CONTROLLED ATMOSPHERE STORAGE OF PEACHES AND NECTARINES

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Our work at Beltsville on the CA storage of stone fruits has, for the past 5 seasons, been confined to peaches and nectarines.

In the course of these studies peaches and nectarines have been stored in atmospheres with oxygen levels of 1/4, 1, 3 and 21% in combination with carbon dioxide levels of zero and 5%. Fruit was stored in these atmospheres for 3, 6 and 9 weeks at 32°F and in one test for 3 weeks at 40°. After storage the fruits were ripened in air at 60 or 65° and fruit quality was evaluated. Five peach varieties (Redhaven, Sunhigh, Loring, Redskin and Redglobe) and one nectarine variety (Late Le Grand) have thus far been tested under all or some of the above conditions.

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One of the first things we learned was that 40°F is a very poor temperature for storing peaches or nectarines. After only 3 weeks at this temperature fruit of all varieties tested (Redhaven, Sunhigh, and Late Le Grand) developed internal breakdown when transferred to air at 60° regardless of the previous storage atmosphere. Use of 40° was discontinued in subsequent tests.

After several tests the 3-week storage periods at 30°F were also discontinued. This was done because the various atmospheres did not maintain fruit quality any better than air. The fruit from all of the atmospheres ripened with acceptable quality after 3 weeks at 32°. So, if storage for only 3 weeks is required air storage at 32° probably would be satisfactory, at least for the varieties used in these tests.

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After 6 and 9 weeks of storage differences among the fruit from the various atmospheres became noticeable. These differences often were not apparent when the fruit was first removed from the various atmospheres but became apparent after the fruit was ripened in air. This was especially true with respect to the internal appearance of the fruit.

Fruit from the atmospheres with no CO_2 usually became dry and grainy in texture, developed a watery translucent breakdown about the stone and many had badly discolored flesh. Fruit from atmospheres with 5% CO_2 usually retained good yellow flesh color, were juicy, and had little breakdown. There were exceptions to the above statements. Some varieties of fruit in 1/4% O_2 with no CO_2, retained as good flesh color as fruit from atmospheres with CO_2.

Not only did fruits from the CO_2 atmospheres have a better internal appearance but they retained better quality in other respects as well. Table 1 compares fruit quality, based on several criteria, after storage in atmospheres with and without CO_2. Data were collected on Redhaven and Loring

peaches, and on Late Le Grand nectarines at three O_2 levels (1/4, 1 and 21%) and at three storage periods (3, 6 and 9 weeks). When stored with CO_2 fruits are firmer on removal than fruits stored without CO_2. This agrees with other reports in the literature that CO_2 retards softening. However, after ripening at 65° fruits stored in 5% CO_2 at all O_2 levels were softer than fruits from atmospheres with no CO_2. Actually, fruits from the CO_2 atmospheres softened more like freshly harvested fruit as they ripened immediately after harvest, than fruits stored in atmospheres without CO_2.

Internal flesh color and flavor were better, and CO_2 production lower, in fruit from the CO_2 atmospheres than in fruit from atmospheres with no CO_2 (Table 1). Acidity was higher and decay was lower in fruit from the 5% CO_2 atmospheres than in fruit from atmospheres without CO_2. It appears from these data that the most pronounced effects were due to the presence of CO_2 in the atmosphere.

The benefits from lowered O_2 levels were not as readily apparent as those from increased CO_2 levels. Nevertheless, fruits from the low-oxygen levels (1/4 and 1%) had lower respiration rates, remained firmer during storage, had less decay and were somewhat more acid than were fruits from 21% O_2 (data not shown).

Table 1 shows that flavor was best in fruit stored with CO_2. After 6 and 9 weeks storage, flavor of all peach varieties was best when 5% CO_2 was combined with 1% O_2. As pointed out earlier, differences were slight after 3 weeks storage. For nectarines, flavor was equally good in fruit from both the 1 and 21% O_2 levels with 5% CO_2. Flavor generally declined with time in storage but for most peach varieties stored in the 1% O_2- 5% CO_2 atmosphere flavor was retained at an acceptable level through 6 weeks storage. However, the flavor of Redskin and Redglobe peaches after 6 weeks storage was perhaps only of borderline acceptability. The flavor of Late Le Grand nectarines from the 1% O_2 - 5% CO_2 or 21% O_2 - 5% CO_2 atmospheres, remained high and very acceptable through 9 weeks storage in 2 out of 3 years. This past season, however, nectarines stored in the 21% O_2 - 5% CO_2 atmosphere for 9 weeks were poorer in flavor than those from the 1% O_2 - 5% CO_2 atmosphere. Peaches and nectarines that were stored in 1/4% O_2 sometimes had a fermented flavor so this atmosphere is not recommended.

Although decay was less in fruit from the CO_2 atmospheres than in fruit from atmospheres without CO_2, it was not adequately controlled. We, therefore, included decay control treatments in our most recent CA tests. These treatments, applied before storage, consisted of a hot-water dip (125°F for 2 1/2 minutes) and a fungicide dip (0.5% Benlate).

Hot-water dips before storage did not reduce decay during 9 weeks storage on any variety tested in any atmosphere (only air, 1% O_2 - 5% CO_2 and 21% O_2 - 5% CO_2 were used in these tests). Hot-water treatments not only failed to control decay but sometimes injured both peaches and nectarines. The injury, a browning of the skin, did not become evident until the fruit had been in storage for several weeks and it was usually most severe on fruit stored in the 5% CO_2 atmospheres.

The chemical dip also injured some fruit but only in the peach varieties.

Redhaven and Redskin peaches are the only varieties that have been tested with this chemical, so far, and both were injured. The injury again was usually most severe in fruit stored in 5% CO_2. Decay was reduced slightly in Redskin but not in Redhaven by this chemical. Decay was reduced in nectarines treated with Benlate and the fruit was not injured.

Aside from the injuries in the decay-control treatments the external appearance of the fruit throughout these investigations remained very good.

Two points should be emphasized in conclusion: (1) Peaches and nectarines kept best in a 1% O_2 - 5% CO_2 atmosphere at 32°F. (2) The maximum storage period was 6 weeks for peaches and 9 weeks for nectarines.

Table 1. Quality of peaches and nectarines stored at 32°F in atmospheres with and without CO_2 (1966)[1]

Attribute measured	CO_2 level during storage 0%	5%
Firmness at removal (lb)	9.1 b[3]	9.6 a
Firmness after ripening[2]	2.8 a	1.9 b
Flesh color after ripening (100 indicates excellent color)	82 b	96 a
Taste rating after ripening (7-like very much, 1 dislike very much)	3.8 b	4.2 a
CO_2 production (mg/kg/hr) (in air at 65° after CA storage)	59 a	55 b

[1] Each value is the mean of 3 varieties (Redhaven, Loring peaches and Late Le Grand nectarines) 3 storage periods (3, 6 and 9 weeks) and 3 O_2 levels (1/4, 1 and 21%).

[2] Fruit were ripened in air at 65°F.

[3] Paired values followed by different letters differ from each other at the 1% level of significance.

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Q. Have you had injury from Benlate?

A. There was no injury on nectarines from Benlate in the CO_2 atmospheres, but some injury occurred in CO_2 from the hot water. There was some decay control by Benlate on nectarines. There was relatively good control of decay on peaches, but where the injury was moderately severe, it was rather difficult to evaluate decay control.