Considering its importance to consumers, flavor seems like it should be a high priority in potato breeding programs. However, it is typically not evaluated until late in the development of potential cultivars. For several reasons, it is difficult to breed for improved potato flavor. First, there is no high-throughput evaluation method for flavor, so it is not assessed in early generations of breeding programs, where most genetic variability is present. By analyzing flavor only in the advanced stages of a breeding program, breeders are not likely to make progress toward superior flavor. Second, an understanding of the biochemical basis of flavor is needed to allow breeders to carry out laboratory analyses in early generations. Some compounds have a large impact on flavor, so small changes may result in very noticeable, and perhaps not desirable, changes. That is, we cannot simply breed for higher levels of compounds. Instead, those compounds must fall within a desirable window. A third complication with breeding for flavor is that the optimum flavor goal is typically not known and is likely to be variable among consumer groups. Some people likely prefer bland flavor, while others would rather have a more complex flavor profile. If potato varieties were marketed by name and consumers were educated about the properties of each cultivar, then differences in flavor could be used as a marketing tool. Finally, taste thresholds vary considerably among panel members in sensory evaluations. The human genetic variation component of sensory analyses is not easily addressed.

The three major components of flavor are taste (due to nonvolatile compounds), aroma (due to volatile compounds) and texture (mouthfeel). All three components interact to produce a flavor response. Flavor is strongly influenced not only by potato variety, but also by production and storage environments. Although raw potatoes are bland, they contain flavor precursors, such as sugars, amino acids, RNA, and lipids. Cultivar, production environment and storage environment influence the levels of these compounds and the enzymes that react with them to produce flavor compounds. Cooking causes the biochemical changes that produce most of the important flavors in potato.

Human taste receptors monitor bitter, sour, sweet, salty, and umami (a Japanese word meaning delicious). Potato tubers contain compounds that stimulate all of these taste components except for salty. Bitterness can result from glycoalkaloids, while organic acids such as chlorogenic acid can produce a sour taste. Potato tubers also contain low levels of sugars, which may contribute directly or indirectly to flavor. Sweetness has historically been considered an undesirable flavor component in potatoes, but the consumption of sugars in the U.S. has increased dramatically in recent decades. Today’s consumers seem to prefer sweeter foods. In our flavor studies, we have found that sweetness of baked potatoes is positively correlated with desirable flavor.

Ribonucleotides act as precursors for umami compounds, which act as flavor enhancers. These flavor enhancers play a role similar to MSG in cooking. Although low in raw potatoes, relatively high levels of ribonucleotides are released by the breakdown of RNA as tubers are heated during cooking. A synergistic effect is detected when ribonucleotides interact with certain amino acids. These interactions are considered to be mainly responsible for boiled potato flavor.

Aroma compounds develop when tuber tissues are sliced and/or heated. Cooked potatoes produce hundreds of aroma compounds, which exhibit a wide range of concentrations and odor
thresholds. The most important aroma compounds are produced by the breakdown of lipids and by the Maillard reaction, the same process that produces dark colored fries and chips. Pyrazines produced by the Maillard reaction are considered to be among the most important and characteristic components of baked potato flavor.

During baking, a potato warms first at the surface, causing water to evaporate from the skin. Over time, a crust develops and the potato gradually warms from the outside toward the interior. In contrast to baked potatoes, water loss in boiled potatoes is minimal and the interior warms quickly but never exceeds 100°C. Boiled tubers contain higher levels of lipid breakdown products than do baked potatoes due to tissue damage caused by slicing. During microwave baking, the temperature of the potato increases relatively uniformly, with all parts reaching 100°C within a few minutes of each other. In contrast to oven baking, the skin remains cooler than the interior of the tuber, due to evaporative cooling. A crust does not develop, so the rate of water loss is higher. Microwave-baked potatoes have lower levels of volatile compounds than oven-baked or boiled potatoes, probably due to evaporative cooling at the tuber surface and the loss of volatile compounds that are carried away in evaporating water. Consequently, they tend to be less flavorful than boiled or baked potatoes, and they receive lower ratings in sensory analyses.

Pigments such as anthocyanins (red/purple) and carotenoids (yellow) are not thought to directly influence flavor. However, carotenoid breakdown products following cooking have been reported to contribute to flavor of sweet potato. These compounds have low odor thresholds (people can smell them at very low levels), so they have the ability to make significant contributions to aroma. Breeders are interested in creating high antioxidant clones for their increased nutritional value, but this may have a negative effect on flavor. Increasing the terpene biosynthetic pathway that leads to increased levels of carotenoids in sweet potatoes resulted in new flavors that consumers generally found disagreeable.

Texture is one of the most important quality attributes of potato tubers. It not only affects consumer preference, but it also influences the release of volatile flavor components during chewing. Texture is easily recognizable by consumers, who tend to have distinct preferences. Potato texture is a complex trait, controlled by many factors, including specific gravity, amylose content, and cell wall structure. Much variation can be described by determining the degree of a tuber’s mealiness or, at the opposite end of the spectrum, waxiness. A mealy potato is dry and granular, while a waxy potato is moist and gummy. Mealiness has been found to be associated with high dry matter content but other factors are important as well.

Another component of texture is the size and structure of starch grains in raw tuber tissue. Starch gelatinizes and swells during cooking. This creates pressure in cells as it expands. The proportion of each tuber cell occupied by gelatinized starch influences tuber moistness. Cells that are filled with gelatinized starch are associated with a mealy texture, while those with less starch and more loosely-held water produce a waxy texture. The loosely held water in the latter cell type is released upon chewing, producing a moist mouthfeel. The gelatinized starch in the mealy types retains water, creating a dry mouthfeel. Cell size has also been found to be associated with mealiness. Tubers given high mealiness scores by taste panelists were found to contain more starch and have larger cells than less mealy tubers.