Refrigeration and Pre-Cooling of Citrus Fruits

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The subject of "Packing and Shipment of Citrus Fruits" is so broad and complicated that I have chosen to treat upon only one phase of its problems, viz: on the application of refrigeration and pre-cooling.

The use of the physical state of "cooling" to assist in the keeping of perishables is of ancient origin. Since the development of modern ice making and refrigerating machines, the subject has become of deep interest to those who grow and market perishables in the warmer climates. This development has caused, in recent years, the formation of a system of specially designed "refrigerator" cars which are in increasing heavy demand for movement of the highly perishable commodities.

Any discussion of the value of refrigeration for the movement of citrus fruits must necessarily be based upon some predetermined data as to what point on the thermometer scale it is most desirable to reach. Cooling, in the first place, tends to keep fruits and vegetables fresh and to hold back the ripening process. It reduces the rate of, but does not eliminate respiration of all vegetation and, in doing so, tends to keep within the commodity its water content. Aside from this desirable feature we have the equally important one of retarding decay. Competent scientific investigators seem to have established that blue mold, an ever present fungus disease of our citrus fruits, develops quite slowly below 40 degrees F. while it becomes active at temperatures from 50 degrees upward. Stem end rot, whether due to Phomopsis citri or Diplodia, seems to be comparatively slow in its development at temperatures around 50 degrees and almost dormant at 40 degrees. As these decays are responsible for most of Florida’s losses in distribution, refrigeration has, within the last few years, assumed a prominent place in our marketing scheme.

The rate of cooling in a refrigerator car depends largely on the arrangement of ice bunkers and the nature of floor, together with the general arrangement of load. In the case of plain box bunker equipment without floor racks the air circulation is often so retarded that cars promptly moved to eastern markets can reach destination before a desirable "keeping" temperature is reached. If vertical air columns are maintained along the sides of car ice chambers and a false, slatted floor is provided, the general average temperature drop is materially hastened. As a rule, however, a Florida car moving in our fall or spring months is from 3½ to 5 days on its journey before the temper-
ature average of its load is reduced to 45 degrees.

Within the last few years there has been a decided drift toward the idea of pre-cooling in many of the fruit and vegetable centers of our country. Pre-cooling, as we are accustomed to speak of it, means a forced process of refrigeration, this being done as soon after the fruit is picked as is consistent with modern packing and handling methods. This is done usually by means of mechanical refrigeration in rooms especially designed and heat insulated. At present there are six pre-cooling plants in this State and, roughly estimating, they represent a capital outlay of over one-half million dollars. Should each one of these plants operate at full capacity they could put out a total of over 50 cars per day. While definite figures are impossible at this time, it is safe to say that 2,000 cars of citrus fruits and 500 cars of vegetables will roll pre-cooled from Florida this season.

If the process of pre-cooling is to become widely distributed over our State it must hold out, for our consideration, some basic economic merit. To date it bids fair to do this, as it is possible to rapidly reduce the temperature of perishables to a point where decay is practically arrested. It also appears, from records carefully compiled, that under favorable conditions, the pre-cooled method of shipment can be done with financial gain as compared with the present standard refrigeration method. In moving a pre-cooled shipment it is entirely feasible to properly cool the fruit within 24 hours; load it into a car with the bunkers filled with ice and then ship it to destination without further icing providing the time in transit does not exceed 11 or 12 days in the winter months and from 8 to 10 days during the fall or spring months.

The process of pre-cooling cannot be considered as a cure-all for our many citrus ills. It should only be used as an aid in marketing and should never be considered as a preserving or pickling process. Let us consider the case of one single orange: First it becomes injured in the picking process; it then goes to the packing house and stands there for a day or two, after which it is dumped into a soaking tank heavily charged with blue mold spores. From this tank it goes through the packing house routine and finally into a cooler, where the temperature is reduced to a point around 50 degrees. The chances are that this orange will never enter into consumption. However, if the injured orange had been put through the house in a reasonable time and had been properly cooled, the odds would have become reversed and any tendency for the development of decay would have probably been arrested enough to allow it to make for its grower a satisfied final customer.

Let us consider for a minute the difficulties which nature and the industry have devised to worry the engineer who plans on extracting the heat from the modern package of citrus fruits. An orange is over 90% water and water has the highest specific heat of any known substance. Added to this, nature has surrounded the liquid contents with a covering composed of light, pithy material which ranks very
high as an insulator against the transmission of heat. For these reasons it takes, under favorable conditions, at least one hour to cool one orange from 85 degrees downward to 40 degrees. In order to further complicate the cooling process, this orange is now wrapped in a layer of paper, thus adding an extra layer of heat insulation and also creating a dead-air space between the orange and its wrapper. After this the orange is placed in a box with others and the loose paper of the wraps is carefully tucked between the several fruits, making it extremely hard to even force an air circulation through the packed box.

These conditions have so complicated the situation that now, under the most favorable circumstances, it will require about 6 hours to cool the several oranges in the box through the 85 to 40 degree range, and to this we must add another hour if the so-called “wad pack” is used. These last figures as to time are given for concentrated cooling effort on a single box and must be multiplied by at least three or four when a large number of boxes are stacked in a typical pre-cooling room. From the foregoing it can be seen that we have come up, step by step, from one hour to approximately one day and, with improper air pressure and distribution, together with other minor details, it is easily possible to consume two days’ time in reaching a desirably low and uniform temperature.

Pre-cooling carries with it many new responsibilities for the individuals or associations who choose to adopt it. Under the standard refrigeration method as furnished by our common carriers it is customary to order an iced car, load it and await results. With pre-cooling, the entire order is changed. All that can be done to deliver the fruit to market in sound condition must be done before the car doors are sealed. First, the management is entrusted with properly pre-cooling the fruit to a desired temperature. Again, only such cars as are in good condition should be used, as cracks at doorways, hatches and similar defects are sure to add elements of danger in transit. The proper amount of ice must be supplied before the car leaves for its destination. If any one of these three items is neglected, the chances for sound delivery are lessened and the process can soon become a heavy liability instead of a valuable asset.

The fundamentals of pre-cooling as well as its possibilities have long been determined. Much work of an investigational nature has been done by the United States Department of Agriculture, dating from 1907. Much of this work was done in California during a four-year study of conditions there and later the work was continued in Florida. In this investigation it was practically determined that it was not commercially advisable to attempt pre-cooled shipments from California to the far eastern markets unless re-icing was done at least once in transit, this being made necessary by the length of time required for the trip. Florida conditions are, as a rule, entirely different in that our principal markets are much nearer as regards both distance and time. During the last two seasons I am not aware of any pre-cooled cars that have been re-iced in
transit from Florida plants. A careful study of individual car records on approximately 2,000 shipments warrants the statement that transit re-icing is not necessary from this State under normal shipping conditions if fruit is properly cooled and iced before shipment.

In closing, I wish to voice the conviction that pre-cooling is with us to stay. Its advantages are becoming more and more apparent each season and it will, in the not far distant future, become a truly important branch of the State's marketing operations. Of necessity it will be limited to the larger producing centers and larger packing houses, as the overhead charges incident to its adoption preclude its universal use. Notwithstanding this added expense, to the house that ships under refrigeration 50,000 boxes or more yearly, it becomes of great interest and, if properly handled, it will soon demonstrate its value.