

## THE HANDLING OF SOME PHILIPPINE FRUITS WITH SPECIAL REFERENCE TO THE ETHYLENE, BORAX, AND PARAFFIN TREATMENT\*

**T**HE use of ethylene gas ( $C_2H_4$ ) as a means of forcing the development of color in citrus fruits was patented by Dr. F. E. Denny, of the United States Department of Agriculture, in 1923. Several gases that will bring about artificial coloring were known at that time, but ethylene is the safest and most practical of those discovered. Denny and his co-workers have preferred not to use the term "ripening" in describing the effects produced.

Studies on the effect of ethylene on various fruits and vegetables at the Minnesota Agricultural Experiment Station in 1924 gave positive results, especially with celery and tomatoes. The application of ethylene in the blanching of celery was a commercial success. By taste and by chemical analysis ethylene treated celery was found to be higher in sugar than the untreated celery. It was also found that tomatoes treated with ethylene were sweeter than the untreated ones.

Subsequent investigators of the U.S. Bureau of Chemistry and Soils reported that there is no decided change in the composition of the edible portion of citrus brought about by the ethylene method of coloring. The sugar and acid contents of the fruits were practically the same. No pronounced difference was noticed between the treated and untreated oranges except in colour. With some fruits, however, like persimmons, they concluded that the color was enhanced and the astringency lessened or destroyed.

Experiments on the use of ethylene on other fruits were equally successful. Pears for canning are picked when hard and green and stored in cellars or in cold storage. The fruit softens and colors unevenly, and it becomes necessary to sort it several times in order to obtain materials suitable for canning. The ethylene treatment of pears showed that the fruits were softened considerably after four days. Untreated pears required from ten to fourteen days to soften and 18.2 lb. pressure to puncture the flesh of the pears, while the treated fruit required 5.5 lb. The treatment of apricots and peaches did not seem to give satisfactory results. These fruits soften quickly after harvesting and contain no starch which could be converted into sugar.

### PROPERTIES OF ETHYLENE

Ethylene is a colorless gas of faint, pleasant odor with a boiling point of  $-103^{\circ}C.$ , and specific gravity 0.97. The gas accelerates the only coloring

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and ripening processes of fruits and vegetables. Its use not only shortens the time of ripening but also lowers the acidity of early apples, plums, and pineapples. It also eliminates packing house and shipping losses due to rot, fungus growths and uneven ripening.

Ethylene can be procured in cylinders under a pressure of 1,200 lb. per square inch. It is inflammable and forms explosive mixtures with air when mixed with it in the proportions between 3 and 20 per cent. There is, however, little danger of inflammability when the maximum concentration used for coloring is not over 1 part of the gas in 1,000 parts of air. The gas has no effect on animal life at this dilution. The cylinders should be handled with care, and should not be exposed to unusually high degrees of heat. No light or fire should be allowed in the room where the containing cylinder and measuring apparatus are kept, especially during the treating process. Measuring gauges accompany a cylinder of the gas in order to measure the dosage of the injected gas, when delivered under such high pressure. In the absence of compressed gas, ethylene can be prepared in the laboratory by heating alcohol with concentrated sulphuric acid to 170°C. and passing the gas through concentrated sulphuric acid and sodium hydroxide to remove impurities such as sulphur dioxide, alcohol, and ether.

It is the purpose of these experiments to find out the effect and utility of ethylene treatment on Philippine fruits. Native oranges, principally the Batangas mandarin, are usually still green in colour when picked and sold in the markets. No treatment is given the fruits except the grading for size and curing by storage in underground cellars. Although they are sweet after curing the fruits remain green in color. If the green color of the native oranges can be transformed into a uniform bright yellow by ethylene treatment, the attractiveness and the market cost will be increased. There are other fruits besides the citrus, such as mangoes, avocados, lanzones, etc., that may commercially be treated to advantage with ethylene. In addition to ethylene treatment, other processes of handling fruits such as the borax and paraffin treatments which are as yet unknown here but which are regular commercial operations in fruit districts of many foreign lands which if properly studied and applied to our fruits may produce profitable results. A 4 to 5 per cent. borax solution is used in commercial packing houses for dipping the fruits to prevent mold wastage. The fruits are then dried and polished with paraffin with the aid of mechanical brushes.

## MATERIALS

The fruits studied include the following:

1. Varieties of oranges.
2. Varieties of grapefruits.
3. Pummelos, limes and lemons.
4. Mangoes, caraboa and pico varieties.
5. Chicos.
6. Avocados.

Practically all fruits studied were harvested from the Bureau of Plant Industry's experimental and propagation farms.

## EQUIPMENT

Cylinder of ethylene gas at 1,200 lb. pressure.

Measuring gauge.

Pyrex distilling flask.

Air pump.

Wash bottles.

Burners.

Ethylene chambers.

(a) One of 101 cubic feet capacity

(b) One of 5 cubic feet capacity.

(c) Tanauan ethylene chamber of 537 cubic feet capacity.

## MATERIALS (CHEMICALS)

Alcohol, 95 per cent.

Sulphuric acid.

Sodium hydroxide.

Borax.

Paraffin wax.

## EXPERIMENTAL

The fruits are arranged carefully in racks inside the ethylene chamber, the door shut tight, and ethylene injected into the chamber in concentrations of 1:1000 and 1:5000. The injection of the gas is done once every 24 hours. Every day thereafter until the treatment is completed, the chamber is aerated for about two hours before the gas is injected again. The ethylene treatment is continued until the fruits are fully colored and soft.

Ethylene is obtained from a cylindrical tank under 2,000 pounds pressure, and measured by passing through a gauge calibrated in cubic feet per minute. The time of injecting the gas into the larger box is not over one minute as its capacity is only 101 cubic feet. For the smaller chamber the period of injection is correspondingly decreased.

In other experiments, ethylene is generated by heating the calculated amounts of ethyl alcohol and concentrated sulphuric acid in a distilling flask at 170°C. The gas is purified by passing it through concentrated sulphuric acid and sodium hydroxide solutions. To drive all the gas generated into the chamber an ordinary foot blower connected to the distilling flask is used.

At the Tanauan Citrus Experiment Station, Tanauan, Batangas, the handling of citrus fruits on a bigger scale was started January 18, 1933. The volume of the ethylene chamber built for the ethylene treatment of citrus fruits was 537 cubic feet. It was 151 inches long, 88 inches high, and 75 inches by 65 inches wide on opposite sides. Batangas mandarin and Szinkom oranges were picked on the same day and loaded into the ethylene chamber.

The first charge of ethylene gas was applied at 4.30 p.m. January 18 by heating a calculated mixture of 7.5 cc. of 95 per cent. alcohol and 7cc. of concentrated sulphuric acid enough to produce ethylene gas in the proportion of 1 part of gas to 5,000 parts of air. The gas was passed for thirty minutes into the chamber that has been shut tight to prevent leaks.

The next day, January 19, the chamber was opened at 7.30 a.m. and aërated for two hours by blowing cold air into it by means of a blower connected to a small gasoline engine. Gas was applied at 9.30 a.m. and continued until 10.30 a.m. Gas was injected at 4.30 to 5.00 p.m. on the afternoon of the same day.

The chamber was opened at 7.40 a.m. January 20. A pronounced change in color of the fruits from green to yellow was noticed on the second day of treatment. After aërating for two hours the chamber was closed and gas admitted again for one hour. The chamber was not opened again until the next day, January 21, at 7.40 a.m. On the third day, 90 per cent. of both varieties of oranges were fully colored. The flavor of the Szinkom oranges was somewhat sweeter after the treatment. The fully colored fruits were removed from the chamber and soaked in a 3 per cent. borax solution at about 40°C. for two to three minutes, and allowed to dry on a table at room temperature.

The remaining fruits which were still greenish were treated again with ethylene gas on the afternoon of January 21. The next day, January 22, some of the Szinkom oranges showed signs of burn from the effects of the ethylene gas.

After removing the citrus fruits from the ethylene chamber, the fruits were soaked in a 4 to 5 per cent. borax solution at 46° to 49°C. for several minutes. This temperature aids materially in cleansing the fruit and at the same time helps in preventing rots such as pythiacystis or brown rots. The fruits are then dried in a heated chamber for a short time. A hot-air heated chamber is best for the purpose. After drying, the fruits are treated with a solution of paraffin in a white, odorless, and tasteless mineral oil solvent. The paraffin reduces moisture loss and probably slows the rate of respiration. The fruits are then packed carefully in boxes or crates and pre-cooled in cold storage at 35°F.