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CRITICAL OXYGEN LEVEL FOR THE RESPIRATION OF LYCOPERSICON ESCULENTUM

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Low oxygen concentrations are widely used as a means for retarding the respiration and ripening of fruits. Decreasing the oxygen level results in a corresponding decrease in the rate of respiration and a subsequent increase in the storage life of fruits. Certain fruits, however, respond typically to a 'critical oxygen level' below and above which there is an increase in the rate of respiration. This increased respiratory activity at subcritical oxygen levels has been attributed to anaerobic respiration.[1]

It is possible that prolonged storage of fruits in subcritical oxygen concentrations may result in the accumulation of toxic end products due to incomplete oxidation and may thus shorten the storage life or injure the quality of fruit. It is therefore important to determine the 'critical oxygen level' for the respiration of different fruits and vegetables. The present study was undertaken to determine the 'critical oxygen level' for the respiration of tomatoes, hitherto not reported in the literature.

Mature, hard, green tomatoes weighing 2.0 to 2.25 kg were kept in sealed desiccators which were connected to cylinders which had been previously evacuated by a vacuum pump. Final analysis of the mixture in the cylinder was carried out with an Orsat analyzer having a 100 ml burette. The gas mixture consisted of 2.5% oxygen and 7.5% oxygen with and without 100 ppm of ethylene. A cylinder filled with air and another filled with air containing 100 ppm of ethylene were used as controls.

At the beginning of the experiment, air was removed from each desiccator with a vacuum pump and a mercury manometer was attached to test for the leaks in the system. The desired gas mixture from the cylinder was then flushed through the desiccator at a constant rate of 0.3 standard ft^3/hr. Outflowing gas from the desiccator was sampled with a 25-ml syringe and introduced in a gas chromatograph. The amount of CO_2 was determined using a thermal conductivity detector and an 8-in 60–80 mesh silica gel column. The rate of respiration was followed on the basis of ml of CO_2 liberated 1 hr/kg of fruit. Experiments were carried out in a constant temperature walk-in type growth chamber maintained at 72°F and a thermograph was kept in the chamber to record the temperature fluctuations.

An analysis of the figure shows the following trends:

1. The control sample in air exhibited a typical climacteric burst in respiration.

2. The presence of ethylene in air accelerated the rate of respiration and caused an earlier and a greater rise in the climacteric peak.

3. Decreasing the oxygen level to 7.5% and 2.5% resulted in a corresponding decrease in the rate of respiration. The climacteric rise in 7.5% oxygen was much suppressed while in 2.5% oxygen the climacteric rise was completely eliminated.

4. Ethylene with 7.5% oxygen accelerated the rate of respiration and induced a typical climacteric rise. With 2.5% oxygen on the other hand, ethylene did not alter the respiratory behaviour of fruit.

Previous studies have shown that ethylene with O_2 concentrations above 2.5% accelerated the respiration of banana tissues.[5] The present studies showed that ethylene accelerated the respiration of tomato fruit exposed to 7.5% oxygen but had no effect on the respiration of the sample exposed to 2.5% oxygen. It should be noted that the respiratory activity of the sample exposed to 2.5% oxygen and that exposed to 2.5% oxygen with 100 ppm of ethylene were almost identical. The respiratory behaviour of tomato at this low oxygen level thus was not affected by the presence of ethylene.

Burg[2] suggested that ethylene along with oxygen could bind itself to a metallic receptor present in the cell and that the formation of labile products depended on the saturation of the receptive site with oxygen. At the 2.5% oxygen levle, ethylene did not accelerate the rate of respiration. This could be explained by assuming that the required

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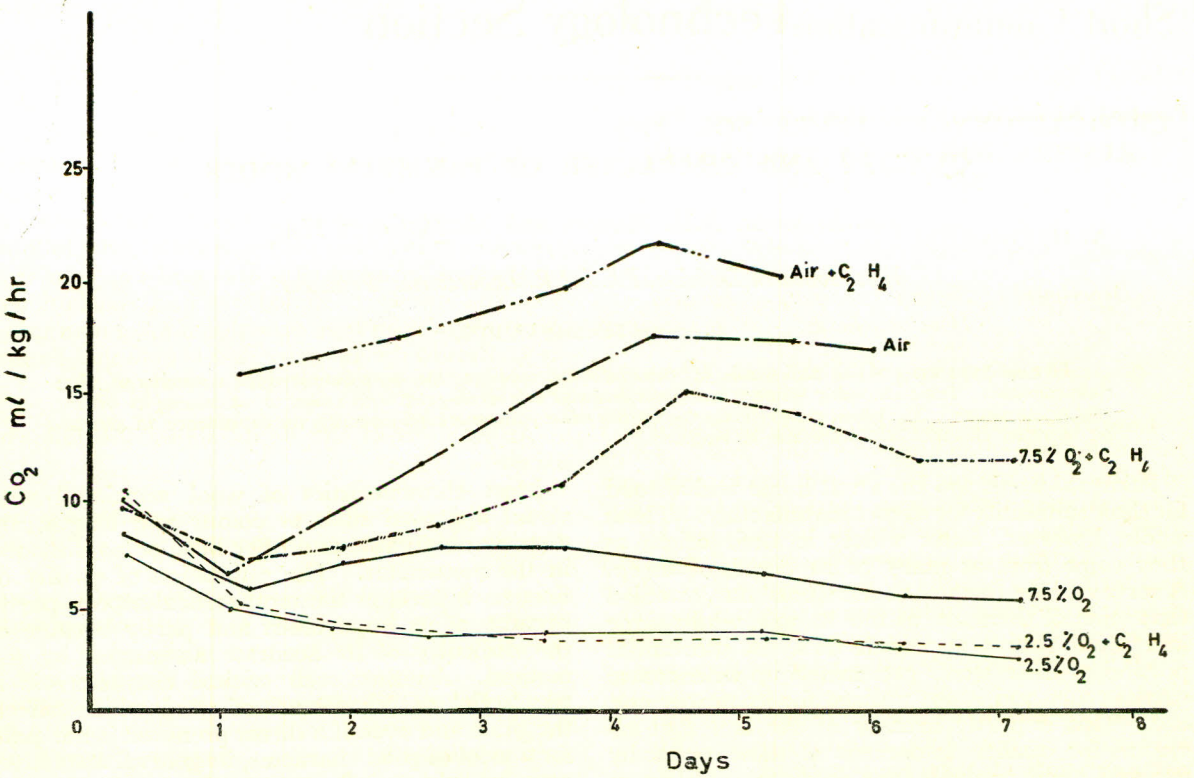

Fig. 1.—Effect of low O_2 concentrations and ethylene on the respiration of tomatoes at 72°F.

amount of oxygen was not present to saturate the metallic receptor. It may therefore be proposed that the tissues had a tendency to pass from the aerobic phase of respiration to the anaerobic phase. The 'critical oxygen level' for the respiration of tomatoes thus appears to be close to 2.5% oxygen.

Critical oxygen levels reported for other fruits and vegetables are: mangoes, 9.2%;[6] bananas, 2.5%;[4] spinach and snap bean 1%, asparagus 2.5%, peas and carrots 4%[3] and lemons 5%[1] The present value of 2.5% for tomatoes lies within the range of values reported for other fruits and vegetables.

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