

EFFECTS OF KINETIN ON RESPIRATION, ETHYLENE PRODUCTION, AND RIPENING OF BANANA FRUIT SLICES*

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Thin slices cut from many plant tissues develop an increased respiration rate in the day or days after cutting (Laties 1963; ap Rees 1966). After slicing, the metabolism of the tissue changes in a number of respects including the capacity for salt and other solute uptake (Asprey 1937; MacDonald 1967), the relative contribution of the pentose phosphate shunt to total hexose catabolism (ap Rees and Beevers 1960; ap Rees 1966), and the induction of a number of enzymes (Edelman and Hall 1965; Willemot and Stumpf 1967). In the case of slices of artichoke tissue, the presence of either indoleacetic acid or kinetin inhibits the increases, in response to slicing, of respiration, of phosphate uptake, and of invertase activity (Palmer 1966). While aspects of the latter experiments have been criticized (Vaughan and MacDonald 1967) the conclusion that the growth factors affect the response to slicing has not been challenged.

When slices are prepared from fruit tissue they develop an increased respiration rate, ethylene output, and malate dehydrogenase (decarboxylating) activity (Galliard *et al.* 1968; Rhodes *et al.* 1968). With slices of green bananas, a peak in ethylene evolution is reached 6–8 hr after slicing (McGlasson 1969), and a peak in respiration 20–25 hr after slicing (Palmer and McGlasson 1969). If 2,4-dichlorophenoxyacetic or indoleacetic acid are added when the bananas are sliced, ethylene evolution and the respiratory response are increased (Vendrell 1969). The latter effect contrasts with the inhibition by indoleacetic acid of the responses of artichoke tuber to slicing. In this communication we report experiments which measure the effect of kinetin on the response of banana fruit to slicing and on the ripening of banana fruit slices.

When kinetin solution (20 or 100 μM) was infiltrated into freshly cut transverse slices of green banana fruit, the peak in ethylene evolution occurred earlier, and the maximum rate of ethylene evolution was 30% greater, than in slices infiltrated with water or left uninfiltrated [Fig. 1(a)]. The respiration rate of kinetin-treated slices exceeded that of controls throughout the 48-hr period after slicing [Fig. 1(b)]. In the presence of kinetin the maximal respiration rate attained was about 30% greater than in its absence. The presence of kinetin enhances the responses of banana fruit tissue to slicing, and in this respect banana fruit contrasts with artichoke tuber tissue. A stimulation of ethylene production in response to kinetin treatment has also been reported in etiolated pea seedlings (Fuchs and Lieberman 1968).

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To test the effect of kinetin treatment on the ripening of banana slices, slices 6 mm thick were infiltrated with a 100 μM kinetin solution immediately before exposure to 60 p.p.m. ethylene for 16 hr. The respiratory climacteric developed

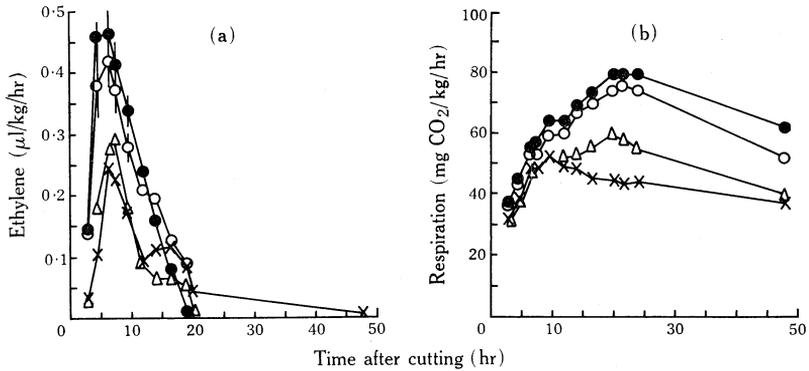


Fig. 1.—Ethylene (a) and CO_2 (b) production by slices infiltrated with distilled water (Δ), 100 μM kinetin (\bullet), 20 μM kinetin (\circ), or retained as uninfiltrated controls (\times). Each treatment was replicated three times, using bulked samples of four slices. Slices were cut from fruit 3 days after harvest. Bars show standard errors. Where errors are not shown these are less than the height of the symbol.

normally in the slices (Palmer and McGlasson 1969), and the presence of kinetin did not influence this response. Accumulation of ethanol-soluble carbohydrate in the pulp was little different in the presence of kinetin (Table 1). However, peel degreening was markedly retarded by kinetin treatment (Table 1), so that the peel

TABLE 1

ETHANOL-SOLUBLE CARBOHYDRATE IN PULP AND CHLOROPHYLL CONTENT OF KINETIN- AND WATER-INFILTRATED BANANA SLICES RIPENED WITH ETHYLENE
Freshly cut slices were infiltrated with 100 μM kinetin solution or water, and treated with ethylene (60 p.p.m.) for 16 hr. Each result is the mean of duplicate extracts made from two slices. Total carbohydrate was determined on 80% (v/v) ethanol extracts of pulp tissue by the method of Pinnegar (1965). Chlorophyll was measured in 80% (v/v) acetone extracts of peel (Mackinney 1941)

Days after Ethylene Applied	Ethanol-soluble Carbohydrate in Pulp (g/100 g fresh wt.)		Chlorophyll (mg/100 g fresh wt.)	
	Water	Kinetin	Water	Kinetin
0	0.067 \pm 0.004		9.50 \pm 0.18	
3	0.429 \pm 0.002	0.319 \pm 0.015	1.89 \pm 0.06	6.11 \pm 0.11
4	0.750 \pm 0.025	0.678 \pm 0.007	0.86 \pm 0.04	2.38 \pm 0.10

remained green when the pulp was ripe in terms of softness, sugar content, and the presence of flavour volatiles. A "green-ripe" condition was also observed when slices bathed in 100 μM benzyladenine were exposed to ethylene.

Benzyladenine delays degreening of at least one variety of apple (Smock, Martin, and Padfield 1962). Local applications of kinetin to banana peel delay degreening in the treated areas (Simmonds 1963). Chloroisopropylphenylcarbamate has been reported to delay degreening and softening of bananas (Blake and Stevenson 1959). Although substituted phenylcarbamates are not active in the cell-division bioassay (Bruce and Zwar 1966) they induce many of the responses typical of cytokinins, including the retardation of chlorophyll loss in leaves (Mann *et al.* 1967).

When the auxins indoleacetic acid or 2,4-dichlorophenoxyacetic acid are infiltrated into banana slices, ripening in response to applied ethylene of both the pulp and the peel is delayed (Vendrell 1969). When gibberellic acid is infiltrated into slices, immediately prior to ethylene treatment, pulp ripening proceeds normally, but degreening of the peel is delayed (Vendrell 1970). Our results show that kinetin treatment also delays peel degreening but not pulp ripening under these conditions. The degreening of the banana peel in response to ethylene treatment has now been shown to be delayed when an auxin, a gibberellin, or a cytokinin is applied.

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