Specialty Corns

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History

Five hundred years ago, Columbus became one of the first Europeans to set eyes on maize or corn (*Zea mays*), the foundation of most great New World civilizations, including those of the Incas, Mayans, and Aztecs. In 1540, Coronado found pueblo Indians growing corn under irrigation in the American Southwest. The Jamestown Colony learned how to grow corn from the Indians in 1608, and corn helped keep the Pilgrims alive during the winter of 1620.

The inability of corn to survive in the wild on its own makes its ancestry a puzzle. Probably the oldest known remains of corn are cobs dating back 7000 years found in Tehucan, Mexico. Most corn historians feel that a wild grass called *Teosinte* is probably one of its primary ancestors. An eight-row race called *Harinoso de Ocho* was known to have been grown in the Southwest about 700 AD.

Corn Classification

Corn is one of the most diverse grain crops found in nature. Selection pressure by both humans and nature has resulted in various types of corn generally classified by characteristics of their kernel endosperm (tissue surrounding the embryo that provides food for the seed's growth).

The most common types of corn include flint, flour, dent, pop, sweet, and waxy. The physical appearance of each kernel type is determined by its pattern of endosperm composition as well as quantity and quality of endosperm (fig. 1).

A seventh type of corn called *pod* or *tunicate* may also be characterized by flint, dent, flour, sweet, pop, or waxy endosperms. In pod corns, however, each individual kernel is enclosed in a glume, or husk. These types have little commercial value except as an ornament.

Kernels of flint corn have mostly hard, glassy endosperms with smooth, hard seed coats (pericarps). Flour corn endosperms are made of soft starch with thin pericarps. Dent corns with flinty sides and soft cores of starch that cause the end of the kernels to collapse or dent during drying fall between the flint and flour types. Popcorns are basically small-kerneled flint-type corns. The wrinkled, glassy appearance of sweet corn kernels is the result of a sugary gene that retards the normal conversion of sugar to starch during endosperm development. Waxy corn carries a gene that produces 100% amylopectin (a complex form of starch).

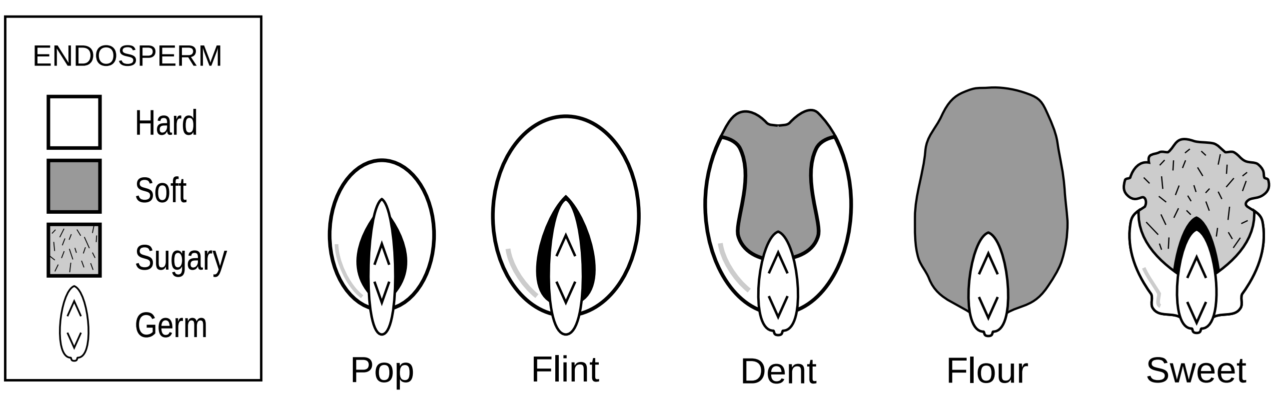

Fig. 1. Endosperm distribution in five types of corn kernels.

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Dent Corn

Today's dent corns originally came from crosses between late-flowering Southern dent corns (Gourdseed) and early-flowering Northern flints. Modern-day hybrid dent varieties grown in New Mexico can produce over 12,000 lb of grain per acre.

Although most dent corns produced in the United States have yellow endosperms, white dents are very popular in human food products because of the whiter starch. White dent corns often receive a premium price from the dry-milling industry since yields are somewhat less than those of the yellow dent corn hybrids.

While the foliage and stalks of dent corn can be used to make a number of products including silage and corn syrups, the kernels make dent corn an economic agricultural giant. On the average, the United States produce over 7 billion bushels of dent corn per year, 85% of which goes into animal feed or exports.

Processed corn products are diverse, including cooking oil and various corn grits, meals, flours, and starches. Corn starches can be processed further into a variety of food and nonfood products including fat substitutes, sweeteners, alcohol, paper, adhesives, paints, soaps, cosmetics, dynamite, tires, and oil-drilling materials.

Corn is also used as a nutrient medium in making antibiotics like tetracycline, penicillin, neomycin, bacitracin, and streptomycin. Riboflavin (Vitamin B_2) and cobalmide (Vitamin B_{12}) are two major vitamins produced from the fermentation of corn steep liquor and dextrose. Other important corn fermentation products include citric acid, glutamic acid, lactic acid, and lysine.

Although most of the products listed above are made from dent corn, other types of corn are becoming more and more important as growers seek to capitalize on niche markets or competitive advantages for specialty corns in localized markets.

Sweet Corn

Sweet corn probably originated from a mutation of a Peruvian corn called *Chuspillo* or *Chullpi*. American Indians grew selections of this mutant race; 'Papoon' grown by the Iroquois in 1779 is the most well known. 'Dantings Early' was one of the first-named sweet corn varieties, while 'Golden Bantam,' released in 1902, became one of the most important open-pollinated varieties. In later hybrid breeding trials, 'Iochief' was developed for the processing industry.

Unlike dent corn, sweet corn is grown primarily for fresh consumption, not feed or flour, although USDA researchers have developed a technique to produce a high-fiber, no-calorie flour from sweet corn pericarps. Immature standard sweet corn is considered desirable when kernels are succulent because of a mutant recessive sugary-1 gene (su-1) that retards the conversion of sugar into starch during endosperm development. In comparison, sucrose produced in leaves from photosynthesis in dent corn is passed on to developing kernels, where it is rapidly converted to dextrin (a nonsweet, water-soluble polysaccharide), and then to starch. The sugary-1 gene slows down this process.

Field corn contains approximately 4% sucrose in the immature milky stage. Standard sweet corn at the same stage contains approximately 10% sucrose. Following harvest, or if left on the stalk too long, sucrose in standard sweet corn is rapidly converted to starch. Kernels can lose as much as 50% of their sucrose at room temperature 24 hours after harvest.

In the past, sweeter varieties have been developed by selections within the homozygous su-1 genotype. One such selection, 'Silver Queen', became the standard to which other varieties were compared. A sweetness breakthrough was accomplished with the discovery of the shrunken (sh-2) gene. Supersweet varieties with this gene exhibit sucrose levels two to three times greater than standard sweet corn at harvest, and two days after harvest sucrose levels will still be relatively high.

Although sh-2 varieties contain more sucrose at and after harvest than standard sweet corn, they exhibit some notable disadvantages. Early releases tended to have tough pericarps and lacked the high levels of water-soluble polysaccharides that give standard sweet corn its creamy texture. They also must be isolated from other varieties of sweet corn, because cross pollination with standard sweet corn will make kernels tough and starchy in both types.

Germination in supersweet varieties is also poor. For good stand establishment, planting depth should be shallower and soils warmer than for standard sweet corn.

'Kandy Korn' is an example of a variety exhibiting another type (Everlasting Heritage) of gene that results in sweeter sweet corn. In combination with the su-1 gene, the "sugar enhanced" (se) gene produces a variety with increased sweetness and creamy texture, requiring no isolation. Varieties with the se gene have sugar levels that normally peak somewhere between su-1 and sh-2 varieties.

Marketing sweet corn effectively depends on promotion and educating the consumer to differences between varieties. For shipping purposes, sh-2 varieties are excellent because sugar conversion to starch is much slower.

High-quality se varieties are popular for roadside stands. Free samples along with recipes are an excellent way to promote these varieties.

Popcorn

Popcorn is one of the oldest forms of corn. Pod forms of popcorn found in Bat Cave, New Mexico, have been radioactive carbon dated at 3600 BC.

Popcorns can be generally classified into two primary types: pearl or rice. Pearl types have smooth, rounded pearl-like crowns, while rice types are pointed. Popcorns also vary in color. Popcorn has a hard, flinty endosperm that surrounds a small amount of soft moist starch in the center. Heating the kernel turns this moisture into steam which expands, splits the pericarp (seed coat), and causes the endosperm to explode, turning the kernel inside out. The moisture content should be 13.5–14% for best results.

Popcorn quality depends on a number of factors. Generally, the more a popcorn variety expands after popping, the better the quality, as a greater volume produces a better texture. Most commercial varieties will expand 30–40 times their volume. Expansion is also affected by moisture content, drying procedure, and amount of damage to the pericarp and endosperm. Other factors affecting quality include flavor, tenderness, absence of hulls, color, and shape.

Shape after popping can vary from spherical (mushroom) to a butterfly shape. Mushroom types are generally preferred in the confection industry, as they are less susceptible to breakage and are easier to coat with flavors or syrups. Butterfly-shaped popcorn has a better mouth feel and is preferred for on-premises popping such as theaters.

Popcorn is normally marketed under contract to a processor or through open-market sales to a processor or local dealers. Sales of contracted popcorn are more secure and open-market sales are often risky, though if growers have good storage, open-market sales may be more lucrative if prices rise. Local sales usually involve growers in packaging and marketing their own products. Although conditions for growing popcorn are the same as for dent corn, special harvesting and specific drying and storage practices are necessary to maintain popping quality.

High-Lysine Corn

Corn is a major staple in many underdeveloped countries. Nevertheless, dent corn is a relatively poor source of protein, requiring diets to be supplemented with other protein sources like beans. Most of the protein in corn is zein (promalin form), which cannot be digested efficiently by humans and other nonruminant (single-stomached) animals like pigs and chickens. Zein in dent corn tends to be very low in lysine and tryptophan, two of the eight essential amino acids that nonruminants cannot synthesize and must obtain from their diet.

In 1963, scientists at Purdue University found that corn strains with opaque-2 (o-2) genes contained lower amounts of zein and higher amounts of lysine and tryptophan in their endosperms than standard dent corn. The opaque-2 gene changes the starch structure in the endosperm, elevating the glutelin (the protein high in lysine and tryptophan) level and lowering the prolamine level. Opaque-2 kernels, however, tend to have soft textures, dull appearances, and very little hard endosperm, making them difficult to harvest and more subject to attack by pests. Opaque-2 varieties also tend to give lower yields and must be isolated from other corns to retain protein quality. Though high-lysine corn continues to show great potential as a more balanced protein for nonruminant animals and as human food in less-developed countries, much work is still needed to increase grain yields.

High-Oil Corn

The highly polyunsaturated, high linoleic acid content of corn oil makes it an excellent source of energy and essential fatty acids for both humans and livestock. Cattle feeders are particularly interested in varieties with greater oil content. High-oil content varieties have higher caloric levels that result in greater animal gains per unit of feed.

Most hybrid dent corns average 3.5–6.0% oil. Varieties with oil content greater than 6.0% tend to have lower yields.

Oil quality is dependent on the relative amounts of unsaturated and saturated fatty acids in the grain. Oils high in linoleic acid and low in oleic, palmitic, and stearic acids are preferred for human diets. As with high-lysine corn, more work is needed to improve adaptability and yields.

Waxy Endosperm Corns

Waxy endosperm hybrids contain 100% amylopectin starch (branched molecular form), rather than the normal dent corn ratio of 72% amylopectin and 28% amylose. The waxy “wx” mutant was found in China in 1908, but was not fully developed until 1936 when researchers from Iowa State University noted its unique properties and started developing hybrids. Steers not only make greater gains when fed waxy endosperm corn, but the stability and clarity of amylopectin starch (similar to tapioca starch) also makes it highly suitable as a food thickener.

White, waxy corn is easily damaged during harvest, handling, and drying. Growers should obtain a contract before planting waxy endosperm corns.

Blue Corn

Atole, tortillas, corn chips, and other corn products have been the backbone of most traditional and present-day Native American and Mexican American cuisines. Blue corn and other flour corns have historically represented the major kernel "type" of corn ground into *harinas* (flour and meals) used to make up these products in the American Southwest. Dent corns, both white and yellow, now dominate this market.

Although Pueblo tribes have historically grown many different colored corns, blue corn is one of the most important for both food and religious purposes. Its blue coloration comes from blue pigmentation found in the aleurone layer just below the pericarp.

Unlike most commercial hybrid dent corns that can yield 10,000–12,000 lb of grain per acre, blue corn is open-pollinated and characterized by relatively low yields of 1,000–4,000 lb per acre. It also tends to lodge (fall down), making it difficult to machine harvest.

Blue corn has a coarser, sweeter, and nuttier taste than other corns grown for flour or meal. Its grainier consistency results in a somewhat denser tortilla than those made from white or yellow corn flour.

In research conducted by the New Mexico Cooperative Extension Service, blue corn, like Opaque-2 corn, was found to be higher in lysine than either white or yellow dent corn varieties used in making tortillas. Most blue corn varieties were also found to be high in iron and zinc.

Blue corn flours and meals have traditionally been used in making tortillas and corn chips. Native American products less well known include *piki* or paper bread, *chaquegue* (similar to corn meal mush), *atole* (corn meal drink), and *nixtamal* (lime hominy used in making stews). Newer products include pancake and muffin mixes and corn flakes.

Ornamental Corn

Many Pueblo tribes planted at least six colors of corn: red, yellow, white, blue, black, and multicolored, with each color generally having a particular use or significance in their culture.

Today ornamental corns are normally used by florists or sold in grocery stores or roadside stands as an ornamental. Ears are picked before they dry; husks are normally pulled back and left attached to the ear. Ribbons can be wrapped around the husks or husks can be woven together into corn ristras. Ornamental corns can be dent, sweet, pop, flint, or floury endosperm types.

Pigmentation in ornamental corns can occur in three areas of the kernel: pericarp, aleurone layer, or the main body of the endosperm. Endosperm may be colorless, yellow, white, or orange-yellow. The aleurone layer may be red, yellow, brown, blue, or colorless.

The genetic makeup of the pericarp comes strictly from the female parent, thus the pericarp color of all kernels on a cob should be the same. Colors may range from colorless to variegated and from brown to purplish-red. The most familiar example is the red color associated with strawberry popcorn.

Corncob Corns

Some varieties of corn are grown for their cobs used in making corncob pipes. At best, cobs should be 1" diameter and long enough to make at least two bowls (2"). The diameter of the cob should be relatively uniform. Cobs should also be woody and sufficiently hard to keep smoking tobacco from burning through the bowl.

Corncobs are also an excellent source of furfural, a selective solvent used in the extraction of crude petroleum. Due to their hardiness and absorbency characteristics, granules made from the woody portion of corncobs are useful for blast-polishing and cleaning oil off castings. They are also useful as carriers for pesticides and fertilizers, while the pith has been used to clean up oil spills in water.

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