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Claypool L L & Keefer R M. A colorimetric method for CO_2 determination in respiration studies. *Proc. Amer. Soc. Hort. Sci.* **40**:177-86, 1942.
[Divisions of Pomology and Chemistry, University of California, Davis, CA]

This paper describes a rapid colorimetric method for determination of CO_2 content in a constant-flow system as a means of measuring respiratory rates of vegetative organs held under various temperature and atmospheric composition regimes. [The *SCI*® indicates that this paper has been cited in over 165 publications since 1955, making it one of the most cited ever published in this journal.]

L.L. Claypool
720 Elmwood Drive
Davis, CA 95616

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Upon returning to the Department of Pomology at the University of California early in 1937 with a research assignment in postharvest physiology, I became interested in studying the physiological effects of controlled atmosphere (CA) as measured by CO_2 production. The only acceptable method in use at that time was slow and cumbersome, limiting the number of test lots that could be handled simultaneously. My interest in measuring CO_2 evolution of commodities held in many different atmospheric compositions and temperatures required a much more rapid method.

To accomplish this, I sought the collaboration of R.M. Keefer, a physical chemist. A colorimetric method of measuring pH seemed promising. The flow-meter system that I had worked with previously fit perfectly with this method. The scrubbing tower for removing CO_2 from the compressed air source was eliminated when the air source was changed to the outside atmosphere.

Although initially we had no experience with commodities that might produce pH-effecting volatiles other than CO_2, the possibility of such occurring was noted. Changing the indicator following each reading was suggested. However, many experiments have been run by others where the same indicator solution was reused with no apparent problems. During class demonstrations, we found aberrations in respiratory curves of some of the leafy vegetables, particularly the crucifers. These have been traced to the production of ammonia, particularly after deterioration had reached the somewhat advanced stage.[1] A tube containing a non-volatile acid solution ahead of the colorimeter tube containing indicator solution removed NH_3, permitting normal readings for CO_2.

The rate of flow through of air or other atmosphere may influence respiratory-rate readings.[2] If the rate is excessive, ethylene produced by a ripening commodity may not attain a physiologically active level in the chamber, resulting in a slower ripening rate than would occur in a comparable lot with a lesser ventilation rate. However, if the flow rate is too slow, CO_2 may accumulate to a level sufficient to delay the ripening process. Ethylene determinations were not made initially, but recent information supports the assumption of the ethylene effect. By the use of gas chromatography, we have also found that elevated CO_2 levels in a storage atmosphere greatly retard ethylene production even at desirable ripening temperatures.[3]

Colorimetric respiratory-rate determinations of commodities held in atmospheres containing considerable amounts of CO_2 are limited in accuracy. However, the flow-meter system used with the colorimetric method of measuring respiration is excellent as a means of mixing gases (oxygen, nitrogen, and CO_2) to obtain controlled atmospheres of desired composition.

Although the colorimetric method is now more than 40 years old, it remains highly useful in many circumstances where broad physiological effects associated with CO_2 evolution are of interest.

1. **Morris L L.** Personal communication, 1983.
2. **Claypool L L, Maxie E C & Esau P.** Effect of aeration rate on the respiratory activity of some deciduous fruits. *Proc. Amer. Soc. Hort. Sci.* **66**:125-34, 1955.
3. **Claypool L L.** *Effect of CO_2 containing atmospheres on C_2H_4 production of certain fruits.* Unpublished speech presented to the Gordon Conference on Postharvest Physiology, 21-25 August 1972, Andover, New Hampshire.

