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## Respiration and Ethylene Production of the Developing 'Kerman' Pistachio Fruit<sup>1</sup>

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**Abstract.** Respiration rate of whole 'Kerman' pistachio (*Pistacia vera* L.) fruit increased progressively during seed growth and development and gradually declined after the completion of seed growth. Blank (seedless) fruit, on the other hand, respired at a constant rate which was 5 to 6 times lower than that of fruit with seeds. There was no indication of a climacteric peak in respiration of fruit with seeds. Ethylene evolution from seeded fruit was not significantly different from that of blank fruit. Constant low levels of ethylene were maintained throughout the period of shell and hull dehiscence, as well as fruit maturation, indicating that this hormone is probably not involved in those processes.

A respiration and ethylene evolution study was started in 1978 as part of a research project to modify rate of maturation of the pistachio nut. Initial

respiration measurements of immature fruit, using the method developed by Claypool and Keefer (4), showed large variations among replicate samples collected on the same date from the same tree. Both seed abortion (2) and to a minor extent parthenocarpy (5) contribute to a relatively high incidence of blank nuts (without kernels) in 'Kerman', although they do not abscise from the trees but remain until harvest. Fruit with no kernels developing in them are

identical externally to those with kernels until shortly before maturity when the epidermis of seeded fruit assumes a milky appearance. Unequal numbers of blank fruit in the replications were eventually determined to be responsible for variation in rate of respiration from one replication to another (Fig. 1). The higher the percentage of blank nuts in a sample, the lower was the respiration rate. Fruit in which kernels were developing exhibited respiration rates 4 to 5 times higher than that of blank fruit. These data were derived from samples that were separated by floatation in water.

We found, in 1979, that the use of light was a more convenient, rapid, and accurate method of separating blank from seeded fruit. A cardboard box was used to enclose the light and reflector portion of a reading lamp. A hole slightly smaller than the size of a pistachio fruit was cut in the side of the box directly opposite the light source. By placing the fruit one at a time over the hole, blanks were identified as they transmitted more light than fruit with kernels. Accurate identification of blanks, however, was not attainable until the kernels had reached about 75% of their ultimate size.

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Sampling of 'Kerman' fruit from trees at the Wolfskill Experimental Orchards, Winters, California began on June 29, 1979 and continued at weekly intervals until just before harvest on September 6. This is the period during which kernel growth and development take place within the fruit (6,7). Three replicate samples of 100 g each were placed in 400-ml wide-mouth Mason jars connected to a Claypool-Keefer (4) respirometer. A flow rate of 50 ml of air/min was maintained at 20°C for 5 hr. Air from the jars was bubbled for 15 min through the colorimeter tubes filled with bicarbonate solution containing bromthymol blue. A Bausch and Lomb Spectronic 20 spectrophotometer was used to determine light transmission at 615 nm from which CO<sub>2</sub> output was calculated (8).

A 10-ml sample of the atmosphere in each jar was injected into a Carle 211 analytical gas chromatograph equipped with a flame ionization detector for ethylene determination.

The pericarp of the pistachio fruit, a drupe, rapidly enlarges and reaches about ultimate size generally 30 days after anthesis, i.e. the first of April (6,7). The ovule, supported by a curved funiculus that occupies a small portion of the locule, remains dormant until the end of June when it enlarges rapidly and fills the locule during July. Respiration rate of the fruit increased as seed growth and development was initiated the last of June in the present study (Fig. 2). From a low of 36 ml CO<sub>2</sub>/kg-hr on June 29, rate of respiration increased rapidly, as seed size increased, to a maximum of 125 ml CO<sub>2</sub>/kg-hr on Aug 3. The rate gradually declined after seed growth was completed. There was no indication of a climacteric peak of respiration that is associated with ripening of many fruits, including some drupes (1).

Accurate separation of blank fruit from those with developing kernels was not possible until July 27. Respiration rate of blanks varied slightly between 23 and 27 ml CO<sub>2</sub>/kg-hr throughout the sampling period (Fig. 2). Had it been possible to select with certainty blank fruit from the samples collected prior to July 27, it seems likely that their respiration rates would have been similar to those sampled on and following that date. Respiration rates of fruit with kernels shown in Fig. 2 prior to July 27 may be somewhat low because of uncertainty as to number of blanks included. It is clear, however, that fruit with kernels respire at rates 5 to 6 times higher than those without kernels. It is assumed that this is a direct result of seed growth and development, although an effect of the seed upon the pericarp in stimulating its respiration is a possibility.

There was no significant difference in ethylene evolution between blank fruits

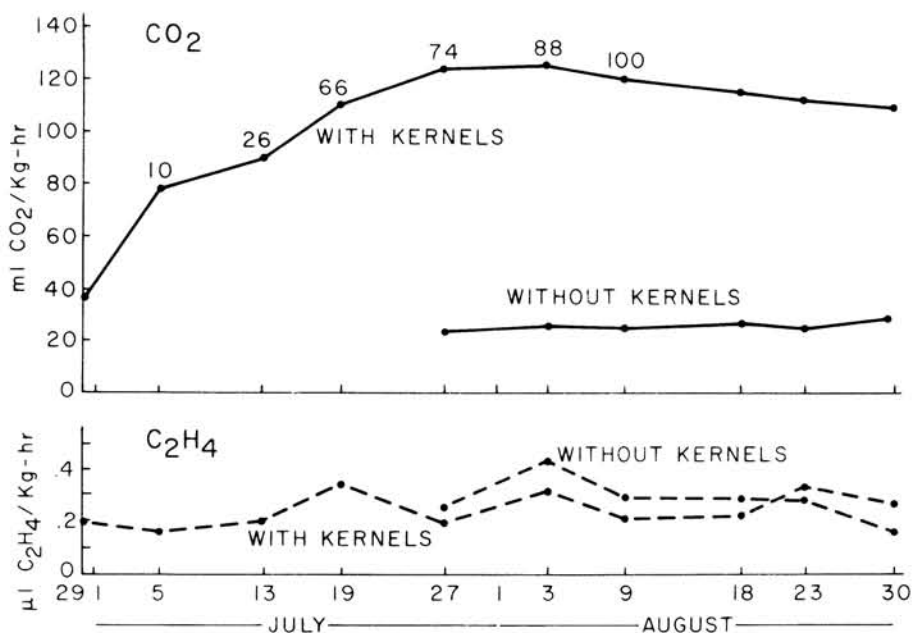


Fig. 2. Comparative rates of respiration and ethylene evolution of pistachio fruit with and without kernels. Numbers on respiration curve indicate percent kernel growth of ultimate size.

and those with kernels, both never exceeding the relatively low level of .44 µl/kg-hr (Fig. 2). These data indicate that the pericarp of the pistachio fruit is solely responsible for ethylene synthesis. Ethylene evolution was at a constant level throughout the period of

seed growth and development and subsequent fruit maturation, hence it apparently is not involved in shell (endocarp) and hull (exocarp and mesocarp) dehiscence nor in maturation and ripening, as it is in many other fruits (3).

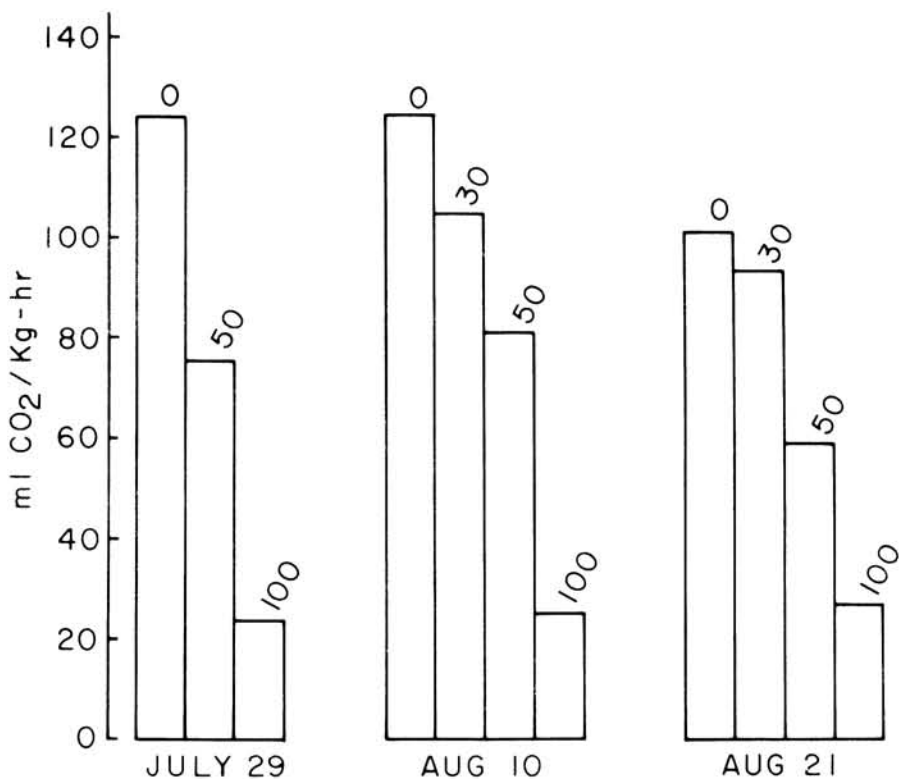


Fig. 1. Relationship between percentage of blank pistachio fruit in a sample (numbers above bars) and rate of respiration as determined on 3 dates during the latter period of nut development.

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