

Quality Assurance for Strawberries: A Case Study

by Beth Mitcham

The two most important factors for quality assurance of strawberries are temperature and rapid marketing. Fresh strawberries are one of the most popular items in the produce case; however, strawberries are also one of the most perishable of fresh commodities. The berries are very fragile and susceptible to mechanical injury, their thin skin results in rapid loss of water in low humidity environments and strawberries have one of the highest respiration rates of all fresh commodities. For these reasons, establishment of a successful quality assurance program is essential to a profitable marketing program for strawberries.

Will quality assurance cost me money? Actually, quality assurance should save you money. Estimates of losses at wholesale, retail and consumer levels range from 28 to 41% with 9 to 11% at the wholesale and retail levels. The major cause of loss was grey mold which was associated with bruising and soft or leaky berries. If a shipper sells 100,000 strawberry trays per month at \$6.50 per tray and was able to cut product losses by 3% (from 7% to 4%) by implementing a successful quality assurance program, he would save \$19,500 per month or \$234,000 per year. Assuming extra costs are incurred with a quality assurance program of \$60,000/year associated with salaries and \$8,000/year, associated with equipment and supplies, the net increase would be \$166,000. Quality assurance can really pay for itself and also improve product quality to the customer.

What are the quality factors for strawberries? The factors which are important for strawberry quality include:

- degree of ripeness, generally judged by percentage of pink or red color
- gloss, an indication of freshness and absence of water loss
- absence of defects such as decay, bruising, and shriveling
- flavor, determined by sugars, acidity and flavor volatiles (see Table 1)



- berry size and uniformity
- firmness, absence of soft, overripe or leaky berries
- price and availability

Table 1. Influence of relative levels of sugars and acids on strawberry flavor.*

Sugar	Acid	Flavor Quality
high	high	good
high	low	bland
low	high	tart
low	low	tasteless

*Volatile compounds also play an important role in fruit flavor.

Determining quality specifications. The first step in setting up a quality assurance program is to determine the company's criteria for quality for the product. What do your customers want? Are they more concerned with price and availability than quality? Is ripeness and flavor important or is appearance most important? There may be different quality factors for different types of customers. Once the critical quality factors are determined, develop objective means to measure those quality factors. Keeping records of quality-related factors can allow evaluation of company performance and assist in management decisions regarding quality assurance.

Varieties and ripeness at harvest. Quality assurance for strawberries begins in the field with variety selection. Strawberry varieties vary greatly in berry firmness when ripe, sugar and acid content, disease susceptibility, and yield. Selection of the varieties to grow can have a tremendous impact on potential fruit quality. Fruit with better flavor may have lower yields or less disease resistance. Management must determine which varieties will be grown and at which stage of ripeness fruit will be harvested to best meet their goals for fruit quality. Strawberry fruit do not continue to ripen after harvest and will not increase in sugar content. Therefore, riper fruit will have higher sugar content and better flavor quality. Several commodity groups have found that a percentage of customers will pay more for riper fruit with higher sugar content (soluble solids content). To supply consistent flavor quality to these customers, soluble solids content (SSC) should be monitored to

ensure a minimum SSC is reached. A minimum of 7% SSC is recommended for strawberry and 10% would be excellent. The level of ripeness should be monitored in harvested trays to check picker performance.

Cultural practices affect quality. Cultural practices and preharvest disease control can have a tremendous influence on postharvest quality and storage life. Because postharvest fungicides are not used on strawberries, preharvest disease control is very important. Low light intensity has been associated with lower levels of ascorbic acid, red color and SSC. High nitrogen fertilization has been associated with softer fruit, lower SSC and less flavor.

Avoiding berry injury and diseased fruit. Careful handling and sorting during harvest to prevent berry injury and avoid placing injured or diseased berries in the tray is needed. Training and supervision is critical. Harvesters should be given an incentive to harvest with care. Monitoring of harvested trays for the presence of defects provides critical information to crew supervisors to give them the tools necessary to improve overall harvested quality.

Rapid cooling and prompt marketing are critical. After harvest, the most critical factors to monitor for strawberry quality maintenance are pulp temperatures and time delays in the system. The faster the fruit are cooled and the closer the pulp temperature is maintained to 0°C (32°F), the higher the fruit quality and the longer the shelf life. Low temperatures slow fruit softening and slow growth of decay-causing pathogens.

The time between harvest and cooling of the berries is critical for quality and shelf life. A record of harvest time and picker number should be kept with each tray harvested. The elapsed time from harvest to cooler should be recorded along with fruit pulp temperatures. A management decision must be made regarding the acceptable time from harvest to cooler. Less than a one hour delay is recommended to avoid losses in strawberry quality and postharvest life. An investment in additional small trucks and drivers may be necessary to ensure more frequent trips to the cooler.

Cooling of berries. Upon arrival at the cooling facility, pallets should be transported immediately to the forced-air cooler. Cooler temperature should be maintained at -1 to 0°C (30 to 32°F) and 90 to 95% relative humidity. Fruit should be cooled to 0 to 1°C (32 to 34°F) before movement to the cold storage room. Separate cooler

and cold storage rooms can allow for more efficient cooling. If the refrigeration system cannot keep cooler air temperatures near 0°C (32°F), additional refrigeration capability may be necessary, requiring a capital investment in quality. Cooler air temperature and pulp temperatures of the warmest berries upon removal from the cooler should be monitored regularly. Cold storage air temperatures should also be monitored and records maintained.

Management of shipping temperatures. Management must also determine the temperature at which fruit will be allowed to be shipped. It is highly recommended to cool berries to 0°C (32°F) before shipment, especially if pallet covers and modified atmosphere (MA) are to be used. Transport vehicles do not have the capability to cool product but only have the capability to maintain product temperature. This is a critical area where commitment to quality must be balanced with market demands and volume flow. Shipping strawberries across country at temperatures warmer than 0°C (32°F) will greatly reduce fruit quality and shelf-life. See Figure 1 for a sample Wholesale Shipping Checklist.

Truck loading. Careful attention to the transport vehicle at product loading is essential. Trucks should be cooled to near 0°C (32°F) prior to product loading. The condition of the insulation, doors, refrigeration system and air delivery shoot should be checked on each load. Strawberries should be center loaded, to prevent warming or freezing of product during transit, and well secured. If the truck condition fails to meet the criteria established to maintain fruit quality during shipment, the buyer should be notified that the seller cannot guarantee the arrival condition of the fruit due to truck conditions.

Wholesale and Retail Quality Assurance

Incoming product should be inspected immediately for pulp temperature. If berries are warmer than 4°C (39°F), fruit quality would be benefited by forced-air cooling. A small, portable forced-air cooler can be used in the cold room to recool strawberries which have warmed during transit. Alternatively, pallets or trays can be spread in the cold room to facilitate rapid cooling. Cooler temperature should be maintained at 0°C (32°F) with 90 to 95% relative humidity. The condition of the transport vehicle should also be checked, including incoming air temperature. If MA pallet bags are present, they should be checked for arrival condition and then removed to allow for product

recooling. After product has been transferred to the cooler, an inspection of berry condition should be conducted. Fruit should be evaluated for color, firmness, gloss, shrivel and decay. If decay is discovered, trays should be repacked as quickly as possible avoiding excessive warming of the fruit during this period. The temperature of outgoing product and the condition of delivery vehicles should also be carefully monitored, as described previously for shippers.

Discarding inferior product. One of the most important quality assurance decisions that management must make is to determine the minimum level of quality at which product will continue to be marketed. The difficult decision to discard inferior quality product, especially when additional product is unavailable and demand is high, requires a firm commitment to quality. The causes of product losses should be recorded as this information can be useful for management decisions to improve product quality. The length of time product is held in the cooler should also be recorded.

At the retail level, strawberries should be displayed in refrigerated cases or returned to the cold storage room at night. If relative humidity in this room is lower than 85%, placing clean, plastic film over the strawberry trays may help to reduce water loss by creating a humid environment around the trays.

Further Reading

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Figure 1. Sample Strawberry Checklists are available*

Strawberry Receiving at Cooler

Strawberry Shipment Checkpoints

Wholesale/Retail Incoming Product Checklist

Wholesale Shipping Checklist

Date _____ Ship to _____

Transport Company _____ Driver _____

Description	Sample 1	Sample 2	Sample 3	Average
Days in Cooler				
Average Color ^{1/}				
% Decayed Berries				
% Soft Berries				
Outgoing Pulp Temperature	°F	°F	°F	°F
Truck Temperature at Loading	°F	°F	°F	°F
Truck Condition				
Refrigeration Air Delivery System				

1/ Color: 1/2 red, 3/4 pink, 2/3 pink or red, etc.

Comments/Action _____

Inspected by: _____

* These Sample Strawberry Checklist Forms are available from Pam Moyer, Postharvest Outreach Program, University of California, Davis, CA 95616 or Fax 916 752-8502, 4 pages.