SHORT COMMUNICATION

ETHYLENE PRODUCTION BY SLICES OF GREEN BANANA FRUIT AND POTATO TUBER TISSUE DURING THE DEVELOPMENT OF INDUCED RESPIRATION*

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It is well known that injury and infection by disease organisms may stimulate ethylene production by plant tissues (Williamson 1950; Burg 1962; McGlasson and Pratt 1964). The increased ethylene production which results from injury in fruit tissues may hasten the onset of a respiratory climacteric. This response, which has been observed in slices cut from three-quarter-grown cantaloupe fruit, may herald the commencement of physiological changes leading to natural ripening (McGlasson and Pratt 1964). However, in underground storage tissues, stimulated ethylene production may be concerned with the mechanisms of wound healing (Stahmann, Clare, and Woodbury 1966; Imaseki, Uchiyama, and Uritani 1968). The phenomenon of induced respiration in tissue slices of bulky underground storage organs has been known for many years (Laties 1967) and more recently it has been found to occur in sections or slices of other plant parts (ap Rees 1966). Palmer and McGlasson (1969) observed a similar rise in slices of green banana fruit which they considered to be a form of "induced" respiration.

No information has been found which directly relates ethylene production and induced respiration in plant tissue slices, although the possible involvement of a volatile compound(s) in the regulation of metabolism in potato tuber tissue has been alluded to by Laties (1962). The results reported here show the effects of cutting on ethylene production by slices of green banana fruit and potato tuber tissue.

Materials and Methods

Green banana fruit slices were prepared and incubated at 20°C as described previously (Palmer and McGlasson 1969). Slices of potato tuber (*Solanum tuberosum* L., cv. Bungama) were prepared as follows. Cross-sections about 4 cm thick were cut from a potato tuber. Cylinders about 2·8 cm in diameter were then cut from these sections. The cylinders were sliced into sections about 2, 4, and 6 mm thick. The slices were rinsed with water, dried lightly with tissue paper, placed in respiration jars, and ventilated with humidified air (about 1 litre/hr) as described for banana slices.

Carbon dioxide production by the slices was measured with an infrared gas analyser (model SB2, Grubb Parsons & Co. Ltd., England). Ethylene measurements were made with a gas chromatograph fitted with a flame ionization detector (model 15CFX, Loenco Inc., U.S.A.). Operating conditions were as follows: the column was 152 by 0·32 cm packed with 60–72 mesh activated Al_2O_3 (Wilkens–Varian Aerograph), oven temperature 55°C, nitrogen carrier gas 50 ml/min, hydrogen 24 ml/min, and "medical" air (Commonwealth Industrial Gases) about 400 ml/min. Samples (2·5 ml) of the effluent air from each respiration jar were injected with a gas-tight syringe. The lowest concentration of ethylene that could be measured was 0·005 p.p.m.

* Manuscript received October 7, 1968.

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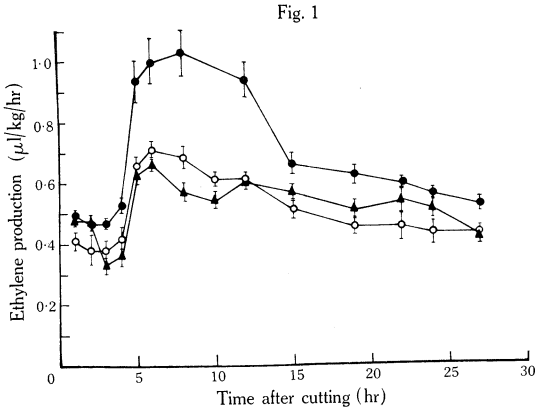
Results and Discussion

Figure 1 shows the rates of ethylene production by slices of green banana fruit, measured initially about 1 hr after cutting. The initial rates were several times higher than the rate of intact fruit. Ethylene production by intact fruit assayed under comparable conditions was barely detectable (less than 0·05 μl/kg/hr). A second rise in the rate of ethylene production was detected 4 hr after cutting and the maximum rate was reached at 6–8 hr.



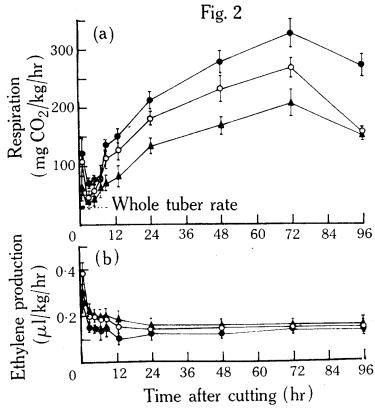


Fig. 1.—Ethylene production by slices of green banana fruit. Each point is the mean of three composite samples cut from three matched fruit. Each sample consisted of eight 2-mm (●), six 4-mm (○), or four 6-mm (▲) slices. The vertical bars indicate estimates of the standard deviations of the population.

Fig. 2.—Carbon dioxide (*a*) and ethylene production (*b*) by composite samples of potato slices. Other details and symbols as for Figure 1.

The corresponding times for the induced rise in respiration were 3–6 hr and 15–20 hr respectively (Palmer and McGlasson 1969). A simple inverse relationship between maximum ethylene production and slice thickness was not observed; the rate of ethylene production was substantially greater with 2-mm than with 4- and 6-mm slices. Ethylene production by the slices fell within 2 days to barely detectable levels. These patterns of respiration and ethylene production were observed provided that slices were cut several days before the onset of the endogenous climacteric (Palmer and McGlasson 1969).

Ethylene production by potato tissue, initially less than 0·015 μl/kg/hr in the intact tuber, was greatly stimulated by cutting (Fig. 2). No further rise in ethylene production was observed, but instead ethylene production decreased gradually over the first 24 hr and then stabilized at a low rate. Slice thickness had no significant effect on the rate of ethylene production, although there was clearly an inverse relationship between the magnitude of induced respiration and slice thickness. These patterns were the same whether the slices were cut under a safe-light (Wratten Filter series 3, <1 f.c./ft^2) and incubated in the dark, or cut and incubated under normal laboratory lighting (about 30 f.c./ft^2). Imaseki, Uchiyama, and Uritani (1968) reported similar rates and a similar pattern of ethylene production by 2-mm slices of sweet potato roots.

The significance of an "induced" rise in ethylene production accompanying induced respiration in banana slices and the absence of this effect in potato slices is not readily apparent.

Imaseki, Uchiyama, and Uritani (1968) showed that applied ethylene stimulated the formation of peroxidase and phenylalanine–ammonia lyase and the increases in oxygen uptake and chlorogenic acid content which are characteristic of aging in sweet potato slices. The optimum ethylene concentration was 1–10 p.p.m. Stahmann, Clare, and Woodbury (1966) previously reported that in sweet potato tissue ethylene induced a resistance to infection by the fungus *Ceratocystis fimbriata* and an increase in the activity of peroxidase and polyphenol oxidase. In potato (*Solanum tuberosum*) they found that ethylene treatment increased the activity of polyphenol oxidase but not of peroxidase. Stahmann, Clare, and Woodbury (1966) suggested that, *in vivo*, ethylene arising from infected tissue may stimulate in adjacent sound tissue metabolic changes which may lead to disease resistance. Although there is no cell division at the cut surfaces of banana slices (Palmer and McGlasson 1969), as there is in potato slices during healing, it is possible that ethylene plays a role in the "recovery" of banana slices from the effects of cutting, perhaps by temporarily stimulating the mobilization of reserves to provide the energy needed for repair processes. Jones (1968) reported that low concentrations of ethylene may enhance release of α-amylase from barley aleurone cells. Preliminary studies with ^{14}C-labelled metabolites (McGlasson, Palmer, Vendrell, and Brady, unpublished data) do not suggest any qualitative changes in the respiratory metabolism of banana slices following cutting, but show that glucose and some organic acids are taken up more rapidly by the cells when slices are infiltrated at 17 hr instead of immediately after cutting.

Acknowledgments

Technical assistance by Messrs. M. J. Franklin and N. Wade is gratefully acknowledged.

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