On The Processing Of Japanese Persimmons With Partial Vacuum

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In the United States considerable investigations have been made in the past on the available methods of artificial removal of astringency from Japanese persimmons, by Gore (1), (2), Lloyd (4), Overholser (5), and others; and two methods, a treatment with carbon dioxide and a treatment with ethylene have been recommended.

The work of Overholser (5) indicates, however, that processing the fruits with carbon dioxide tends to retard subsequent proper ripening and color development, and the fruits treated with ethylene, (as well as with propylene or various vapors, such as ethylene chlorhydrin, ethylene chloride, and ethylene bromide), soften very rapidly reducing considerably the period of marketing.

The brief note here reported deals with the effects of partial vacuum in comparison with those of carbon dioxide and ethylene on the Japanese persimmons. This work was suggested by Dr. Overholser to the writer to study during his stay at the University of California in Davis, California, Dr. Overholser thinking the processing with partial vacuum would produce better effects on the fruits than that of either carbon dioxide or ethylene.

The fruits used were collected from Newcastle, California, in the fall of 1929, and stored in a room of 30° F. for several days until the treatments were started. The fruits were divided into several lots.

In the lot of partial vacuum cooking kettles for high pressure were used as containers for fruits. As it was difficult to avoid entirely the leakage of air in the kettles, and a manometer connected with the evacuated kettle showed a considerable depression during one day, the pump was worked three times a day through the period of treatment, to keep the kettles in an almost constant amount of vacuum.

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To subject the fruits to carbon dioxide, they were kept for six days in sealed containers, in which carbon dioxide was evolved from respiration of fruit and accumulated to a sufficient concentration.

In the lot of ethylene treatment, the fruits were subjected to a concentration of 1 part of ethylene to 2000 parts of air.

The change in firmness of the fruits was recorded by using electrical resistance measurements, which were made as reported by Overholser in his paper (5) with the exception of using the electrodes of stainless iron and the alternating current galvanometer in place of the electrodes of platinum-iridium and the telephone respectively.

For gas analysis an Orsat's apparatus was used.

The results which are summarized in Table I were obtained with Hachiya collected on Oct. 16.

Table I—The Effect of Carbon Dioxide, Ethylene, and Partial Vacuum Treatment for the Removal of Astringency and Ripening in the Hachiya Variety

At the time of commencement of the treatment the fruits were firm, very astringent, and yellow colored, slightly red on the top and remained green only at stem-end. The fruits were kept in a room of 15°-23°C. during experiment. Initial resistance was 9856.08 ohms. 8 fruits were used for each determination

Treatment	Gas Analysis at Close of Treatment	Specific Resistance in Ohms	
		Oct. 29, just after removal from container	Nov. 1, 3 day after removal from container
Sealed in container for 6 days	39.5% CO ₂ 1.0% O ₂ 59.5% N ₂ (by difference)	5744.51	2609.09
Treated with ethylene for 1 day	15.1% CO ₂ 4.0% O ₂ 80.9% N ₂ (by difference)	7658.45	2143.38
Evacuated 500mm. for 6 days		5193.47	1984.95
Evacuated 500mm. for 3 days		7910.29	3041.55
Evacuated 650mm. for 3 days		8036.08	4568.37
Check	Surrounded by atmospheric condition	2092.48	1351.72

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Degree of Astringency and Ripening	
Oct. 29	Nov 1.
Firm, non-astringent; remained green at stem-end	Soft, non-astringent; remained green at stem-end; dark spots appeared on the surface, skin became somewhat tough, stem-end remained firm and unripe
Firm, weakly astringent; remained green at stem-end	Very soft, overripe, non-astringent; red color fully developed
Firm, almost non-astringent; remained green at stem-end	Mushy, overripe, non-astringent; red color fully developed
Firm, weakly astringent; remained green at stem-end	Soft, non-astringent; upper half red, but lower half yellow
Firm, weakly astringent; remained green at stem-end	Soft, non-astringent; yellow to stem-end
Very soft, overripe, non-astringent; red color fully developed	Mushy, very overripe, non-astringent

In this experiment all fruits softened very rapidly and the check specimens were considerably softer than the fruits of any treated lot at both of the measurements, just after removal from container and three days after removal. The comparatively high temperature of the room where the fruits were placed during experiment and the advanced ripeness of the fruits used, though they were yet firm and strongly astringent at the time of commencement of the treatment, probably caused this rapid softening. But, when we indicate the resistance determined three days after removal in terms of percentage to the resistance measured just after removal from container, the resistance decreased during three days after removal to 45.42. per cent. in the lot of carbon dioxide treatment, 27.99 per cent. in the lot of ethylene treatment, 38.22 per cent. in the lot evacuated 500mm. for 6 days, 38.45 per cent. in the lot evacuated 500mm. for 3 days, 56.84 per cent. in the lot evacuated 650mm. for 3 days, and 64.60 per cent. in the check lot. From these figures we can compare the effect of each treatment on the rate of subsequent softening, and it will be seen that softening occurred most rapidly with the fruits treated with ethylene and most slowly with the check specimens. Evacuation of 500mm. for 6 days, caused subsequent softening to be slower than did ethylene, but more rapid than did carbon dioxide.

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To make this relation more clear, the less ripened fruits were desirable for experiment material, but as it was the end of harvesting season, Hachiya in the proper condition of ripeness could not be found. However, at Newcastle there was another fruit called a late-season strain of Hachiya. This fruit is not a real Hachiya but is very late-season, and in any case this variety was the only one which had unripe fruit still on the trees at that time.

Using these fruits the experiment was repeated, and the data obtained are shown in Table II.

Table II.—The Effect of Carbon Dioxide, Ethylene, and Partial Vacuum for the Removal of Astringency and Ripening in the so-called Late-Season Strain of Hachiya

The fruits were collected on Oct. 31, and stored in a room of 30°F. until the experiment commenced. They were very firm, very strongly astringent, and yellow-colored only on the upper part, the lower half remaining green. They were placed in a room of 15°–20°C. during experiment. Initial resistance was 8989.68 ohms. 8 fruits were used for each determination.

Treatment	Gas Analysis at Close of Treatment	Specific Resistance in Ohms		
		Nov. 13, just after removal from container	Nov. 19, 6 days after removal	Nov. 25, 12 days after removal
Sealed in container for 6 days	42.0% CO ₂ 0.5% O ₂ 57.5% N ₂ (by difference)	6638.75	4778.58	3571.77
Treated with ethylene for 1 day	9.2% CO ₂ 10.9% O ₂ 79.9% N ₂ (by difference)	7975.29	3414.62	1683.17
Evacuated 650 mm. for 6 days		6489.99	3526.74	3256.97
Evacuated 500 mm. for 6 days		6709.07	3552.71	2781.17
Check	Surrounded by atmospheric condition	8779.19	8412.38	8288.70

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Degree of Astringency and Ripeness		
Nov. 13.	Nov. 19	Nov. 25
Very firm, slightly astringent; colored just like before treatment	Firm, non-astringent; lower half of surface and pulp blackend	Soft, non-astringent; blackened part of skin became somewhat brittle
Very firm, very astringent; yellow over all the surface	Soft, non-astringent; more advanced in color development	Mushy, overripe, non-astringent; slightly transparent and browned
Very firm, weakly astringent; colored just like before treatment	Soft, non-astringent; lower half of surface darkened, but not as intensely as in the fruits treated with CO ₂ and darkening did not occur in pulp	Soft, non-astringent; remained in the same state as on Nov. 19
Very firm, weakly astringent; colored just like before treatment	Soft, non-astringent; darkening occurred on the surface same as in the fruits of the lot evacuated 650mm.	Soft, non-astringent; remained in the same state as on Nov. 19
Very firm, very astringent; yellow all over the surface	Very firm, very astringent; more advanced in coloring	Very firm, very astringent; nearly same in coloring as on Nov. 19

In this experiment it appeared clearly that partial vacuum caused the rate of subsequent softening to be much slower than did ethylene but more rapid than did carbon dioxide. Though the fruits subjected to carbon dioxide became soft slowly, but more rapidly than the check specimens, the subsequent proper ripening was retarded very much in these fruits. Further development of coloring was almost entirely retarded and the portion of skin which was green at the time of treatment turned black during a few days after removal from container and became somewhat brittle or tough in texture. The pulp under the blackened skin also turned brown with the blackened vascular-bundles and its taste became insipid, lacking in sweetness. This abnormality of ripening occurred most intensely at the stem-end, which was the most unripe portion of the fruit, while the blossom-end where yellow color had developed at the time of harvesting, remained yellow showing no darkening. This injury seems, therefore, to be very closely related with the degree of ripening, and the more un-

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ripe the fruit, the more seriously it is affected.

Partial vacuum resulted in retardation of color development and also darkening of surface, but the effects occurred less intensely than in the lot of carbon dioxide treatment, and the darkening did not extend into the pulp. As shown in Table I, in the first experiment darkening was limited to the surface also in the fruits treated with carbon dioxide, and did not occur at all with the fruits of the evacuated lots. This abnormality of subsequent ripening occurring lightly in the first experiment would be due to the fact that the fruits used in the first experiment were more ripe than the fruits used in the second experiment.

In his experiment with Triumph and Zenji, Gore (1) observed that when the fruits were kept in carbon dioxide for prolonged intervals a large proportion of them became dark in color on softening subsequently.

From these data obtained it can be seen that the effects of partial vacuum on the ripening of the Japanese persimmons are the same in nature with the effects of carbon dioxide treatment, but occur in less intensity.

In the evacuated containers there would be practically neither accumulation of carbon dioxide evolved from anaerobic respiration nor oxygen, because the containers were evacuated three times a day during treatment. Therefore, the lack of oxygen would be responsible for the effects of partial vacuum which appeared on the persimmon fruits in these experiments. As the treatment with carbon dioxide, in which there was a large amount of carbon dioxide and a very small amount of oxygen in the containers at close of treatment, resulted in the same effects more intensely than did partial vacuum, the effects are intensified when oxygen deficiency is accompanied with excess of carbon dioxide. Overholser (5) investigated the effect of excess of oxygen, nitrogen, and carbon dioxide on the ripening of the Emon variety and stated that the presence of oxygen favored the development of greater intensity of the reddish colors, and its absence and the presence of carbon dioxide retarded color development. Kidd, West, and Kidd (3) observed that the percentage of oxygen and carbon dioxide was the most important factor of the gas storage of apples.

It may be said that the partial vacuum treatment seems worthy of further investigations promising the desirable effects on the Japanese persimmons.

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SUMMARY

- (1) Placing the fruits of Japanese persimmon in the evacuated container for several days results in a more rapid loss of astringency than in the check specimens.
- (2) The fruits treated with partial vacuum do not become soft as rapidly as the fruits treated with ethylene.
- (3) Partial vacuum has the same tendency to retard subsequent proper ripening as carbon dioxide treatment, but retardation does not occur to so great an extent as in the case of the fruits subjected to carbon dioxide treatment.

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