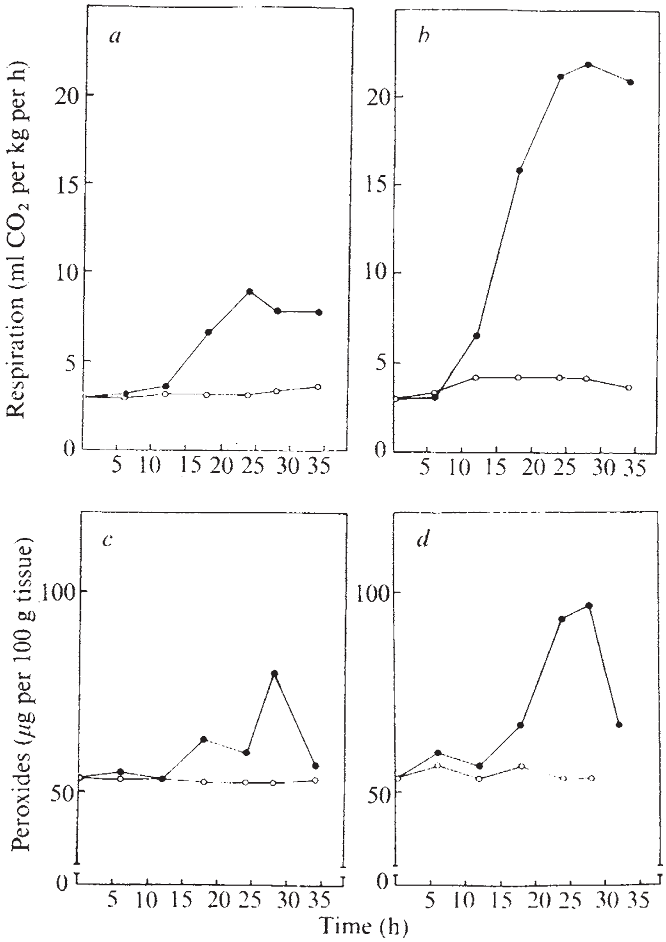
Influence of ethylene and oxygen on respiration and peroxide formation in potato tubers

APPLICATION of ethylene to potato tubers induces a respiratory upsurge[1], comparable with that in ripening climacteric fruit[2], but which can be studied independently of other ethylene-induced processes occurring in fruit. It has been suggested that ethylene catalyses oxygen-requiring processes, reflecting in part oxygen utilisation in the formation of peroxides[3]. We report here that high O_2 tensions, in combination with ethylene, markedly enhance the respiratory rise, which is accompanied by a corresponding increase in peroxides.

Locally grown potato tubers (*Solanum tubersom* L., variety Northchip) were preconditioned at room temperature for 2 weeks after harvest. Four tubers weighing together approximately 1.0 kg were each placed in a 4-l jar and ventilated continuously, at a flow rate of 400 ml min^{-1}, with 21% (air) or 100% O_2, supplemented with 0 or 10 p.p.m. ethylene as previously described[3]. The potatoes were kept at 21 °C throughout the experiment. Evolution of CO_2[4] and peroxide[5] was monitored at 6-h intervals for 36 h. All determinations were run in duplicate.

Figure 1*a* and *b* shows that in the absence of ethylene respiration was at a steady rate in both air and 100% O_2, although in oxygen the rate was somewhat higher. Addition of ethylene to air resulted, after a lag, in a respiratory rise, reaching a peak two or three times the initial rate after 24 h, followed by a decline. By comparison, after a comparable lag, ethylene in 100% O_2 induced a rapid rise in respiration to almost ten times the initial rate.

Fig. 1 Effect of ethylene on CO_2 evolution (*a* and *b*) and peroxide formation (*c* and *d*) in air (21% O_2) and 100% O_2. Ethylene concentrations were zero (○) and 10 p.p.m. (●).



The results show that although ethylene was required to trigger the respiratory rise, as previously observed[1], oxygen tension was the rate limiting factor. A similar interaction between oxygen and ethylene has been obtained in the induction of synthesis of lycopene, the red tomato pigment, in the non-ripening *rin* mutant[3]. As in potato respiration, ethylene was obligatory for the initiation of lycopene synthesis but O_2 tension was the rate limiting factor.

We hypothesised that the changes in the oxygen tension reflect, in part, peroxide formation and that ethylene triggers the process, because (1) ethylene stimulated peroxide formation in fruit[5], and (2) peroxide forming enzymes are stimulated by high O_2 tensions[6].

To test this hypothesis, we measured the changes in peroxides in the tubers as related to the effect of different O_2 tensions with and without ethylene. As with CO_2 evolution in the absence of ethylene, the peroxide level did not change in air or 100% O_2 (Fig. 1*c* and *d*, respectively). Addition of ethylene resulted in an upsurge in the formation of peroxides. As with CO_2 evolution, the peroxide levels were stimulated by high O_2 tensions.

Solomos and Laties[7] proposed that ethylene triggers an alternative respiratory pathway (cyanide insensitive). Our demonstration that the respiratory rise, as influenced by ethylene and oxygen, is accompanied by an upsurge in peroxides suggests that the alternative respiratory pathway leads to the formation of peroxides.

The formation of peroxides in plants is catalysed by several enzyme systems[8], but may also result from the dismutation of superoxides[9]. In any case, the upsurge in peroxides represents the formation of partially reduced oxygen forms, while in respiration molecular oxygen is reduced completely (formation of water). The action of ethylene, as shown in potatoes, may therefore be to divert the flow of electrons from the complete reduction of molecular oxygen to the formation of partially reduced oxygen forms, such as peroxides, which by comparison with O_2, represent oxygen forms which readily react with cellular constituents[8,9]. In this way, ethylene may induce redox changes in tissues, including the oxidative breakdown of senescence-retarding hormones in fruits[5], and thereby the onset of senescence processes.

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Received July 12; accepted September, 7 1976.

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Characterisation of human cell lines and differentiation from HeLa by enzyme typing

THE value of a great deal of research on cells in culture depends on the certain identity of the cells under investigation. Contamination of one cell line with another, leading to mixed cultures or in some cases complete overgrowth of the original cells by the contaminating line, is a long-standing problem. Interspecific contamination has been