The Importance of Maintaining Flavor Quality of Fresh Vegetables

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Although consumers often base their purchase decisions on external appearance (e.g., color, size, shape, and freedom from defects), texture, firmness, and aroma, high quality FLAVOR is arguably the most important factor leading to satisfied and repeat customers. However, while much work has been conducted optimizing and improving the shelf life of fresh vegetables on the basis of appearance and firmness, evaluation of shelf life in terms of flavor quality and flavor retention (flavor life) has been largely neglected until only recently. For example, flavor is not included in the USDA grade standards for any vegetable. One reason may be that flavor is difficult to measure. The balance of sugar to acid is known to be an important measurement related to flavor and is often used as an indication of maturity in fruits. However, while it is relatively easy to measure sugar and acid content of various commodities, the unique flavor of a commodity is really a complex interaction between these and hundreds of other non-volatile and volatile (i.e., aroma) compounds. These give rise to the overall perception of taste: aroma, sweetness, sourness, bitterness, astringency, pungency, hotness or burning, etc.

With increased research into flavor quality has come the confirmation that a vegetable’s flavor life is shorter than its appearance-based shelf life. Therefore, for satisfied repeat customers, fresh vegetables should be sold and consumed well before their appearance makes them unmarketable.

Much research is still needed to identify and understand the relationship between a particular commodity’s flavor quality and various pre- and postharvest factors. However, researchers already know that the following factors can influence flavor quality and quality retention of fresh vegetables.
Preharvest Factors:
While breeding programs have traditionally focused their efforts on developing commodities with greater disease resistance and yield, plus larger size and better color, they also have often inadvertently selected for varieties producing less abundant flavor and aroma compounds. As more is learned about the volatile and non-volatile components important for the flavor of a particular commodity, it is hoped that breeders will select for lines with better flavor. Even now, breeders are developing commodities that maintain firmness better and that can be harvested at a more mature, higher quality state while still surviving the rigors of transport and marketing.

Environmental conditions in the field can influence flavor. For example, exposure to high temperature increases respiration which often reduces acid content within vegetables. This in turn increases the sugar to acid ratio and may make the produce taste sweeter. However, too little acid may result in an insipid taste.

Soil fertility may also influence flavor. For example, because sulfur compounds are important contributors to onion flavor, sulfur fertility in the field can influence the resulting taste of onions after harvest. The higher the sulfur content, the more pungent the onions tend to become.

Of course one contributing factor of flavor that has long been known is maturity. For example, tomatoes harvested after ripening on the vine are usually sweeter, less sour, and do not contain off-flavors that may be detected in fruit that were harvested immature.

Postharvest Factors:
Ethylene exposure may cause both beneficial flavor changes (i.e., associated with ripening processes), or negative changes. For example, ethylene promotes ripening of cantaloupes and the release of aromatic compounds. However, ethylene also may cause off-flavor development in vegetables such as cabbage and sweetpotato, and leads to the development of bitterness in carrots due to induced isocoumarin production.

Mechanical injury promotes decay, water loss, and the production of secondary metabolites, many of which lead to the development of off-flavors.

Storage and shipping temperatures can have profound effects on vegetable flavor. Moderately high temperatures promote accelerated ripening and senescence, and may accelerate the development of off-flavors that were induced by other factors. Very high temperatures may prevent commodities from ripening properly, result in rapid loss of organic acids (again, causing insipid taste), and lead to the development of off-flavors (from fermentation). Conversely, storing commodities at chilling temperatures often substantially reduces the production of many important flavor and aroma compounds.

The use of controlled or modified atmospheres (CA or MA) may lead to the development of off-flavors if fermentative metabolism is induced. Off-flavors and aromas are often induced at oxygen levels of 0.25% to 2% and at carbon dioxide levels of 10% to 20%. However, commodities vary widely in their tolerance to elevated carbon dioxide levels, with some tolerating very little increase. Even without the induction of fermentation, use of CA or MA may reduce the production of aroma volatiles. In addition, even waxes, wraps, and other types of
coatings or packaging may restrict gas diffusion to such an extent that off-flavors develop. Therefore, when applying a coating, pay attention to type, thickness, and evenness of the coating to always maintain adequate gas diffusion. On the positive side, properly maintained CA or MA environments may reduce acidity loss, the conversion of starch to sugar, and the loss of ascorbic acid (vitamin C) and other vitamins.

So, remember to consider the taste of your product when estimating its shelf life; and also consider possible effects on flavor when making changes in your production and handling procedures.

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