Photo: Shawn Lineham, © Shawn Linehan Photography

Figure 1. Green kabocha 'Sweet Mama'.

Kabocha and Buttercup Squash for Western Oregon Gardens

Alice Formiga, Jennifer Wetzel, Lane Selman, Shinji Kawai and Alex Stone

Introduction

Kabocha and buttercup squash are gaining popularity among chefs, home gardeners, home cooks, and professional growers due to their outstanding culinary characteristics and small size. This short primer on kabocha and buttercup history, production practices, flavor and uses may inspire more gardeners to grow and eat these exceptional winter squashes.

Kabochas

Kabochas weigh from 1.5 to 5.3 pounds. They are round, oblate or teardrop-shaped, with dark green, blue-gray or bright red-orange rinds. Their dense, starchy flesh often has the consistency, flavor and sweetness of sweet potatoes.

In Japan, "kabocha" is a general term for winter squash and pumpkins. In the United States, the term "kabocha" refers to a type of *Cucurbita maxima* squash that was bred in Japan. In Japan, it is called "kuri kabocha" or "chestnut squash" because of its nutty flavor.

Cucurbita maxima was originally domesticated in South America, and many varieties became widespread in North America during the 19th century. It was likely introduced to Hokkaido, Japan, in the 1860–70s during the early Meiji Era, when government officials imported many new seeds and food crops. It became known there as "western squash." In contrast, "Japanese squash" referred to *Cucurbita moschata*, a species which had arrived in Japan much earlier.

In the late 1870s, *Cucurbita maxima* were planted at Sapporo Agricultural College, which was founded with the help of American agricultural advisers. From there,

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Figure 2. Gray kabocha 'Winter Sweet'.

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Photo: Shawn Lineham, © Shawn Linehan Photography
Figure 3. Red kabocha 'Sunshine'.

seed was distributed to farmers for seed production. Varieties included *Cucurbita maxima* 'Hubbard', which was popular in the United States at that time. In Japanese, 'Hubbard' was called 'Masakari' after a type of axe because cutting its hard rind required a sharp tool. Japanese farmers and breeders soon began selecting from 'Hubbard' and other *Cucurbita maxima* squash cultivars for smaller fruit, early maturity, sweet flavor, dry texture and long storage.

Other than 'Hubbard', we do not know which *C. maxima* varieties were used in Japanese kabocha breeding. There were many other small hubbard and turban varieties available with dry flesh in the late 19th and early 20th centuries. Japanese commercial kabocha varieties do not typically have a protruding "turban" or "button" on the blossom end; however, there are local heirloom varieties that have this characteristic in some regions of Japan.

Pumpkins were eaten in Japan as a subsistence food during World War II, so kabochas were not the first choice of consumers in the years immediately following the war. However, when Takii Seed Company introduced the dark green 'Delica' (aka 'Ebisu'), an F1 hybrid kabocha, in 1964, it became popular. Many more F1 hybrid kabocha varieties are available today.

Japanese breeders crossed *Cucurbita maxima* with *Cucurbita moschata* in the 1940s, resulting in hybrid kabocha squash with high yield, early maturity, heat tolerance, chestnut-like flavor and disease resistance. 'Tetsukabuto', released in 1951, is one such variety. Its name means "iron helmet" in Japanese. The male parent was 'Kurokawa No.2', a Japanese *C. moschata*, and the female parent was *C. maxima* 'Delicious'. 'Tetsukabuto' is grown in the U.S. primarily as a rootstock for grafting melons, although it is a popular fresh-market squash in Brazil. It is productive, long-storing, and has excellent culinary quality when grown in western Oregon.

Japanese and Japanese-American firms sold Japanese squash varieties in the U.S. in the first half of the 20th century. During the 1970s, more U.S. seed companies gradually started selling kabochas, spurred by an interest in healthy eating and macrobiotic cooking. For example, Johnny's Selected Seeds listed 'Blue Kuri' in 1974 and 'Uchiki Kuri' in 1976. By the late 1980s, kabochas became increasingly common in American seed catalogs, along with many other specialty and international vegetables. Several hybrid kabochas were chosen as All-America Selections, such as dark green 'Sweet Mama' (AAS 1979) and orange-red 'Sunshine' (2004).

Buttercups

Buttercups typically have thick, dark-green skin with light stripes and a blockier shape than kabochas. Their flesh is orange-yellow, sweet and dry, though not as dry as the flesh of kabochas. Buttercups have a protruding lighter gray-green "button" surrounded by a circular scar at the blossom end of the fruit. In spite of their differences, kabocha and buttercup squash are often considered to be a single type in marketing and breeding, and the terms are sometimes used interchangeably.

Photo: Shawn Lineham, © Shawn Linehan Photography
Figure 4. Buttercup 'Bonbon.'

Buttercups were developed by breeders at North Dakota State University. They wanted to breed a squash with a rich, sweet flavor to substitute for sweet potatoes, a popular warmer weather crop that cannot be successfully grown in North Dakota.

The first buttercup, 'Burgess Buttercup', was developed in 1925, the result of an accidental cross

between 'Essex Hybrid' and 'Quality'. 'Essex Hybrid' is an orange, slightly squared, turban-type squash that was found in a field of 'American Turban' in 1879. 'Quality', a small, green-skinned variety with thick, dry flesh, was found in a field of 'Delicious' and selected by a customer of Joseph Harris & Co and introduced in 1914. 'Delicious' was introduced by J.J.H. Gregory & Son in 1903. The company said 'Delicious' descended from almost all the varieties they knew, including 'Hubbard', 'Faxon' and yellow and blue Brazilian varieties. 'Faxon', a variable green or yellow variety, had appeared in 1893 and was originally from southern Brazil. So it is possible that 'Hubbard', 'Delicious', and other *Cucurbita maxima* varieties may be related to both buttercup and kabocha-type squash (Figure 5, page 4).

Additional buttercup varieties have since been developed, including F1 hybrids. The F1 hybrid Buttercup 'Bonbon' was chosen as an All-America Selections winner in 2005. It has a semi-bush habit, it is earlier and more productive than 'Burgess', and it tastes sweet with a creamy texture.

Types and varieties

Many kabocha and buttercup varieties were trialed in western Oregon in 2014–2017. The varieties listed in Table 1 performed best in terms of yield, soilborne disease resistance, size, flavor, storage rot resistance and storage duration. Many varieties that perform well in other regions do not perform well here due to their susceptibility to soilborne and storage diseases unique to this region that reduce yield and storage duration.

Production

Soil preparation and nutrient management

Kabochas and buttercups grow best in fertile, well-drained soil. Take a soil sample and send it to a soil lab for analysis; adjust pH to 5.5–6.5 and correct nutrient deficiencies.

Squash need approximately 60 pounds per acre of plant available nitrogen. For more information on soil testing and fertilization, refer to the OSU Extension publications *A Guide to Collecting Soil Samples for Farms and Gardens* (EC 628) and *Fertilizing Your Garden* (EC 1503), available from the OSU Extension Catalog https://catalog.extension.oregonstate.edu.

Planting

Kabochas and buttercups can be transplanted or seeded directly into the field from mid-May to early June, when the soil is dry and ready to be worked. Plant up to twice as many seeds as desired and thin to the appropriate density after emergence.

It is more helpful to plant single seeds at a greater planting density than "double seeding" at the desired density, as thinning single seedlings is faster and causes less disturbance to the roots.

Plant seeds approximately 1 inch below the surface of the soil and keep the planting medium moist for two to three weeks. Smaller transplant cell sizes need to be watered more frequently. When seedlings develop two true leaves, they are ready to be planted in the field, approximately two to three weeks after seeding.

Table 1. Varieties of Kabocha and Buttercup squash for western Oregon

Type	Variety	Species	Color	Size	Storage duration	Commercial seed source
Kabocha	Sweet Mama F1	*C. maxima*	green	very large	long	Osborne Quality Seeds
	Delica F1	*C. maxima*	green	large	medium	Takii Seed
	Sunshine F1	*C. maxima*	red-orange	large	short	Johnny's Selected Seeds
	Winter Sweet F1	*C. maxima*	blue-gray	large	long	Johnny's Selected Seeds
	Blue Kuri	*C. maxima*	blue-gray	medium	short	Adaptive Seeds
Buttercup	Bonbon F1	*C. maxima*	green	large	medium	Johnny's Selected Seeds
	Burgess Buttercup	*C. maxima*	green	medium	short	Johnny's Selected Seeds
Interspecific hybrid	Tetsukabuto	*C. maxima* X *C. moschata*	green	medium	very long	Nichols Garden Nursery

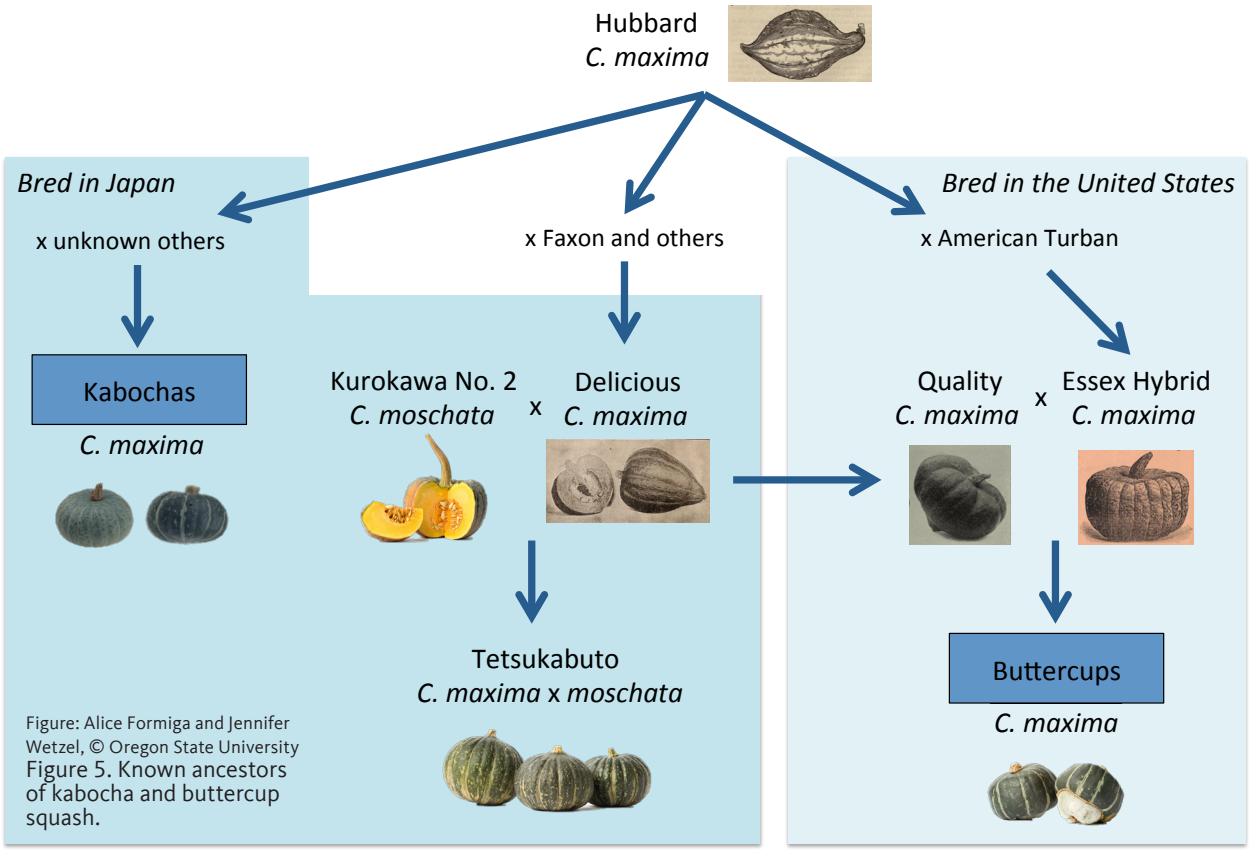

Figure: Alice Formiga and Jennifer Wetzel, © Oregon State University

Figure 5. Known ancestors of kabocha and buttercup squash.

Kabochas and buttercups set fewer fruit per plant compared to other common winter squash varieties such as butternuts and acorns. For this reason, it is more productive to use a higher planting density. Under full irrigation, space each plant 8 inches to 1.5 feet apart and space each row 5 feet apart. Higher planting densities decrease the size of each fruit and increase the number of fruit.

Irrigation

Irrigated winter squash require approximately 1 inch of supplemental water per week. This can be applied using overhead sprinklers or drip irrigation.

Harvest

Kabocha and buttercup fruit are sufficiently mature to be removed from the vine at 45 days after pollination (45 days after flowering).

They are not fully ripe at this stage, but they no longer require nutrition from the plant in order to ripen further. Leaving the fruit in the field longer than necessary increases the likelihood of sunburn, exposure to rot pathogens, cracking and rodent damage.

Most farmers and gardeners don't take notes on when their squash plants flower, so it is not possible to use days after pollination to schedule harvest. And the skin color for green, red and gray kabochas doesn't change much when the fruits are mature. However, there are other strategies for determining when to harvest:

- **Stems are corky and dry.** The stem is an umbilical cord to the squash fruit. Stems become corky and dry as the plant excises the fruit as part of the maturation process. Once the stem is dry and brown, the fruit is mature and can be removed from the plant
- **The leaf canopy has senesced (died).** When there is no more leaf cover, exposed fruit have a greater risk of sunburn. Kabochas and buttercups are susceptible to sunburn, which makes the fruit more susceptible to rotting. If the entire plant is dead, there is no reason to leave the fruit on the plant or in the field.
- **The weather is dry but rain is in the forecast.** In western Oregon and Washington, summers are typically dry and falls are typically rainy. It is best to harvest kabochas and buttercups before heavy rains in order to decrease soil splashing onto fruit, which will increase the risk of storage rots.

When harvesting fruit, cut stems as close as possible to the fruit. Handle the fruit and stem gently, as any

damage to the skin or removal of the stem can increase the risk of rotting in storage. Gently brush off dirt and debris; vigorous washing or dipping the fruit in hot water have not been shown to improve storage.

Pest and disease management

Insect pests

Striped cucumber beetle (*Acalymma vittatum*) and spotted cucumber beetle (*Diabrotica undecimpunctata*) are the two most important insect pests of winter squash in Oregon. Striped cucumber beetles prefer *Cucurbita* crop species. Adults emerge in the spring and feed on young winter squash seedlings. They continue to feed on the leaves, flowers, fruit skin and fruit throughout the season. Spotted cucumber beetles attack a wide range of crops and cause damage similar to striped cucumber beetles.

Control measures are limited for both species. The most effective control measure is to cover the crop at seeding (before emergence) or immediately after transplanting with row cover. The edges of the row cover must be tightly sealed so the beetles cannot crawl underneath. Remove the row cover when the plants bloom, so that bees can pollinate the flowers.

Other strategies include dipping the foliage of transplants into kaolinite clay (Surround or Surround WP, NovaSource International), before planting, and then following up with additional applications of clay as the plants grow. You can also use other organic or conventional insecticides labeled for cucumber beetles. For more information on cucumber beetle, including pesticide recommendations, refer to the *Pacific Northwest Insect Management Handbook* (https://catalog.extension.oregonstate.edu/insect). For organic management recommendations, refer to "Managing cucumber beetles in organic farming systems" at https://articles.extension.org/pages/64274/managing-cucumber- beetles-in-organic-farming-systems.

Diseases

Powdery mildew (caused commonly by *Podosphaera xanthii* or *Erysiphe cichoracearum*) is a common squash disease. It can thrive and spread in temperate conditions with high relative humidity and in hot, dry weather, particularly after a mild winter or a cool, wet spring. This disease often appears on squash plants in the late summer and early fall and is not a concern as long as the fruits are no longer relying on the plant for nutrients. Midseason powdery mildew epidemics are a concern, since they reduce nutrient supply to the fruit and reduce fruit yield and quality.

The *Pacific Northwest Plant Disease Management Handbook* outlines the following practices that are effective in combating this disease:

- **Exclusion.** If purchasing transplants, make sure to use only healthy, disease-free plants.
- **Cultural practices.** Increasing plant spacing and increasing water-use efficiency can minimize the relative humidity under the canopy of squash plants, which will in turn decrease the incidence of powdery mildews. Overhead irrigation is used by commercial farmers to suppress the disease as the water washes the pathogen spores off the leaves.
- **Resistance.** While there is good genetic resistance in other types of winter squash (e.g., some acorn and butternut varieties as well as pumpkins), there is no powdery mildew resistance in Cucurbita maxima.
- **Chemical and biological control.** Refer to the *Pacific Northwest Plant Disease Management Handbook*. For organic fungicides, see "Managing cucurbit powdery mildew organically" at https://articles.extension.org/pages/30604/managing-cucurbit-powdery- mildew-organically.

Root and crown rot

There is a newly diagnosed disease caused by several soilborne fungi (primarily *Fusarium solani*) that rots squash roots and crowns (Figure 6). This disease stunts plants and reduces fruit size and yield; severe outbreaks can kill entire plants. The disease also affects melons, watermelons and cucumbers. Plant nonhost crops for at least three years between these crops.

Storage rots

A variety of soilborne fungi cause fruit rots in storage. A damaging blossom end fruit rot occurs in western Oregon, caused by *Fusarium culmorum*

Photo: Hannah Rivedal, © Oregon State University

Figure 6. Squash root rot.

Photo: Alex Stone, © Oregon State University

Figure 7. Squash fruit rot.

(Figure 7). Growing varieties with resistance to this storage rot is the best measure against storage losses. Drip irrigation minimizes splashing of soil particles (carrying pathogens) onto the fruit, reducing storage rot incidence. Remove fruit from the field 45 days after flowering and before fall rains to reduce fruit exposure to soil splashing.

Ripening

Just like pears, kabocha squash ripen after harvest and they taste best when they are fully but not overly ripe. Kabochas and buttercups need to ripen for one or more months after harvest for best culinary quality. At harvest, they still have high starch and low sugar contents. During ripening, starch is converted to sugars, which improves the consistency of the squash and increases sweetness.

Squash varieties achieve peak eating quality at different times during the fall and winter (Figure 8). Below is a calendar showing the peak culinary quality for common winter squash and regionally high-performing kabocha and buttercup varieties. These time frames are based on brix (a measure of sweetness), dry matter and taste preference data collected monthly throughout the winter.

Long-storing varieties resistant to storage rots. Winter squash varieties vary in their inherent storage longevity; some retain excellent culinary quality for over six months, while others degrade much sooner. Winter squash grown in western Oregon are affected by unusual and damaging storage rot pathogens. When growing squash for winterlong storage, it's wise to grow varieties that are resistant to these pathogens. Kabocha varieties vary in their susceptibility to these pathogens. Rot-susceptible varieties that should be eaten in the fall include 'Bonbon' and 'Sunshine'. Long-storing, rot-resistant varieties include 'Tetsukabuto', 'Sweet Mama' and 'Winter Sweet'. 'Tetsukabuto' is the only kabocha

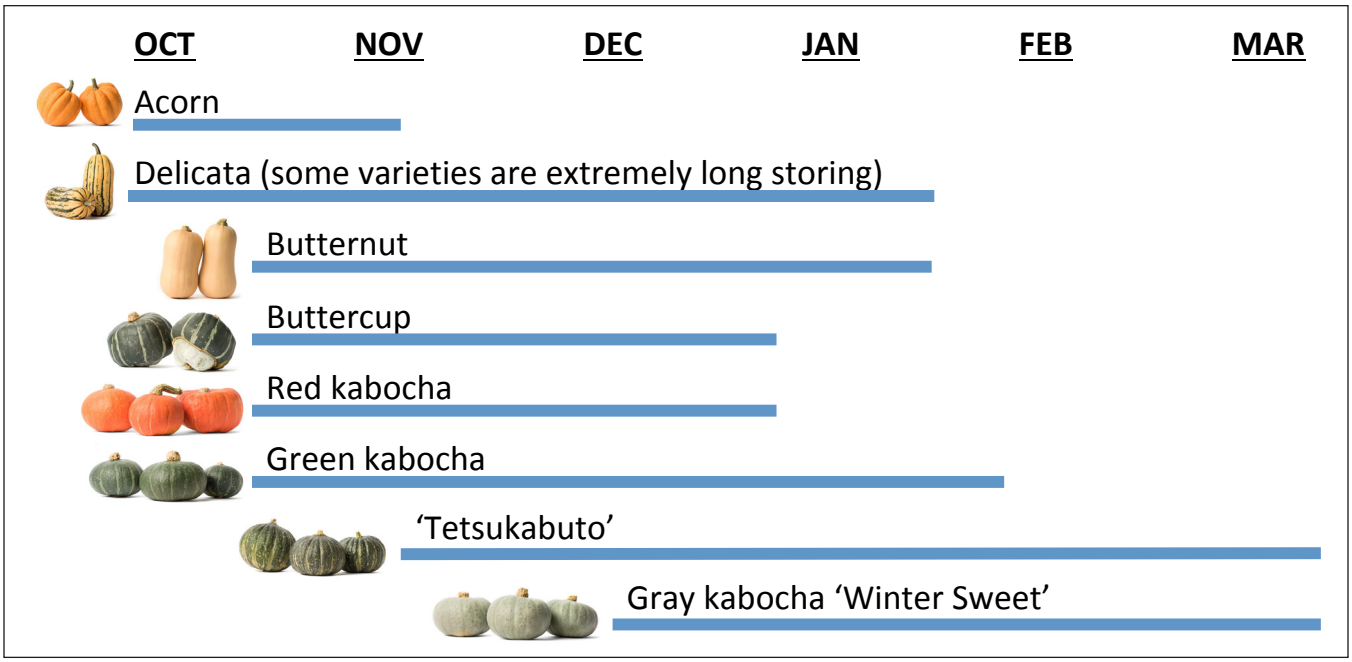

Figure: Jennifer Wetzel and Alex Stone, © Oregon State University

Figure 8: Peak culinary quality for regionally high-performing kabocha and buttercup varieties. *Cucurbita pepo* 'Acorn' and 'Delicata' and *Cucurbita moschata* 'Butternut' are also included for reference.

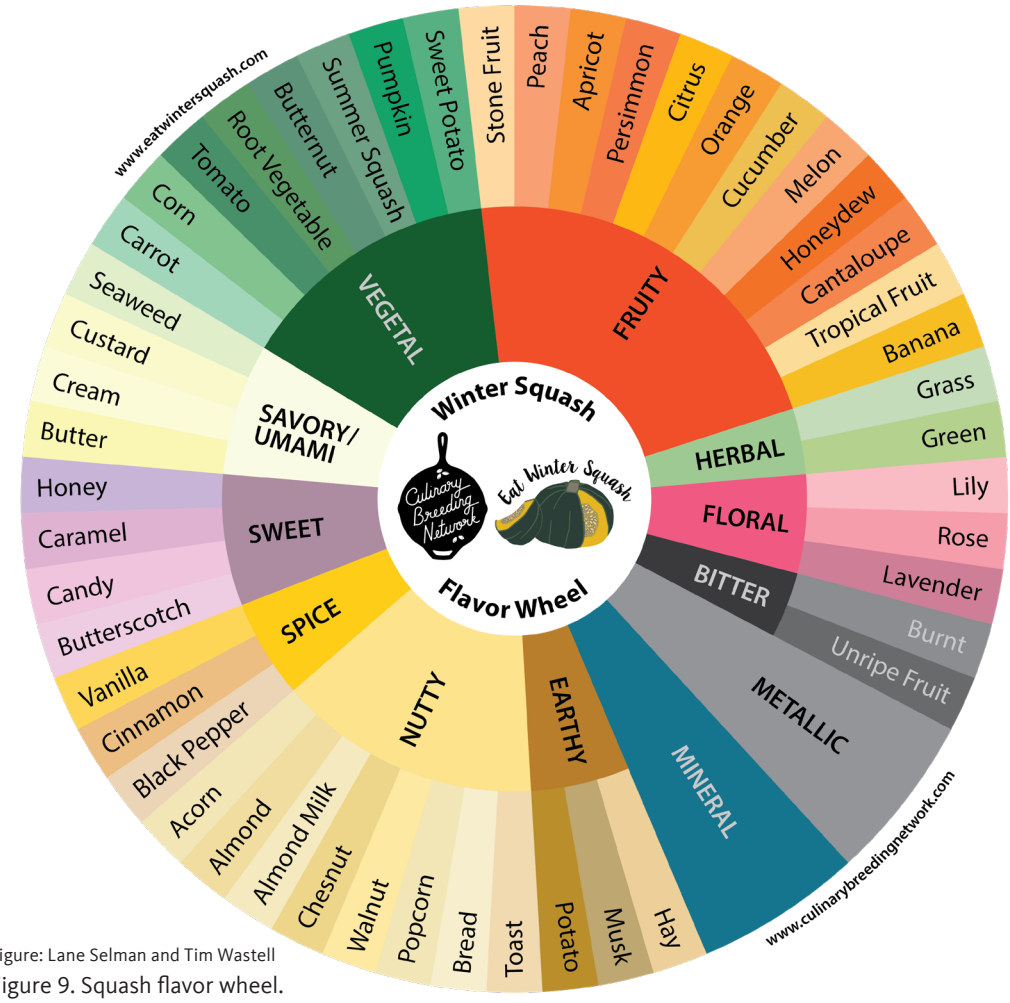

Figure: Lane Selman and Tim Wastell

Figure 9. Squash flavor wheel.

type that can be reliably grown in this region and stored through April with almost no storage losses.

Storage environment. Most Extension publications recommend a storage environment maintained between 52°F and 54°F and 50% to 70% relative humidity. However, research in western Oregon showed that most kabochas and other winter squash can be stored successfully in a storage space maintained above freezing with otherwise fluctuating temperature and humidity.

Flavor and uses

Flavor

Kabochas and other *Cucurbita maxima* varieties offer great flavor diversity. The Culinary Breeding Network and the OSU Squash Research Project worked with chefs and food scientists to describe flavors present in *C. maxima* varieties, including kabocha and buttercup varieties.

The flavor wheel above displays flavor categories in the inner ring and flavor subcategories in the outer ring. For example, some varieties have flavors reminiscent of chestnuts, which is a flavor subcategory within the major category "nutty."

Many kabochas and buttercups have fruity flavors such as cantaloupe and melon; nutty flavors such as chestnut, almond and acorn; and sweet flavors such as caramel and honey. While this tool may be useful for describing squash flavors, it is difficult to classify individual varieties by flavor. Flavor can often vary widely between individual squash specimens, as well as the degree of ripeness, time in storage and storage conditions. How sweet the squash is, how the squash is prepared, and individual preferences can also affect tasters' perceptions of flavor.

Uses

Kabochas and buttercups can be used in any recipe calling for butternut or acorn squash. They can be prepared as main courses, salads, side dishes or desserts. One of the advantages of using these varieties,

besides their sweet nutty flavor, is their texture—kabochas are known for their drier flesh. They hold their shape in stews and curries, and if used raw and grated into a winter salad, they'll add a sweet crunch and burst of orange color. For more information on varieties and recipe ideas, visit www.eatwintersquash.com.

For more information

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