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Investigations of Processes in

AVOCADO FRUIT RIPENING

Fruits of most avocado varieties do not soften while still on the tree. Softening of picked fruit, with an accompanying increase of oxygen uptake, can be speeded by supplying chemicals to inhibit respiration of the fruit. In contrast, softening was delayed in these tests by supplying a preparation of unknown composition obtained from a bacterium grown anaerobically in a sucrose solution.

HAAS, FUERTE, and most other avocado varieties ordinarily will not ripen until a few days after the fruit is removed from the tree. Storage life thereafter is generally very short at room temperature. Recent experiments conducted at the University of California, Los Angeles, to study the little known factors involved in the ripening process of the avocado indicated that while the fruit is attached to the tree, a substance is transferred to the fruit—presumably from the leaves—which prevents softening.

Experiments showed that when the branch to which the fruit was attached was girdled at different distances from the fruit, altering the ratio of leaves to fruit, a direct correlation occurred between the number of leaves supporting the fruit and the longevity of the fruit on the tree (see table). If leaves are covered by aluminum foil or dark paper to prevent photosynthesis, and if the branches are girdled so that there is no other way for the fruit to get any materials through the phloem from other branches which are exposed to light, the positive effect of leaves is absent. As shown in the table, such fruit will abscise and fall as if there were no leaves supporting it. This suggests that the factor which regulates fruit longevity on the tree and is synthesized in the leaves is light-dependent.

RELATIONSHIP BETWEEN NUMBER OF LEAVES SUPPORTING A FRUIT AND LONGEVITY OF THE FRUIT ON THE AVOCADO TREE

Number of leaves	Fruit and leaves covered by aluminum foil	Average number days until fruit fell
0	no	18
1	no	24
3	no	31
5	no	37
0	yes	15
5	yes	16

Auxins are organic substances characterized by their ability in low concentrations to promote growth of plant shoots and produce various other effects. To test whether or not auxins play a role in the longevity of fruit on the tree, the apical and lateral meristems, where auxins are present, were removed and the wounds covered with vaseline.

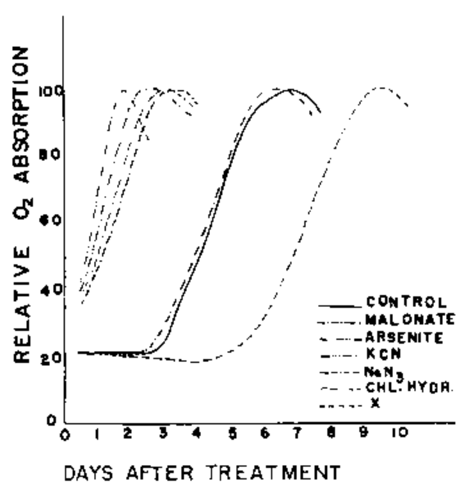
Growth regulators

No effect was observed when compared with fruits where the meristems were not removed. Another test was made by supplying different solutions of growth regulators such as indoleacetic acid, gibberellic acid, and kinetins at concentrations of 1, 5, 10, and 100 ppm respectively, to detached fruits through the cut stem. No effects were demonstrated with any of these regulators when compared with the control fruits which were supplied with water only.

To look for the factor which prevents the development of the abscision layer and the maturation of the fruit while attached to the tree, different solutions such as sucrose, percitol (7-carbon sugar exuded by the tree), glycerol-phosphate, acetyl phosphate, 3-phosphoglyceric acid, glyceraldehyde, glyoxylic acid, and pyruvate, were supplied at pH 7.0 to the detached fruit through the stem. The stem of the fruit was cut and attached (under water) by a rubber tube to a glass tube containing the solutions. Again, no effect was shown for the solutions compared with the control fruits which were supplied with water only.

A leaf extract of freshly picked leaves —washed, blended in water, and supplied to the fruit—as a supernatant from centrifugation at 30,000 × gravity for 15 minutes also had no effect on the fruits.

In one of the experiments, contamination with unidentified bacteria occurred when the detached fruit was supplied with a sucrose solution. When the solution in which the bacteria had grown for a few weeks under anaerobic conditions was supplied to the fruit, the longevity of the detached fruit was significantly increased —as measured by the development of the abscission layer and initiation of the climacteric (see graph). The solutions were



Effect of metabolic inhibitors and other factors on initiation of the climacteric in avocado fruit. "X" is a solution from the bacterium grown anaerobically.

absorbed by the fruit for two to three days only. At the end of the third day no uptake occurred. The factor involved is still unknown.

In other experiments, different metabolic inhibitors known to affect respiration were supplied to detached fruits by the same procedure mentioned above. Immediately after application, a rise in the respiration rate started. When cyanide and chloral hydrate were supplied, the fruit softened entirely. When azide and arsenate were used, the basal half of the fruit did not soften. Malonate, a specific inhibitor for the tricarboxylic acid cycle, had no effect.

High CO_2

Since the solution in which the bacteria were grown anaerobically was high in carbon dioxide, the effect of potassium bicarbonate was checked by supplying $KHCO_3$ at 0.3 molar to the fruit. Fruit supplied with bicarbonate ripened three to five days earlier than controls. To check the effect of the pH of the solutions as a possible explanation of the results, hydrochloric acid and sodium hydroxide (0.1 normal) were supplied to the fruit. Fruits supplied with HCl ripened three to four days earlier than the controls, while fruits with NaOH ripened two to three days earlier than the controls which were supplied with water. The bicarbonate effect, therefore, could be due to the high pH. The treatments did not appear to alter the flavor of the fruits.

Sugar content

The sugar content of avocado fruits decreases with age. This may account for the fact that fruit picked early in the season requires longer to reach the climacteric than fruit picked late in the season. These experiments suggest that avocado fruits are dependent on a constant supply of substrates from the leaves. A reduction in the flow of the materials, below a critical level, results in initiation of the ripening processes. Picking of fruit results in the same effect. The characteristics of the substance or substances involved are not known, but sugar may be involved. Ability to control the processes involved in avocado fruit softening requires still further research.

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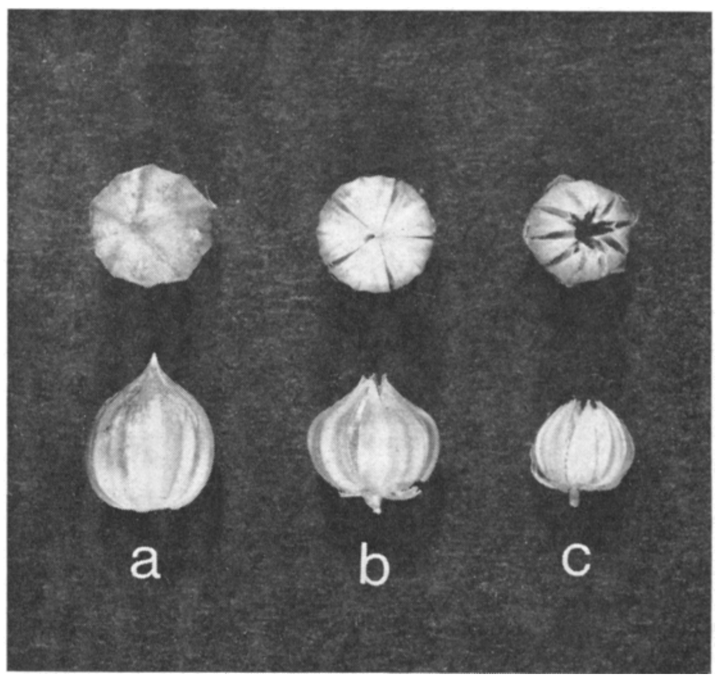
Germplasm available for NEW FLAX . . . with different types

LINSEED OIL is still preferred by paint manufacturers in spite of keen competition from other seed oils and synthetic materials. For this reason, breeding efforts have always been directed toward flax varieties with high linolenic acid content contributing quick-drying qualities to the oil. To develop different types of linseed suitable not only for paint and varnish, but other industrial uses, U.C. researchers at Riverside began collecting and screening a large number of flax strains to make available germplasm with great variability.

Over 1,500 lines of cultivated flax from the United States and abroad were grown at the Experiment Station at Riverside. Analyses of 350 of these lines which appeared to have above average adaptation to California conditions showed the following percentage ranges in fatty acid composition: palmitic, 4 to 7; stearic, 2 to 4; oleic, 14 to 33; linoleic, 7 to 18; and linolenic 45 to 66%. Iodine values ranged from 162 to 196. Most of these seed collections are genetically heterogeneous. Single plant selections with widely varying oil compositions could probably be made. Striking examples of this possibility are apparent in other oil crops. In rapeseed, samples from single plants of the variety "Liho" had a range of 6 to 50% in erucic acid content. In safflower, mutant types have been found with 75% oleic and 15% linoleic acid in contrast to 20% oleic and 70% linoleic acid, respectively, as found in the commercial varieties grown in California. Thus, when



Indehiscent capsule of cultivated flax (a); two types of dehiscent capsules in wild species of flax (b) and (c). (Dehiscence is defined as the bursting open of a pod or capsule at maturity.)