OBSERVATIONS ON CONDITION OF FLORIDA VEGETABLES IN NEW ENGLAND AND CHICAGO MARKETS, 1987 AND 1988

JEFFREY K. BRECHT AND STEVEN A. SARGENT
University of Florida, IFAS
Vegetable Crops Department
Gainesville, Florida 32611

WAYNE CRAIN
Florida Fruit and Vegetable Association
4401 E. Colonial Drive
Orlando, Florida 32814-0155

Abstract. Two trips were made to Northern market areas to observe Florida vegetables and to interview supermarket chain warehouse managers and produce buyers. The first trip in 1987 was to Boston area markets including Rhode Island and southern Maine. The second trip in 1988 was to Chicago area markets. As a result of these trips it was concluded that a major education effort is called for in the areas of postharvest handling technology and postharvest physiology. This effort should be directed at both shippers and receivers in order to modernize and improve the handling of Florida vegetables. Some areas identified include proper and thorough precooling, avoidance of mechanical injuries during harvest, handling and packing, use of proper shipping containers with adequate labelling, and palletization of shipments. Other areas in need of attention are storage and distribution of vegetables at proper temperatures with regard to chilling injury, and intelligent use of ice and humidity control systems in produce warehouses. It is apparent that in many cases the quality of Florida vegetables is being impaired by improper handling practices on the part of both of shippers and receivers. Efforts to improve the postharvest handling of Florida vegetables should result in expansion of the market for the state’s products and improved quality for consumers.

Meetings between IFAS postharvest personnel and representatives of the Florida Fruit and Vegetable Association (FFVA) were begun in 1986. The purposes of these meetings are: 1) to assist IFAS postharvest research and extension personnel in identifying priority industry problems and developing solutions to those problems and 2) facilitate communication between the IFAS postharvest group and the Florida vegetable industry. It was recognized that development of first-hand knowledge by the IFAS group of the condition of Florida vegetables in Northern markets was a necessary antecedent to the achievement of these objectives. Thus, in 1987 and 1988 trips were made to New England and Chicago where we observed vegetables from the state, talked to produce buyers and warehouse managers, and tried to identify problems and potential problems occurring within the postharvest handling chain. The produce warehouse/distribution facilities of five New England area grocery and supermarket chains were visited in April of 1987 and three Chicago area operations were visited in April of 1988. Two market development representatives from the Division of Marketing, Florida Department of Agriculture and Consumer Services arranged the trip itineraries and guided us on these trips: Don Combs in New England and Linda Lacey-Kozlowski in Chicago.

We recognize that the problems encountered during the course of short trips to market areas do not necessarily represent major or even common problems over an entire season or over many seasons. Similarly, problems observed in specific shipments do not necessarily reflect poorly on the particular shipper’s season-long operation. The most important sources of information on our trips were conversations with directors of produce, produce buyers, warehouse managers and produce inspectors. Their comments on produce quality, comparisons with produce from competing growing areas, market potential of certain specialty crops, etc., coupled with our observations of produce arrival condition and handling practices allow us to make what we consider to be valid assessments concerning Florida vegetables in these markets. Additionally, we will discuss produce packaging, warehouse facilities and produce handling practices observed on these trips.

Commodities

Lettuce, celery and other leaf crops. Virtually all of the iceberg lettuce and celery at the operations we visited was from California. The small size of the Florida industry relative to California affects buying decisions due to the availability of steady supplies over a long season from California shippers. The presence of soil on muck-grown lettuce and celery from Florida was commonly cited as the number one quality problem with Florida product. Bulk harvesting of these crops with trimming and washing operations performed in the packinghouse may be worth considering to address this concern. Occasional problems with decay, wilting, browning and russet spotting were reported, probably indicative of cases of poor temperature management and ethylene exposure.

Other leaf crops, including escarole, endive, parsley, cabbage, Chinese cabbage, and Boston and romaine lettuce, were also observed. The amount and variety of leaf crops from Florida were much less in Chicago than in New England. Quality of these commodities was generally good but problems with wilting and mechanical injury were common. Many of these types of vegetables benefit from top and package icing to counteract poor temperature and humidity control in transit and storage. Unfortunately, our observations indicated that product from Florida was less likely to have ice in evidence than product from California and Georgia where most of the other examples of leaf crops originated. Mechanical damage was caused by overpacking of shipping cartons. The wirebound crates commonly used for this group of commodities appeared to be especially damaging in this regard. Whenever any packages are overpacked, the product bears the weight of the load instead of the package, causing unnecessary mechanical damage to the product from compression and, in the case of the wirebounds, cutting and gouging by sharp edges.

Sweet corn. The virtual wholesale switch by Florida sweet corn growers to high sugar varieties (supersweet, shrun-
The quality of the sweet corn observed in New England and Chicago was variable but generally good. Mechanical injury from overfilled wirebound crates and water loss evidenced by wilted husk leaves were all too common. Although routinely top-iced in Florida, no evidence of residual ice was seen in any of the lots of sweet corn we observed except for a very few cases in which a small amount of ice was added to the top of the pallet in the destination warehouse. Examples of sweet corn from California shipped in waxed, corrugated cartons with residual package ice from slush ice application was seen in 1987. At least one Florida shipper has begun using this procedure. The system ensures thorough cooling and eliminates water loss since the sweet corn is encased within the carton in crushed ice. The produce films used for tray packs of sweet corn should also effectively control water loss.

A complaint commonly heard among sweet corn buyers in both New England and Chicago was lack of uniform count within packages. Some effort at standardization in this regard is probably warranted. However, the problem is probably one most suitably addressed by cultural practices and cultivar selection which result in more uniform ear size.

There was some suggestion that improper handling of the supersweet corn might be occurring because of a perception that these cultivars are less perishable than standard cultivars of sweet corn. While sugar levels remain high in the supersweets compared to traditional cultivars of sweet corn, water loss and pericarp toughening remain as significant postharvest problems. These processes are strikingly affected by precooling, storage temperature and humidity control. Lack of concern for these factors results in sweet corn which is relatively sweet, yet tough and mushy and on the whole undesirable. Development of negative perceptions of supersweet sweet corn by consumers due to improper handling is a potential occurrence that should be of concern to sweet corn growers, shippers and buyers.

Cucumber, eggplant, pepper, and squash. Florida appeared to be the major supplier of this group of commodities at the time of our trips in both New England and Chicago. Some product from Mexico and California was in evidence in New England but very little from these growing areas was seen in Chicago. Three main areas of concern regarding this group of commodities are mechanical injury, nonuniformity of size within cartons and improper storage temperatures.

While some examples of mechanical injury could be found in all of the commodities in this group, the main problem encountered on our trips was bruising and actual cracking of the shoulders of the largest sizes of bell peppers. This damage may be occurring during dumping into field bins, on the packingline wherever drops and turns occur, and during the carton closing operation. This type of damage is cumulative and the appearance of individual points of injury deteriorates with time due to brownning, water loss and decay. It was apparent from the lack of this type of damage on the small size peppers that the geometry and structural integrity of large pepper fruit predisposes them to injury. Packinglines must be designed and other procedures tailored for the most susceptible fruit in order for this injury to be curtailed.

Nonuniformity of size relates to the count of items per carton. Improvements in sizing efficiency are no doubt possible for this group of commodities. Poor size uniformity, while a common complaint of those we spoke with, was generally not evident to us in the lots that we examined.

A somewhat puzzling problem related to this group of vegetables was storage at chilling temperatures in the warehouses. The handlers we visited almost universally believe from their experience that these commodities hold best at 35 to 40°F. Recommended storage temperatures are actually 50 to 55°, 46 to 54°, 45 to 55°, and 41 to 50°F for cucumbers, eggplants, peppers and squash, respectively (1). Pulp temperatures of 44°F down to 34°F were measured in peppers and cucumbers in some of the warehouses. Coupled with lack of humidity control, these temperatures were resulting in development of chilling injury symptoms that were evident in the warehouses. Most of the time these commodities are over-wrapped with PVC film and displayed in refrigerated display cases at retail. It is possible that the lack of rewarmin control of water loss obtained with this retail handling system retards the onset of chilling injury symptom development. Problems encountered by these operators when holding cucumbers, eggplants, peppers and squash at higher temperatures in the past could have been due to ethylene exposure in mixed loads (as these commodities are commonly shipped) and to more rapid development of decay on injury sites. The solution to this dilemma would require elimination of mechanical injury, prompt and thorough precooling, and maintenance of optimum storage temperatures in order to eliminate chilling injury without creating other quality problems.

Specialty packs of colored bell peppers, assorted types of chili peppers, and fresh pickling cucumbers were much more common in Chicago in 1988 than in New England in 1987. Whether this difference reflects market preferences or consumption trends over time we don't know. Most of the colored peppers were of Dutch origin, packed in extremely bright, eye-catching cartons and of generally excellent appearance.

Tomatoes. Florida tomatoes were high volume items during our trips to Chicago and New England. Some Mexican tomatoes were seen in both market areas, but more were seen in Chicago. Mature-green tomatoes are subject to three main quality problems: chilling injury, decay and immaturity. The Florida Tomato Exchange has addressed the first problem for years via educational materials with the message "don't refrigerate tomatoes". Although the operations that we visited all appeared to be doing good jobs with tomatoes in terms of temperature management,
we did encounter two shipments with symptoms of chilling injury. One of these was on the warehouse receiving dock. Education efforts should be aimed at all segments of the industry plus consumers.

A few samples of tomatoes with soft rot and rhizopus rot were seen. This type of decay suggests poor sanitation and/or dump tank management problems were responsible.

When we travelled to New England in 1987 the 7x7 size tomatoes had only recently been eliminated by the Florida industry. Elimination of this smallest size class has gone a long way toward reducing the incidence of immature tomatoes. The major problem that we saw now occurs at the retail level where ripe tomatoes are sorted out to be placed on display while the remainder are held until ripe or thrown away only when decayed. The least ripe (immature) tomatoes on arrival apparently are put on display and sold no matter how long they take to ripen. Growers should schedule harvests of each field as often as practicable in order to improve uniformity of maturity and retailers should discard fruit that take excessively long times to ripen. This is at least as important as avoiding chilling injury to ensure high quality tomatoes.

Miscellaneous. Several specialty items were seen on these trips which Florida could potentially enter the market with or increase its market share. For example, the amount and variety of mushrooms which are common items in New England and Chicago area markets are striking. Also, a number of tropical vegetables such as chayote, bitter melon, malanga, etc. which are produced in Florida were being purchased mainly from Mexico and Central America. Similarly, watermelons from Mexico, including small fruited types, were observed. Various examples of semi-processed salad vegetables were seen. Most of these were prepared locally or in the individual stores, but at least one example was seen of precut cauliflower florets from California in plastic bags with package ice. Florida producers should investigate the market for these commodities and products.

Packaging

Certain commodities from Florida such as tomatoes, citrus and avocados which are regulated by marketing orders are subject to regulations stipulating that containers be marked to indicate the kind of produce, net weight, count, or volume. In addition, the name and address of the grower or shipper should be plainly marked on the container. However, we encountered many examples of other types of Florida produce (often, by necessity, identified by the buyer or warehouse manager as having come from Florida) with absolutely no indication of its origin or contents. This was especially true of cucumbers, eggplants, peppers and squash, and any commodity in wire-bound crates. Generic vegetable cartons with space to stamp a name and address (often blank) or check off a grade or size (usually used) were common. The impression made by produce packaged in this way is decidedly second rate. Tomatoes and citrus from Florida were uniformly well identified in comparison to most other Florida produce. Lack of product identification is frustrating to warehouse managers and personnel whose jobs are complicated by it.

Package design is also of concern to produce buyers. Since all packages eventually end up on 40 X 48" pallets, they should at least be made to the proper dimensions to fit those pallets. Packages which hang over the pallet edge when stacked are likely to collapse even if well made. Marginal packages are sure to fail. Packages for certain commodities are so weak that the product itself must bear the load of upper layers. These are the commodities that are commonly "bulge-packed" such as lettuce. Thus, money saved on cheap cartons is offset by losses due to product damage.

Most of the corrugated cartons in use appear to have inadequate ventilation for good air circulation. While 5% vent space area is a good rule of thumb for corrugated containers, increasing the vent space requires stronger, more expensive material. Wirebound crates afford excellent air circulation and are very strong when properly closed. However, when overfilled or incorrectly stacked they cause serious mechanical damage to the product. The restacking of unpalletized shipments of products in wire-bound crates onto pallets for warehouse movement seemed to cause one or more crates per pallet to burst open. This, combined with the resultant shifting of the pallet stack seemed to be a serious source of mechanical damage.

Facilities

The best combination of practicality and attention to commodity requirements would probably require that produce handled at a distribution warehouse be held in three separate rooms (2): a warm room set at 50°F for chilling-sensitive fruits and vegetables (tomatoes, peppers, cucumbers, tropical fruits and vegetables, etc.); a wet cold storage room set at 32°F for commodities which tolerate direct contact with water or ice (sweet corn, cabbage, green leafy vegetables, celery etc.); and a dry cold storage room set at 32°F for those commodities which cannot tolerate direct contact with water (lettuce, strawberries, mushrooms, etc.). In addition, ripening rooms used for bananas can also be used for ethylene treatment of tomatoes, avocados and honeymelons. All rooms should maintain ambient relative humidity at 90% or above with mist systems to avoid water loss and wilting. If ice is applied generously in and around the cartons of those vegetables requiring wet conditions, and if care is taken to avoid melting ice coming in contact with commodities which don't tolerate surface moisture, then there may be no need for separate wet and dry 32°F rooms. Operations which use a "compromise" of 40 to 45°F for all their produce are not doing an adequate job for most of their items.

Temperature and humidity control was a problem at most of the operations we visited. Measured temperatures were often different from the reported set temperature (Table 1). Since the set temperatures were often not properly chosen, the variation could be beneficial or detrimental but was on the whole somewhat chaotic. Only two of the eight operations visited had any kind of misting system in their produce warehouses. The two operations using supplemental ice did so only sparingly.

Besides poor temperature management in general, there were numerous cases of commodities being held at improper temperatures. Most often this involved storage of chilling sensitive crops at chilling temperatures as mentioned in a previous section. In no case were the large number of commodities requiring 32°F storage for op-


Table 1. Temperatures in produce distribution warehouses.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Room type</th>
<th>Temperature (°F)</th>
<th>measured</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>Wet cold</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Dry cold</td>
<td>40</td>
<td>35</td>
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<tr>
<td></td>
<td>Warm</td>
<td>55</td>
<td>52</td>
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<tr>
<td>B</td>
<td>Cold</td>
<td>38</td>
<td>35</td>
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<tr>
<td></td>
<td>Warm</td>
<td>55</td>
<td>55</td>
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<tr>
<td></td>
<td>Cold</td>
<td>39</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Warm</td>
<td>50</td>
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<td>D</td>
<td>Cold</td>
<td>38</td>
<td>46</td>
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<tr>
<td>E</td>
<td>Cold</td>
<td>38</td>
<td>42</td>
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<td>F</td>
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<td>Warm</td>
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<tr>
<td>G</td>
<td>Wet cold</td>
<td>34</td>
<td>34</td>
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<tr>
<td></td>
<td>Combination</td>
<td>36-55</td>
<td>35-51</td>
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<tr>
<td>H</td>
<td>Cold</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Pepper/cuke</td>
<td>46</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Warm</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

*Misters used to maintain high relative humidity.

*Some ice added to commodities in the warehouse.

During transit. While this allows them to determine if the truck's refrigeration system was in working order, it does not let them know if the product was at the proper temperature when loaded, heated up or cooled down in transit. While pulp temperatures are taken upon arrival, the requirements for arrival temperature are not usually too demanding (e.g. 40°F for sweet corn). These operators have no assurance that the product they have purchased was adequately precooled.

Each load is inspected on arrival by in-house personnel using USDA grades if applicable, or company quality standards. The main problem with the inspection process as with temperature monitoring is that acceptance or rejection of a load may have as much to do with market conditions as quality considerations. Since Florida is likely to be the only major source of various commodities at different times, some negative perceptions of Florida produce are bound to appear when quality shipped is lowered during high priced markets and buyers accept and pay high prices for shipments that might not normally be accepted.

Palletization of Florida produce was brought up several times during these visits. All of the warehouses that we toured are completely palletized and all shipments to retail stores are palletized. Almost all California, Mexico and South Texas shipments arrive on 40 X 48” pallets while, other than tomatoes, strawberries and citrus, almost all Florida shipments arrive unpalletized. This is a major irritant in warehouse operations since it may take 2 to 3 hours for a trucker to unload a trailerload of unpalletized produce by hand compared to 5 to 10 minutes to unload a palletized load by forklift (it is common practice for the trucker to unload his own truck or hire a “lumper”, since the warehouses refuse to pay their union laborers to unload an unpalletized load). It isn’t difficult to imagine the care and concern likely to be shown the product by a man “fresh” from 2-3 days on the road who must unload a trailerload of produce.

There is a real need to encourage Florida shippers to convert to palletized shipping without further delay. The change would require that the unit of purchase be at least one pallet layer to allow proper stacking. The palletizing charge plus savings in reduced handling labor should compensate for loss of load space in trailers of palletized produce. The improved ease of handling and reduction of handling operations has well documented positive effects on produce quality from reduced mechanical injury. While produce from other major growing areas is already predominantly palletized, buyers have not been demanding palletized products from Florida in spite of their voiced complaints to us of problems with incorporating unpalletized products into their operations. Florida’s periodic position as the only major source of certain crops may be preventing buyers (in the interest of maintaining good relations) from demanding palletization.

Handing

The produce operations visited on these trips purchase most of their Florida produce through brokers in Florida and elsewhere. Straight loads of high volume items such as tomatoes, sweet corn and citrus may be purchased directly from grower/shippers. Since many of the commodities they buy from Florida are not high volume items, it is understandable that they want to simplify their dealings by using a few brokers with whom they have developed working relationships for most of their purchases.

The preponderance of mixed load shipments from Florida probably is a major cause of quality problems stemming from temperature and ethylene incompatibilities, difficulty in maintaining proper temperatures during the repeated opening and closing of the trailer that occurs in making up a full load and resistance to palletization. If the broker or his suppliers have storage facilities, then additional variable delays may be built in between harvest and arrival. An excellent aid for determining product compatibility in mixed loads is available from TransFresh Corp. (3).

All of the operations we visited monitored the trailer air temperature during transit. While this allows them to determine if the truck's refrigeration system was in working order, it does not let them know if the product was at the proper temperature when loaded, heated up or cooled down in transit. While pulp temperatures are taken upon arrival, the requirements for arrival temperature are not usually too demanding (e.g. 40°F for sweet corn). These operators have no assurance that the product they have purchased was adequately precooled.

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Conclusions

Florida is the major producer of winter vegetables in the United States but appears to lag behind other major growing areas in adopting and implementing innovative handling practices. The quality problems we observed and discussed with buyers and warehouse managers in New England and Chicago are by and large avoidable through the use of proper precooling, handling and packaging procedures. Extension efforts should be aimed at both Florida producers and shippers as well as buyers of Florida produce. Research suggested by our observations of Florida produce in the marketplace will require examining the entire postharvest system for a targeted commodity in order to increase handling efficiency and improve product quality. Improvements in precooling practices, sizing and grading efficiency and package design should serve to enhance the quality and improve the image of Florida’s produce. Cooperation with grower organizations such as FFVA is vital to the achievement of this goal.
QUALITY CHANGES OF CARROT STICKS IN STORAGE

Materials and Methods

Carrots (commercial Shamrock type) were obtained in 50-lb bags from Zellwin Farms, Zellwood, FL on the same day or the day after harvest. They were stored at 2°C until processed but were used within 3 weeks of storage. The carrots were sanitized by submerging in cold 1% solution of sodium hypochlorite for 30 min before they were peeled mechanically in a Hobart (Model 6430-1) peeler. Carrot sticks (10 mm x 60 mm) were prepared with a Hobart (Model PD 70) power unit with dicer attachment. Carrot sticks or cubes (1 cm³) were vacuum infused with solutes and with infused metabolites. However, carrot flavor was lost under all treatments. Proteins of the carrot tissue to these regulators. The conclusion was drawn that harvested carrot is physiologically too mature for senescence control and therefore these techniques would be more appropriately applied to the growing carrot.

Carrot roots grow in a near anaerobic environment because O₂-tension of the soil is low. When the root is harvested it is exposed to the high O₂-tension of the atmosphere which brings about numerous metabolic changes. Pyruvic acid, for example, contributes about 30% of the total organic acids in the growing carrot. However, one day after harvesting pyruvic acid is about 0.1% of the total acids and malic and isocitric acids increase to 95% from about 25% of total acids (11). In addition, enhanced aerobic respiration promotes depletion of soluble sugars. When the carrot is processed into carrot sticks the respiration rate abruptly but temporarily increases 10-fold (9). The monosaccharides are metabolized depleting the soluble sugars.

A conventional approach to retard respiration and metabolic rates is to lower temperature of the product and modify the gaseous atmosphere. A less conventional approach would be to supply metabolites and growth regulators to the product. We have examined these approaches and measured their effect on quality parameters such as taste, color and texture, and their effect on metabolic changes such as decarboxylation and hydrolytic reactions.

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