Sweetcorn

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Scientific Name and Introduction: Sweetcorn (*Zea mays* L. var. rugosa Bonaf.) is an annual grass of the Poaceae (Grass) family. Traditional varieties are *su1* (*sugary1*) mutants that contain about twice the sugar (primarily sucrose) content of field corn, as well as 8- to 10-times higher water-soluble polysaccharide. The latter imparts a creamy consistency to *su1* sweetcorn. Other mutants with increased sugar content have more recently been used, primarily *sh2* (*shrunken 2*), which has at least double again the sugar content of *su1*, but almost no water-soluble polysaccharide. Less commonly used is *su1/se* (*sugary-enhancer*); *se* modifies *su1* to also double the sugar content, but with no loss of water-soluble polysaccharide content (Wann et al., 1997). The *sh2* mutation inhibits starch biosynthesis while *se* does not. These newer varieties are referred to as "supersweet" and have become the dominant type in all major U.S. sweetcorn production regions. The high initial sugar content, coupled with inhibited starch synthesis in *sh2* varieties, doubles the potential postharvest life of sweetcorn. However, all supersweet varieties remain extremely perishable.

Quality Characteristics and Criteria: High quality sweetcorn has uniform size and color (yellow, white or bicolor); sweet, plump, tender, well-developed kernels; fresh, tight, green husks; and is free from insect injury, mechanical damage, and decay. Sweetness is the most important factor in consumer satisfaction with sweetcorn (Evensen and Boyer, 1986). All sweetcorn varieties lose sweetness and aroma during storage, but the taste of *su1* and *su1/se* varieties becomes starchy while *sh2* eventually taste watery and bland.

Horticultural Maturity Indices: Sweetcorn harvest maturity is determined by a combination of ear fill, silk drying, kernel development, kernel sweetness, and kernel tenderness. The appearance of the juice, or endosperm, is a good indicator of maturity for *su1* and *se* varieties, where a milky (not watery or doughy) consistency represents proper maturity, but not for *sh2* varieties, which always have a watery endosperm.

Grades, Sizes and Packaging: Grades include U.S. Fancy; U.S. Fancy, Husked; U.S. No. 1; U.S. No. 1, Husked; and U.S. No. 2. Grades are based primarily on maturity, freshness, and cob length, as well as freedom from various injuries and decay. Sweetcorn is commonly handled in wire-bound wooden crates, and less commonly in waxed fiberboard cartons, or returnable plastic containers. All contain 54 to 60 ears with a weight of about 19 kg (42 lb). Some is pre-packaged in polyvinylchloride (PVC) film-overwrapped trays (Aharoni et al., 1996; Risse and McDonald, 1990), with the ends of ears trimmed and husks partially removed to expose some kernels. PVC film is highly permeable to O_2 and CO_2 and acts as a moisture barrier.

Pre-cooling Conditions: Sweetcorn is often > 30 °C (86 °F) when harvested, and rapid removal of field heat is critical to retard deterioration. Maximum quality is retained by pre-cooling corn to 0 °C (32 °F) within 1 h of harvest and holding it at 0 °C (32 °F) during marketing. In practice, cooling to this extent is rarely achieved. However, cooling is the first step in a good temperature management program. Sweetcorn has a high respiration rate, which results in a high rate of heat generation. Supersweet varieties have respiration rates equal to that of traditional sweetcorn varieties and lose sugar as rapidly (Evensen and Boyer, 1986; Olsen et al., 1991), so cooling is still critical with these newer varieties. Sweetcorn should not be handled in bulk unless copiously iced, because it tends to heat throughout the pile.

Vacuum-cooling can adequately pre-cool sweetcorn, but it must be first wetted (and top-iced after cooling) to minimize water loss from husks and kernels (Showalter, 1957; Stewart and Barger, 1960). Crated sweetcorn can be vacuum-cooled from about 30 °C (86 °F) to 5 °C (41 °F) in 30 min. Hydro-cooling by spraying, showering, or immersion in water at 0 to 3 °C (32 to 37.5 °F) is effective, although it takes

longer than vacuum-cooling if the sweetcorn is packed. Bulk sweetcorn takes about 60 min to cool from 30 to 5 °C (86 to 41 °F) in a well-managed hydro-cooler, while crated sweetcorn takes about 80 min (Talbot et al., 1991), and few if any operators leave it in that long. Periodic monitoring of sweetcorn temperature is needed to ensure proper cooling to at least 10 °C (50 °F). Hydro-cooling nomographs for bulk and crated sweetcorn are available (Stewart and Couey, 1963).

After hydro-cooling, top-icing is desirable during transport or holding to continue cooling, remove the heat of respiration, and keep the husks fresh. When pre-cooling facilities are not available, sweetcorn can be cooled with package ice and top-ice. Injection of an ice-water slurry (slush ice) into cartons was as effective as hydro-cooling and better than vacuum-cooling in maintaining quality (Talbot et al., 1991), probably due to residual ice in the cartons since the cooling rate was slower than for the other methods.

Optimum Storage Conditions: Traditional sweetcorn varieties are seldom stored for more than a few days, because of the resulting serious deterioration and loss of tenderness and sweetness. The loss of sugar is about 4-fold as rapid at 10 °C (50 °F) as at 0 °C (32 °F). At 30 °C (86 °F), 60% of the sugar in *su1* sweetcorn can be converted to starch in a single day, while only 6% is converted at 0 °C (32 °F). While *sh2* varieties lose sugar at the same rate as *su1* varieties, their higher initial sugar levels keep it sweet-tasting longer. For *sh2* varieties, water loss and pericarp toughening supplant loss of sweetness in limiting postharvest life (Brecht et al., 1990). The former is minimized by prompt cooling, trimming flag leaves and long shanks, and maintaining high RH, usually by icing. Denting of kernels is promoted by water loss from husk leaves (Showalter, 1967). A loss of 2% moisture may result in objectionable kernel denting. Pericarp toughening can also be minimized by prompt cooling and by maintaining sweetcorn at 0 °C (32 °F). Under optimum storage conditions, the potential postharvest life of *sh2* sweetcorn is > 2 weeks.

Controlled Atmosphere (CA) Considerations: Increased attention for CA and MAP was spurred by an interest in marine transport to export sweetcorn from the U.S. to Europe and the Far East, which can involve transit times > 2 weeks. Injurious atmospheres at 1.7 °C (35 °F) contain < 2% O_2 or > 15% CO_2 (Spalding et al., 1978), resulting in fermentation, off-flavors and odors. Reduced O_2 and elevated CO_2 reduce respiration and slow sucrose loss; elevated CO_2 also reduces decay and maintains green husk color (Aharoni et al., 1996; Schouten, 1993; Spalding et al., 1978).

Retail Outlet Display Considerations: Display in refrigerated cases or with ice.

Chilling Sensitivity: Sweetcorn is not chilling sensitive; store as cold as possible without freezing.

Ethylene Production and Sensitivity: Sweetcorn produces only trace ethylene, and exogenous ethylene is not a problem, although high ethylene amounts can lead to husk yellowing given sufficient exposure time.

Respiration Rates:

Temperature	mg CO_2 kg^{-1} h^{-1}
0 °C	30 to 51
5 °C	43 to 83
10 °C	90 to 120
15 °C	142 to 175
20 °C	210 to 311
25 °C	282 to 435

To get mL kg^{-1} h^{-1}, divide the mg kg^{-1} h^{-1} rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg kg^{-1} h^{-1} by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day. Data are from Robinson (1975), Scholz et al. (1963), and Tewfik and Scott (1954).

Physiological Disorders: There are no significant disorders.

Postharvest Pathology: Decay is not usually a serious problem, but when present, it typically occurs on the husk and silks. Trimming ears can promote decay development on the cut kernels and other damaged tissues mainly caused by *Alternaria alternata* (Fr.) Keissler, *Fusarium moniliforme* Sheldon, and *Mucor hiemalis* Wehmer (Aharoni et al., 1996). Thus, proper sanitation and temperature management are important to minimize decay in trimmed sweetcorn.

Quarantine Issues: None.

Suitability as Fresh-cut Product: Fresh-cut sweetcorn kernels are extremely perishable. Their respiration rate is very high; several times that of intact ears. Thus, temperature control is extremely critical if the kernels are to have acceptable shelf-life. Problems during handling can include off flavors, microbial survival/growth, and discoloration if the temperature is not maintained near 0 °C (32 °F). Especially troublesome is browning when the kernels are cooked. This browning is greater in kernels from more mature ears and is correlated with temperature, storage duration, and extent of physical damage.

Special Considerations: None.

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