

a tremendous amount of research is still necessary on all the phases involved from the time the vegetables are grown in the field until they are eaten by the consumer.

¹PLATENIUS, HANS, *Modern Packaging*, Vol. 20, No. 2, pp. 139-143, 1946.

²SCOTT, L. E., *Pre-Pack-Age*, Vol 1, No. 1, pp. 16-18, 1947.

PREPARATION OF PRODUCE FOR PREPACKAGING

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It is agreed by all that the basic aim of prepackaging is to give the consumer a better product and to procure more favorable economic return for the producer and the retailer.

Under the normal method of handling produce, the inedible portion of vegetables left attached constitutes a large portion of the total shipping weight. Cauliflower represents the extreme case where the curd or edible portion represents only about 40% of the total weight. Fresh corn when husked and trimmed eliminates about 50% of the weight, and even carrot tops account for almost 25% of the normal shipping weight. Aside from the additional transportation costs, there is the added labor cost of removing this inedible portion. Accumulation of these waste materials at one location may lead to profitable by-products, such as animal feeds (1, 2).

Handling produce in the same old way up to the retailer or distributor discarding a third or a half in the garbage can, just doesn't make sense.

But let's see how prepackaging might give a better product if given the proper preparation.

Basic quality is the success of any food product, whether fresh, canned or frozen. Basic quality rests on three factors: (1) variety or type of crop, (2) harvesting at the proper stage of maturity, and (3) retention of the desirable constituents during handling, transportation and marketing.

The variety or type of crop must be selected for packaging. Size and shape vary as to variety, and should be chosen for adaptability for prepackaging. Then too, proper production can add in this phase; for example, experiments have revealed that peas can be increased in yield and yet kept in a fancy grade for a longer period by the liberal use of a high nitrogen fertilizer.

Proper maturity is of prime importance, and even though it is already the subject of numerous regulations; nevertheless, it requires considerable attention.

Our third point, retention of the desirable constituents during handling and transportation, is the point which we want to consider in a little more detail.

As we all know, fruits and vegetables are living tissue which respire, and in doing so, the desirable constituents are altered. The higher the temperature, the faster they respire, and the faster they deteriorate.

Leafy vegetables have high heat values, and must be cooled very rapidly to prevent yellowing. The respiration rate of spinach (3) is a good example of the high respiration rate of leafy vegetables.

The principal changes brought about by respiration are: loss of moisture, sugar, Vitamin C, and the loss of other desirable constituents. Asparagus loses almost 6 times as much sugar at 50°F. as at 32°F. Uniced kale (4) loses 44% of its ascorbic acid content in 6 days, 3 times greater than at 32° degrees Fahrenheit. Subsequent changes in the substances in the cell wall leaves produce susceptible to decay producing organisms. All of these contribute to the loss of what we call—freshness.

TABLE I.

Temperature Degrees Fahrenheit	Mgr-CO ₂ per Kg-Hr.	B. T. U. per ton per day	Estimated Storage Life-Days	Pounds of ice per ton per day
75	275.0	60,500	2	420
50	60	16,500	5 to 6	115
33	15	4,125	10 to 20	29

The object of our cooperative experiments last season with Mr. Dickman of Ruskin, Florida, was to study the possibility of reducing these losses through the use of "Steri-cooling." This method of pre-cooling employs the use of large quantities of ice water flooded over the produce to obtain rapid heat transfer. Our standard commercial unit floods almost 2000 gallons of water per minute. Added to the water is a germicide to aid in control of the rot producing organisms.

Vegetables included in these semi-commercial tests were lettuce, broccoli, cauliflower, corn, tomatoes, string beans and lima beans.

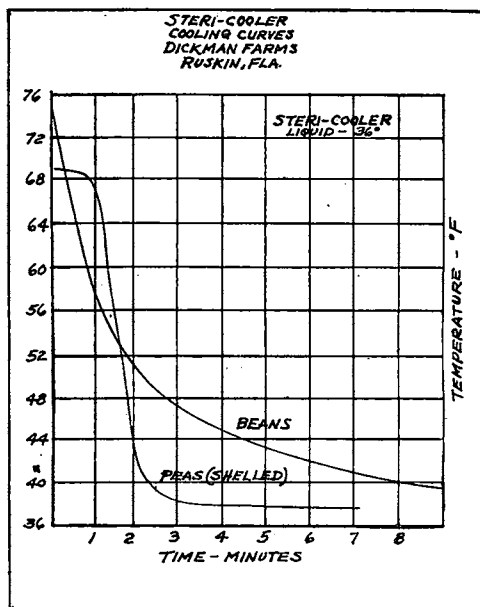
Husked corn was cooled from 86° to a cob temperature of 40° in 24 minutes. Ripe tomatoes were cooled from 80° to 41° in 23 minutes. Other products of less bulk were cooled more quickly as shown on the accompanying graph (Fig. I). These temperatures were taken internally, and naturally exposed surfaces were somewhat lower.

For optimum cooling, the product should be prepared for prepackaging before cooling. This eliminates waste material from using up refrigeration and speeds up the packaging operation following cooling. On corn tests, for example, ears which had to be cut to size following cooling, the temperature had risen to 51°. Cutting before the cooling operation resulted in a 6 degree reduction (45°) when placed in storage. This reduction in temperature under normal refrigeration would require 2 to 3 days, or even longer. Corn may lose 30% of its sugar in 24 hours at 65°F. At 35° this loss is only about 3% (5). A reduction from 60°F. to 40°F. lowers the heat evolved

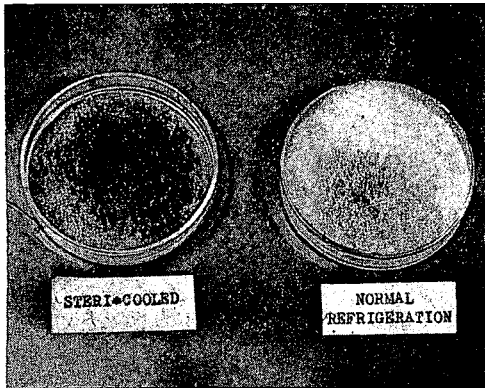
by respiration more than 50%. So it is easily seen how important pre-cooling really is to maintain freshness.

The Steri-cooler liquid contains a germicide designed principally to prevent contamination and build up of organisms in the treating solution. This combined by the quick reduction in temperature of the product treated almost entirely eliminates chance for development of rot producing organisms. Few, if any, of the common transit decays continue to develop at 40°F. and lower.

In order to demonstrate the effect of rapid cooling on various organisms commonly attacking fruits and vegetables, we con-



ducted a special experiment. Petri dishes inoculated with these organisms were held under conditions similar to those produced by Steri-cooling followed by normal transit refrigeration. The check or control sets were held under conditions of normal transit refrigeration. After what was considered normal transit period, these plates were returned to normal room temperature.



The accompanying photographs of plates inoculated with *Rhizopus Rot* (*Rhizopus Nigricans*) were taken after 48 hours. The plate held under conditions of normal transit refrigeration has developed extremely heavy growth with very abundant formation of spores, whereas the plate representing Steri-cooled conditions shows only slight growth and no spores whatsoever.

We do not wish to imply that the Steri-cooler will not eliminate the necessity of maintaining adequate sanitary conditions. A sound routine sanitary cleanup should be put into practice for prepackaging, and should be as thorough as in any other food processing plant. Bacteria, especially the soft rot organism, builds up on plant juices and debris especially around cutting knives, belts, and where trimming is done. Yeasts and molds also develop along with bacteria, and may result in heavy contamination of produce at these points if not kept clean at all times. Poured culture plates for instance, of swabs taken from the cutting belt in the corn operation gave such an

abundance of growth that counts could not be made even at a 1 to 10,000 dilution. These points of possible contamination were soon eliminated by the proper clean up. The importance of sanitation will certainly become more evident as prepackaging develops on a larger scale.

As you may have observed from Table I by this time pre-cooling also saves subsequent refrigeration. For once the product is cooled, less refrigeration is needed to maintain low temperatures. Since the product continues to give off heat, normal cooling actually requires additional refrigeration.

In summary then, preparation for prepackaging should include (1) the removal of the inedible portion—which reduces transportation and refrigeration costs, (2) proper sanitary conditions to prevent contamination, and (3) pre-cooling such as Steri-cooling to insure against loss of freshness and nutritive qualities caused by high respiration rate and also by decay producing organism.

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