice is a form of rice with biosynthesis of beta-carotene (a form of vitamin A). In other words, golden rice is produced through genetic engineering. Beta-carotene gives golden rice its “golden” or “yellow” coloring. White rice, on the other hand, does not contain carotenoids (i.e. beta carotene) and therefore lacks that “golden” coloring. When you consume golden rice, the beta-carotene either accumulates in your fatty tissues or is [transformed into vitamin A](#).

Carotenoids, like beta-carotene, are the colorful plant pigments normally found in a variety of fruits and vegetables (carrots, tomatoes, broccoli, cantaloupe, sweet potatoes, etc.). It is important to note that plants lack the direct form of vitamin A, but do contain beta-carotene, a form of vitamin A. Moreover, your body metabolizes vitamin A when you consume foods rich in beta-carotene. Vibrant fruits and vegetables, along with meats contain vitamin A. If you adhere to a poor diet, you have an increased risk of life-threatening medical conditions and diseases associated with a vitamin A deficiency.

Golden rice is rich in beta-carotene. It is also easily processed by your digestive system. In fact, the natural fatty lipids in golden rice aid in the absorption of beta-carotene, even when little or no oil is added to it. When oil is added to rice it helps your body absorb the carotenoids in it, but in the case of golden rice oil is not necessary to reap the benefits. Other benefits of golden rice include: increased energy (which comes from the starch located within the rice) and a low fat content.

Golden Rice History

Golden rice was invented in 1999 by [Peter Beyer](#), professor at the University of Freiburg, Germany in the Centre for Applied Biosciences and [Ingo Potrykus](#), professor at the Swiss Federal Institute of Technology at the Institute for Plant Sciences. Golden rice was originally produced in 1982 as an initiative for the Rockefeller Foundation. In 1992, a group of research experts and scientists met to perform studies on golden rice pros and cons. Beyer and Potrykus developed a rather complex biosynthetic crop that could be altered to produce healthier and more abundant grains like rice.



Peter Beyer and Ingo Potrykus

Golden Rice and Vitamin A

It is important to understand that golden rice is considered a type of genetically modified rice (GMO). It is a fortified food that is produced to combat a vitamin A deficiency in areas where this vitamin is scarce. More and more people are being diagnosed with a vitamin A deficiency. In fact, young children are the most vulnerable to vitamin-related deficiencies. Approximately 1 million children die of a vitamin A deficiency each year.

A vitamin A deficiency can severely affect a child's eyesight; weaken his/her immune system function and increase his/her risk of chronic conditions. Moreover, in underdeveloped countries, approximately half-a-million people, mostly children, develop blindness, associated with a vitamin A deficiency. Approximately 50% of those diagnosed with this type of deficiency-related blindness die a year or two after becoming blind (Wright, Hinchliffe & Adams, 2005). To make matters worse, approximately 10 million children suffer from malnutrition every year. In severe cases, the malnutrition turns deadly (Wright, Hinchliffe & Adams, 2005).

Low levels of vitamin A can also negatively affect your immune system and cause serious illnesses and/or death. In the last few years, an increase in child deaths (under the age of five) has been linked to deficiencies in vitamin A, protein and zinc. The newest form of golden rice varies from the original strain through the addition of three new beta-carotene genes.

In addition, this newest form of golden rice (invented in 2005) is referred to as Golden Rice 2 because it contains higher levels of beta-carotene than the original golden rice. Golden rice was originally developed, with the support of environmental activists, to improve, enrich, support and enhance health and well-being and it has accomplished its goals. The invention of golden rice has lowered the risk of a variety of health conditions and ailments. [Golden rice has been tested in the Philippines](#) for over two seasons on two different locations in 2012.



White rice vs Golden Rice

Golden Rice Benefits

- Lowers Risk of Blindness, Infections, Cancers and Diseases

Golden rice has the ability to lower your risk of blindness, infections, cancers and diseases. A vitamin A deficiency can increase your risk of vision impairments, age-related macular degeneration and blindness. It can also worsen infections (measles, HIV, AIDS, chicken pox, etc.), especially in children. Approximately 125 million children, worldwide, exhibit chronically low levels of vitamin A (Wright, Hinchliffe & Adams, 2005). The carotenoids found in golden rice can combat adult degenerative diseases. Other benefits of golden rice include: a lower risk of both a variety of heart diseases and prostate, breast and skin cancers.

- Reduces Gastrointestinal Distress

Another one of the benefits of golden rice is that it can reduce gastrointestinal distress. In fact, it is considered a beneficial food to eat following an episode of diarrhea, regardless of the cause. Golden rice behaves like a mild astringent in your gastrointestinal system, which supports easy digestion and restores your intestinal mucus following an episode of gastroenteritis and colitis.

- Reduces High Blood Pressure and High Cholesterol

Golden rice is a low-fat and low-sodium food; therefore it is especially beneficial for lowering high blood pressure and cholesterol. High levels of sodium, a mineral, can lead to fluid accumulation, edema (fluid retention) and a spike in blood volume. The excess fluid can increase your risk of high blood pressure. In other words, the more sodium you consume, the higher your blood pressure may soar. Moreover, one of the most valuable benefits of golden rice is that it prevents fiber-related biliary acids from accumulating in your intestines. Biliary acids found in the liver and transported to your intestines, aid cholesterol production. Golden rice contains no fat (i.e. no cholesterol); therefore it has the ability to regulate your unhealthy blood cholesterol levels.

Problems with Golden Rice

Controversy has surrounded the production of golden rice because it is considered **genetically modified rice** (GMO). Critics have raised concerns of using genetically engineered foods to combat vitamin deficiencies like vitamin A. One of the main problems with the original form of golden rice was that it did not contain enough vitamin A to be beneficially for reducing disease risks. This problem was rectified when the new form of golden rice, Golden Rice 2 was developed in 2005. Critics continue to not only question the effectiveness of using genetically modified rice to improve health, but also the degree to which the nutrients persist once the rice has been cooked.

In a recent study (2009), it was found that golden rice was just as beneficial and effective as supplementing with vitamin A (Tang, Qin, Dolnikowski, Russell & Grusak, 2009). An organization called Greenpeace,

vehemently opposes the production and use of golden rice citing this GMO will encourage the development of more GMOs in the future. Anti-GMO activists argue that an increase in GMOs will cause the degradation of foods to the point where everything that we eat will be artificial and genetically engineered. In the long run these types of non-natural foods will cause a variety of health problems (Tang, Qin, Dolnikowski, Russell & Grusak, 2009).

These activists also argue that a balanced diet that contains beta-carotene (kale, mustard, greens, carrots, broccoli, sweet potatoes, etc.) provides an adequate amount of vitamin A and should therefore be utilized first and foremost. Supporters of GMOs argue that although it would be nice if everyone could adhere to a balanced diet rich in vitamin A, it just is not possible for some people. These supporters cite a lack of available resources and poverty as two of the main reasons why some people have developed nutritional deficiencies. They state that it is important to have alternative food sources to eliminate vitamin deficiencies and improve health and well-being. More research is needed to get a full understanding of golden rice pros and cons.

References:

- Schaub, P., Al-Babili, S, Drake, R & Beyer, P. (2005). Why is golden rice golden (yellow) instead of red? *Plant Physiology* 138 (1), 441–450.
- Tang, G., Qin, J., Dolnikowski, G. G., Russell, R. M. & Grusak, M. A. (2009). Golden rice is an effective source of vitamin A. *American Journal of Clinical Nutrition* 89(6). 1776–83.
- Wright, S. Y., Hinchliffe, E. & Adams, J. L (2005). Improving the nutritional value of golden rice through increased pro-vitamin A content. *Nature Biotechnology* 23(4). 482–7.

www.arcticapples.com/arctic-apples-story/how-we-keep-apples-from-turning-brown

How'd we do that?

So how'd we “make” nonbrowning Arctic® apples? This modern marriage of nature and science is simpler than you may think.



Browning 101

Enzymatic browning is the primary type of apple browning. It is caused by the apple's chemical reaction after cell injury, such as by bruising, biting or cutting the apple. Enzymatic browning is a predominant cause of apple browning due to handling, for example in your kitchen. Arctic apples don't undergo enzymatic browning. (Let any food get old enough, such as leaving it in the fridge too long, and any apple – [including Arctic apples](#) – will eventually suffer other types of browning.)

Meet the PPO gene family

When you bruise, bite, slice or dice an apple, rupturing the apple cells' walls, a chemical reaction is triggered between the apple's polyphenol oxidase (PPO) and phenolics that turns the apple flesh brown. And unfortunately, that reaction burns up the apple's health-promoting phenolics in the process. Read more [here](#). A family of four genes controls the majority of PPO production.

Apple-to-apple transformation

To scientifically breed Arctic apples, Okanagan Specialty Fruits' [science team](#) turns down the expression of the apple PPO genes in a process called gene silencing, which utilizes low-PPO genes from other apples.

Gene silencing is a natural process that all plants (and animals too) use to control expression of their genes. This apple-to-apple transformation is aided by time-proven biotechnology tools. In the end, Arctic apples produce too little PPO to brown. (For an even more detailed description of Arctic apple science, visit the [OSF website](#).)

No [frankenfood](#) here, folks – just apples, now with suppressed PPO to stop enzymatic browning. The transformed Arctic apple plantlets are grafted onto rootstock and grow in a tree nursery until they are ready to be transplanted to an orchard, just as other commercial apple tree seedlings are propagated.*

One small, significant difference

Arctic apple trees behave in the orchard just as other apple trees do – they grow, flower and fruit the same way, and react to pests and weather the same way. And Arctic fruits grow, are harvested, packed, stored and shipped just as other apples are.

In other words, Arctic apple trees and fruits are identical to their conventional counterparts in every way – until you bite, cut or bruise the fruit, that is. That’s when the handiwork of their silenced PPO genes becomes evident. No PPO, no browning. No enzymatic browning, no “yuck” factor to discourage you from enjoying that delicious apple.



http://www.nature.com/polopoly_fs/1.12903!/menu/main/topColumns/topLeftColumn/pdf/497017a.pdf

AquaBounty

A genetically engineered salmon (top) grows twice as fast as its wild counterpart (bottom).

In the remote highlands of Panama, in tanks protected by netting, barbed wire and guard dogs, swim the world’s most expensive and scrutinized fish. These swift-growing salmon have been at the centre of a 18-year, US\$60-million battle to bring the first genetically modified (GM) animal to US dinner tables — a struggle that may be nearing its end.

Last week marked the end of the public’s opportunity to weigh in on a US Food and Drug Administration (FDA) draft assessment of the salmon. Genetically engineered to grow twice as fast as their unaltered brethren, the fish pose no significant environmental threat to the United States when grown in landlocked tanks, says the FDA. The agency needs only to finalize that assessment before deciding whether to approve

the fish for human consumption. The number of opportunities for a surprise delay — a recurring theme in

the history of these salmon — is dwindling (see ‘Against the current’).

The US Food and Drug Administration (FDA) has been slow to approve a genetically modified (GM) salmon made by AquaBounty of Maynard, Massachusetts. The fish would be the first GM animal authorized for human consumption.

1989 Canadian researchers engineer wild Atlantic salmon to overexpress growth hormone.

1995 AquaBounty files an Investigational New Animal Drug application with the FDA.

2001 AquaBounty submits its first regulatory study to the FDA.

2009 The FDA releases guidance for its evaluation of genetically engineered animals as veterinary drugs; AquaBounty completes its FDA submission.

2010 The FDA says that GM salmon is safe to eat.

2012 The FDA completes its draft environmental assessment in May, but does not release it to the public until December.

2013 The public-comment period for the draft environmental assessment is extended by two months and concludes on 26 April.

Environmental groups are preparing to take the battle to consumers by fighting the sale of the fish in grocery stores across the country. Others point out that it will be years before the salmon are anything more than a curiosity. At full capacity, the Panama facility can produce only about 100 tonnes of salmon a year, says Gregory Jaffe, director of biotechnology at the Center for Science in the Public Interest, a consumer group in Washington DC that monitors the regulation of GM foods. That amount is a trifle compared to the roughly 230,000 tonnes of farmed Atlantic salmon that the United States imported in 2012. “You’d have to try hard to eat it,” says Jaffe. “It won’t be as hard as winning the lottery, but it will be close.”

For the firm that developed the fish, AquaBounty Technologies of Maynard, Massachusetts, those 100 tonnes are a hard-won prize. In 1989, the salmon were engineered to overexpress a growth-hormone gene. The result: ‘AquAdvantage’ fish that grew to full size in around 18 months rather than the usual 3 years. The company applied for FDA approval in 1995 and has been stuck in regulatory limbo ever since. AquaBounty has had to demonstrate the food’s safety, and gauge the environmental risk of the sterile fish escaping its tanks and successfully mating with wild salmon. By contrast, the FDA approved the first GM crop for human consumption — the Flavr Savr tomato — after just three years of regulatory consideration.

The uncertainty has taken its toll. To save money, AquaBounty has reduced its staff by more than half. Last year, the company sold off its research and development arm and lost one of its biggest investors. In March, AquaBounty came within a week of running out of cash, says chief executive Ronald Stotish. The firm was saved by last-minute refinancing and fresh investment from Intrexon, a synthetic-biology company based in Blacksburg, Virginia.

At first glance, the Panama facility hardly seems to be the key to financial prosperity. With salmon selling for around \$6.50 per kilogram, AquaBounty would make less than \$1 million each year from the salmon. It would take decades for the company to make back its \$60-million investment if it relied solely on the Panama farm.

Stotish says that the company must expand. Following FDA approval, AquaBounty hopes to sell its salmon eggs to farmers and expand to markets in Argentina, Canada, Chile and China.

To sell AquAdvantage fish in the United States, each farm would require separate FDA approval, but because the food safety of the fish has already been vetted, the approval process would require only an environmental evaluation, says Jaffe.

Yet even with regulatory approval, the battle over AquaBounty’s salmon will be far from over. In March, several speciality grocery stores, including Whole Foods, an international chain based in Austin, Texas, said that they would not sell AquAdvantage fish. Lawmakers in Alaska and Oregon, which both export wild salmon, have repeatedly tried to block the GM fish because they fear contamination of the wild stock and worry that it could drive down the price of farmed salmon.

AquaBounty’s long struggle has discouraged other US companies from producing GM animals for food. Mark Walton, chief marketing officer at Recombinetics, an animal-biotechnology company in St Paul, Minnesota, says that his company will focus initially on medical applications — using modified farm animals as disease models, for example — rather than on livestock for food. Medical applications of GM

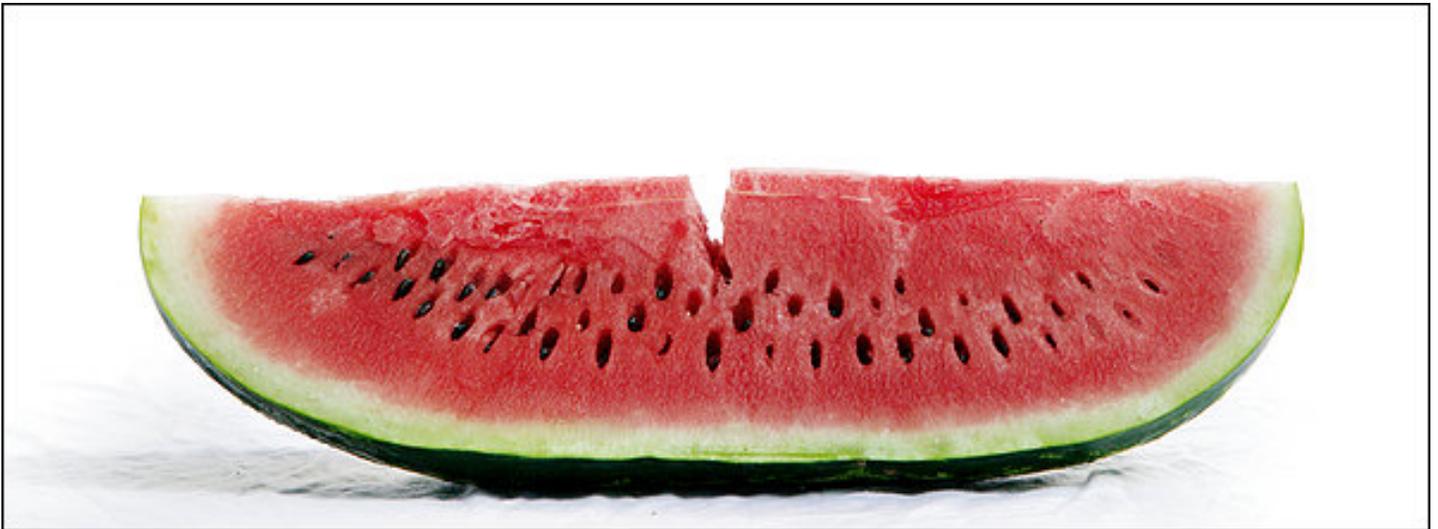
technology do not stir consumer passions in the same way as GM foods, and there is a regulatory precedent: in 2009, the FDA approved a goat that makes an anti-clotting drug in its milk. If Recombinetics invests in agricultural products, Walton adds, the items will probably be marketed outside the United States first. "The AquaBounty example has [made] the company very sceptical about how much investment to pour into the US regulatory process," he says.

Yet Stotish says that GM animal products will inevitably find their way to grocery stores. He points to heavy investment in the technology in China, where dozens of GM farm animals are in development. "I think we will end up eating genetically modified animals of a variety of species," says Stotish. "But they'll come from other countries."

<http://www.washingtonpost.com/wp-dyn/content/article/2010/08/31/AR2010083102643.html>

Watermelons: What happened to the seeds?

Watermelons with seeds are not as popular with consumers, so producers are growing more of the seedless fruits. (Deb Lindsey for The Washington Post)



By Jane Black

Washington Post Staff Writer

Tuesday, August 31, 2010; 11:35 AM

In 1995, Jason Schayot set the world record for spitting a watermelon seed when he shot his tiny black bullet a whopping 75 feet, 2 inches, almost a quarter of a football field. It's a record that would be hard to beat. But Schayot might not have much competition anyway. Within a generation, most Americans won't even know that watermelons have seeds, let alone how to spit them.

According to the National Watermelon Promotion Board, only 16 percent of watermelons sold in grocery stores have seeds, down from 42 percent in 2003. In California and the mid-South, home to the country's biggest watermelon farms, the latest figures are 8 and 13 percent, respectively. The numbers seem destined to tumble. Recently developed hybrids do not need seeded melons for pollination - more on that later - which liberates farmers from growing melons with spit-worthy seeds.

The iconic, black-studded watermelon wedge appears destined to become a slice of vanished Americana. If that sounds alarmist, try to remember the last time you had to spit out a grape seed.

The sea change is all in the service of convenience. "People don't eat watermelon out of hand like they used to. They like to eat it in fruit salads," said Robert Schueller, the public relations director for Melissa's Produce, a California distributor that sells only 10 percent of its watermelons with seeds. "It's a question of ease, time, and there's the safety factor. Kids could choke on the seeds."

You can't blame producers for giving people what they want, though as far as I can tell, childhood mortality rates remain unaffected by the type of watermelons for sale. Nor should we let nostalgia be an obstacle to progress. Seedless watermelons are easier to eat, and it's not only harried soccer moms who prefer them. Chefs such as Eric Ziebold at [CityZen](#) and Todd Gray of [Equinox](#), both usually vocal proponents of heritage varieties, prefer seedless watermelons because they are more easily transformed into elegant cubes and fine dices.

Still, as the end of summer looms, I can't help but mourn the inevitable disappearance of the black-dotted red watermelon. In part, it is a wistfulness for a classic American fruit and its traditions. Without seeds, there can be no seed-spitting contests such as the one in Luling, Tex., home to an iconic watermelon water tower, or the one in Pardeeville, Wis., where the rules are strictly enforced: No professional tobacco spitters. Denture wearers must abide by the judge's decision if their teeth go farther than the seed.

Though there is some debate about it, the flavor of old-time watermelons might also be in jeopardy. And what a flavor to lose! In "Pudd'nhead Wilson," Mark Twain described the true Southern watermelon as "a boon apart . . . when one has tasted it, he knows what the angels eat." Convenience, whether it's a smaller size, a fruit without seeds or year-round availability, always seems to extract a price. And if that sounds alarmist, try to remember the last great tomato you bought at a supermarket.

The watermelon, or *Citrullus lanatus*, belongs to a family of climbing vines that include cucumbers and gourds. And like all fruits, they naturally have seeds. The seedless versions are not genetically modified, as some might assume, but are hybrids that have been grown in the United States since the middle of the 20th century. Breeders match the pollen from a diploid plant, one that contains 22 chromosomes per cell, and the flower of a tetraploid plant, which contains 44 chromosomes per cell. The result is a triploid with 33 chromosomes that is incapable of producing seeds. (The tiny white ones you sometimes find are seed coats, where a seed did not mature.) Breeders call it the mule of the watermelon world.

When farmers first began growing seedless watermelons, they still needed seeded varieties to pollinate them. But that has changed, says Mark Arney, president of the watermelon board, who, for the record, has never spit a watermelon seed farther than 20 feet. Over the past five or six years, the same period when the share of seeded watermelons began to drop precipitously at grocery stores, farmers began using so-called non-bearing pollinators. In other words, instead of planting a percentage of their fields with old-fashioned watermelons to pollinate, they plant another hybrid that produces the flowers that bees need but no actual fruit.

I see the trend at local grocery stores. I haven't found any seeded melons at my local Safeway this summer or at the nearby Whole Foods Market, though a staff member there told me that they sometimes carry organic watermelons with seeds.

The most reliable place to find old-school watermelons is the farmers market. That is not because of any bias in favor of old-fashioned varieties. It's because seedless watermelons are more difficult and expensive to grow. Their seeds are most successful when germinated in a greenhouse rather than outdoors, and farmers must buy hybrid seeds for the pollinator plants. More than half of the watermelons grown at Montross, Va.-based Garner Produce, a regular at Washington markets, are seeded. At Spring Valley Farm and Orchard in Morgan, W.Va., 60 percent of the melons have seeds. "It's easier," said Joe Heischman, a co-manager of the farm. "But I think the seeded ones also taste better. When we put out samples of both, people always say the seeded ones are sweeter."

http://www.ehow.com/info_8058700_oranges-seedless.html

Which Oranges Are Seedless?

In the U.S., oranges are considered to be seedless if they have from zero to six seeds, according to Purdue University's Horticulture and Landscape Architecture website. Because we view seeds as a nuisance when eating fresh oranges, breeders in the 1800s developed trees producing seedless varieties. These varieties are

propagated by taking cuttings from a tree and grafting them onto root stock. A seedless orange is produced when the flowers from which the fruit develop are not pollinated, as the anthers do not develop pollen. The most popular varieties of seedless oranges for eating fresh are naval, Valencia and Jaffa. The Tarocco is Italy's favorite seedless orange.

Farm to Cart Game can be downloaded at:

[http://www.agfoundation.org/files/Farm to Cart Final Game.pdf](http://www.agfoundation.org/files/Farm%20to%20Cart%20Final%20Game.pdf)