Strawberry

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Scientific Name and Introduction

Strawberry, *Fragaria* × *ananassa,* is a perennial of the Rosaceae family. The edible portion, not a true berry, is a multiple fruit comprised of many achenes (seeds) and receptacle tissue. Fruit are produced on short-day and day-neutral plants in many growing areas. However, the major production in the United States is in California, Oregon, and Florida.

Quality Characteristics and Criteria

A high-quality strawberry is uniformly red, firm, flavorful, and free of defects and disease. Sugar content does not increase after harvest; therefore, harvest when fully ripe for best flavor. For acceptable flavor, a minimum SSC of 7% and a maximum TA of 0.8% are recommended (Kader 1999).

Horticultural Maturity Indices

Maturity is based on surface color. The U.S. minimum is half or three-fourths of the berry's surface showing red or pink color, depending on grade. The California minimum is two-thirds of the berry's surface showing red or pink.

Grades, Sizes, and Packaging

U.S. No. 1 grade consists of strawberries with calyx (cap) attached which are firm, not overripe or undeveloped, of uniform size, and free of decay and damage. Each fruit must have at least three-fourths of its surface showing pink or red color. U.S. No. 2 grade consists of strawberries free from decay or serious damage and with at least half of each fruit showing pink or red color. U.S. Combination grade is a mixture of U.S. No. 1 and 2, with at least 80% meeting U.S. No. 1 grade. Strawberries are often packaged by pickers in the field either into open-mesh baskets or into clear clamshell containers of 1 dry pint or 1 dry quart capacity. The mesh baskets or clamshells are held in a corrugated fiberboard tray holding about 4 to 5 kg (9 to 11 lb).

Precooling Conditions

Strawberries are extremely perishable, and it is important to begin cooling within 1 h of harvest to avoid loss of quality and reduction in amount of marketable fruit (Maxie et al. 1959). Temperature management is the single most important factor in minimizing strawberry deterioration and maximizing postharvest life. Forced-air cooling is highly recommended, though room-cooling is used in some cases (Mitchell et al. 1996).

Optimum Storage Conditions

Store at 0 °C (32 °F) with 90 to 95% RH. Strawberry fruit can be stored for up to 7 days at 0 °C

(32 °F), depending on disease pressure.

Controlled Atmosphere (CA) Considerations

MAP for shipment with 10 to 15% CO_2 reduces growth of *Botrytis cinerea* (Wells and Uota 1970) and reduces respiration rate (Li and Kader 1989), thereby extending postharvest life. Use of whole pallet covers for MA is the most common method (Mitchell et al. 1996). Off flavors can develop if higher levels of CO_2 are used.

Retail Outlet Display Considerations

Refrigerated display greatly extends shelf-life and maintains quality. Covered baskets maintain higher RH around berries, reducing water loss and shrivel.

Chilling Sensitivity

Strawberry fruit are not sensitive to chilling and should be stored as cold as possible without freezing.

Ethylene Production and Sensitivity

Strawberries produce very low amounts of ethylene: <0.1 µL kg^{-1} h^{-1} at 20 °C (68 °F). They do not respond to ethylene (Mason and Jarvis 1970). Removal of ethylene from storage air may reduce disease development (El-Kazzaz et al. 1983).

Respiration Rates

Temperature	mg CO_2 kg^{-1} h^{-1}
0 °C	12 to 20
10 °C	50 to 100
20 °C	100 to 200

To get mL CO_2 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 $tonne^{-1}$ day^{-1}.

Physiological Disorders

Perhaps because of rapid marketing and very short storage, few physiological disorders occur after harvest. CO_2 injury, particularly when >15% CO_2 is used, is manifested as a bluing of the skin (Ke et al. 1991), whitening of inner fruit tissues (Gil et al. 1997), and fermentative off flavors.

Postharvest Pathology

Disease is the greatest cause of postharvest loss. The most common decay is botrytis rot, also

called gray mold, caused by *Botrytis cinerea* (Ceponis et al. 1987). This disease can begin preharvest, remaining as a latent infection; or it can begin postharvest. The fungus continues to grow at 0 °C (32 °F), but growth is slow at this temperature. Rhizopus rot, caused by *Rhizopus stolonifer,* is another important disease of strawberry. This fungus cannot grow at temperatures <5 °C (41 °F). Postharvest fungicides are not used on strawberries; therefore, prompt cooling, storing at 0 °C (32 °F), preventing injury, and shipping at 0 °C (32 °F) under high CO_2 are the best methods for disease control. Damaged fruit should be eliminated from baskets to prevent spread of the disease to healthy berries (nesting) (Sommer et al. 1973).

Quarantine Issues

Methyl bromide fumigation is routinely used for strawberries shipped from the United States to Japan and Australia to eliminate live insects. For California, two-spotted spider mites and western flower thrips are the main pests of quarantine concern in exported fruit.

Suitability as Fresh-Cut Product

Strawberries are suitable, and slices have a shelf-life of about 7 days at 2.5 °C (37 °F) and 5 days at 5 °C (41 °F) (Rosen and Kader 1989, Wright and Kader 1997).

Special Considerations

Strawberry fruit are very delicate and easily damaged. Since the harvest crew is responsible for grading, packing, and gentle handling, their training is critical to packing a quality product.

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