RESPIRATION AND RIPENING OF BANANA FRUIT SLICES

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Summary

Transverse slices of green banana fruit (2–6 mm thick) exhibit after cutting an initial burst of respiration which largely subsides within 2 hr, and a broad peak of "induced" respiration at 15–20 hr. Respiration subsequently declines and within 4 days stabilizes at a rate two to three and a half times that of matched, intact fruits. Ripening of the slices occurs naturally within 4 weeks after cutting; it may also be induced at any time by treating with ethylene. In all attributes studied (sensitivity to ethylene, respiratory climacteric, respiratory quotient, peel colour changes, starch to sugar conversion, softening, and aroma development), the slices are comparable to whole fruit. Inhibitors or metabolites may be introduced into the slices by vacuum infiltration. The slices provide a suitable model system for studying the biochemistry of fruit ripening at the tissue level.

I. INTRODUCTION

Although much information about fruit ripening has been obtained from studies of enzymes and subcellular particulates (e.g. Hulme, Jones, and Wooltorton 1965; Lance *et al.* 1965), and of changes in metabolites (e.g. Rowan, Pratt, and Robertson 1958; Barker and Solomos 1962; Wyman and Palmer 1964), the elucidation of the key events must come from metabolic studies of organized tissues (Beevers 1961). To overcome the problems inherent in working with intact fruits, ripening at the tissue level has been studied with thin (0·5–1·0 mm thick) disks of tissue cut from the fruit at the appropriate stages of ripening (Baur and Workman 1964; Ben-Yehoshua 1964; Richmond and Biale 1966; Sacher 1966). In view of the well-documented effects of cutting on plant tissue metabolism (Laties 1963; ap Rees 1966) it seems doubtful that such thin disks are really representative of the whole fruit. This is supported by the work of Ku, Murata, and Ogata (1965) who showed that the respiration rates of thin sections cut from banana fruit during the respiratory climacteric may be markedly different from the intact fruit rates. An additional variable which has not been adequately assessed in some of the previous studies was the fact that the slices were bathed with aqueous solutions for relatively long periods. Appreciable leakage of solutes from apple, banana, and avocado tissue (Baur and Workman 1964; Ben-Yehoshua 1964; Burg, Burg, and Marks 1964) and delays in ripening of avocado tissue (Ben-Yehoshua 1964) have been found when disks or slices were held in water or hypertonic solutions.

Buckley (1962) reported that 3-mm thick, cross-sectional disks of green banana fruit appeared to ripen normally in water-saturated air, suggesting that thicker

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slices might provide a compromise between intact fruits and very thin disks. This report shows that the responses to cutting are much reduced when slices about 6 mm thick (transverse sections consisting of pulp plus the attached peel) are cut from green banana fruit. It has been found that such thick slices, which ripen normally and are convenient to handle, may be readily vacuum-infiltrated with test substances. They are considered a suitable model system for studying the biochemistry of ripening at the tissue level.

II. Materials and Methods

(*a*) *Fruit Supplies*

Green fruits of the Williams Hybrid strain of the Dwarf Cavendish variety were obtained from commercial banana plantations at Coffs Harbour and Avoca, N.S.W. The fruits were slightly immature by commercial standards and arrived at the laboratory within 3 days after harvest.

Individual bananas were dipped briefly in an aqueous fungicidal solution [0·1% 2-(4′-thiazolyl)benzimidazole* plus 0·025% wetting agent] and then enclosed in respiration jars ventilated with humidified air (about 1 litre/hr) at 20°C.

(*b*) *Preparation and Incubation of Slices*

The bananas were surface-sterilized in sodium hypochlorite solution (1·9% w/v available chlorine) for 10 min, then rinsed with water. Slices were cut free-hand from the central portion of the banana and placed in water for 5–10 min to remove surface debris. After drying with tissue paper the slices were placed individually or in groups in 4-oz jars. The slices were supported on fibre-glass mesh which rested on a layer of glass beads. In composite samples the slices were separated by pieces of fibre-glass mesh. Each jar contained about 2 ml of water to maintain a moist atmosphere. The jars were closed with a rubber stopper fitted with glass inlet and outlet tubes plugged with cotton wool to prevent entry of microbes.

All cutting, washing, and other manipulations were performed in a bench-top hood under aseptic conditions, essentially as outlined by White (1955).

The slices were ventilated with humidified air (about 0·1 litre/hr for a single slice to 1 litre/hr for composite samples) at 20°C.

(*c*) *Respiration Measurements*

Carbon dioxide production was measured colorimetrically (Claypool and Keefer 1942) or with an Infrared Gas Analyser, model SB2, Grubb Parsons & Co. Ltd., England. Oxygen uptake was measured with a D.C.L. Servomex Oxygen Analyser, type 83, Servomex Controls Ltd., Crowborough, England.

(*d*) *Preparation of Gas Streams Enriched with Oxygen*

Gas streams containing 30, 40, and 60% oxygen were prepared by mixing streams of humidified high-purity industrial oxygen and humidified air which were metered manometrically. Oxygen concentrations in the gas streams were monitored with the Servomex Oxygen Analyser. Composite samples of slices were ventilated with the gas streams (about 1 litre/hr) at 20°C.

(*e*) *Vacuum Infiltration of Test Solutions*

One to four slices were infiltrated in 4-oz jars containing 15–25 ml of aqueous sterile test solution. Each jar was closed with a rubber stopper which was fitted with two inlet tubes plugged with cotton wool and an adjustable glass rod to force the slices under the solution. A vacuum

* Marketed as Thibenzole by Merck, Sharpe, and Dohme (Australia) Pty. Ltd.

(26 inHg) was applied to the jars for 1–2 min. Shaking during evacuation aided the discharge of air bubbles from the slices.

On removal from the test solutions the slices were dried lightly with tissue paper and placed in respiration jars. The increase in weight of the slices gave the amount of solute infiltrated.

To determine the distribution of solute, 6-mm slices were vacuum infiltrated soon after cutting with a solution of a non-metabolizable glucose analogue ([U-^{14}C]α-methyl-D-glucoside, 18,700 disintegrations/min/ml, specific activity 4·86 mCi/m-mole). Each slice was cut transversely by hand into three slices about 2 mm in thickness. Each thin slice was further divided into three subsamples. These subsamples consisted respectively of the peel, the septa and axil (which included the vascular and a small amount of adjacent tissue that together outline the three carpellary regions of the edible portion of the banana fruit), and the pulp which comprised the remaining tissue. The subsamples were freeze-dried to a final product temperature of about 40°C.

After freeze-drying, the subsamples were oxidized by the oxygen-flask technique of Kalberer and Rutschmann (1961), and the evolved carbon dioxide and water were trapped in a mixture of ethanolamine and methoxyethanol (1:4, v/v) (Jeffay and Alvarez 1961). An aliquot (9 ml) of this solution was transferred to a 20-ml scintillation counting vial and an equal volume of scintillator solution added (4 g 2,5-diphenyloxazole and 0·1 g 1,4-bis(4-methyl-5-phenyloxazol-2-yl)-benzene in 1 litre of toluene). The samples were counted in a liquid scintillation spectrometer (Tri-carb model No. 3325, Packard Instrument Co., Illinois, U.S.A.). Counting efficiency was 66%.

The evolution of $^{14}CO_2$ was used as an indicator of the ability of slices to metabolize [1-^{14}C]acetate. Slices 2, 4, and 6 mm in thickness were vacuum infiltrated soon after cutting with an aqueous solution of [1-^{14}C]acetate. Trapping of respired CO_2 began 2 min after infiltration. Respired CO_2 was trapped in 9 ml ethanolamine–methoxyethanol (1:4, v/v) in apparatus adapted from Godfrey and Snyder (1962), but with omission of the sulphuric acid traps. The presence of water in the air streams (about 1 litre/hr) had no effect on counting efficiency and the loss of trapping solution was negligible, even when the one vial of trapping solution was used for up to 10 hr. Toluene scintillation solution (9 ml) was added and the samples were counted. The back-up vials contained less than 0·1% of the total counts collected during the experiment.

(*f*) *Analytical Methods*

The sugar content in pulp was estimated by measuring the total soluble solids. With slices, the dried surface layer was first removed. Approximately 1 g of tissue was chopped into small pieces, loaded into a 2-ml Luer-tip syringe, and homogenized by ejecting it forcibly through the orifice of the syringe (no needle) into a tared 15-ml centrifuge tube. Two ml of water were added, the mixture was stirred for 4 min, and then centrifuged at 3100 *g* for 15 min. The "% sugar" in the supernatant fluid was measured with an Atago hand refractometer, and the sugar content of the original tissue was calculated.

Volatile constituents produced by ripening slices were analysed by gas chromatography (Wilkens-Aerograph Hy-Fi model 600-D fitted with a flame ionization detector). The sample was 2·5 ml of the head-space vapour taken after holding individual slices in a closed 125-ml jar for 1 hr.

The fractionating column was 20 ft by $\frac{1}{8}$ in. of 3·5% FFAP (Wilkens-Varian Aerograph) on 60–80 mesh chromosorb G. Operating conditions were: column temperature 83°C, nitrogen carrier gas 20 ml/min, and hydrogen 20 ml/min.

(*g*) *Measurement of Microbial Contamination*

The distribution of microbial contaminants over the cut surfaces was examined by placing freshly cut slices on nutrient agar (Difco) and incubating for 24–48 hr at 25°C. A measure of the number of aerobic viable microorganisms was obtained as follows. Sets of two slices were homogenized in 100 ml of sterile phosphate buffer (0·1M KH_2PO_4–Na_2HPO_4, pH 7·2) in a Waring blender for 60 sec. A series of 10-fold dilutions in phosphate buffer was prepared for each suspension and the diluted suspensions were plated on nutrient agar. Microorganisms were counted following incubation at 25°C for 24 hr.

III. Results

(*a*) *Respiration of Slices*

Cutting of green banana slices resulted in an initial burst of respiration followed by a broad peak of increased respiration (Fig. 1). The height of this peak was inversely proportional to slice thickness. In a separate study it was found that gas streams containing 30, 40, and 60% oxygen did not alter this relationship (Fig. 2). Respiration rates at the peak were not changed by 30 and 40% oxygen but there was some reduction in the rates of 2-mm slices in 60% oxygen. Within 3–4 days after cutting, the respiration rates of slices in air stabilized at two and a half to three times the rate of intact fruit until the appearance of the typical respiratory climacteric [Figs. 3(*a*) and 3(*d*)].

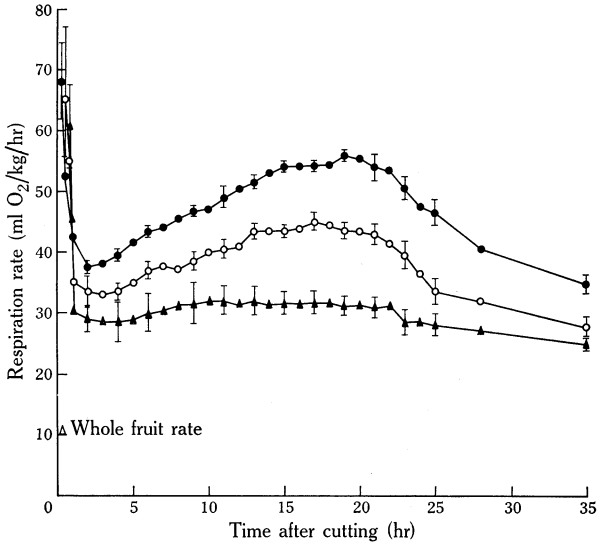

Fig. 1.—Oxygen uptake by slices 2 (●), 4 (○), and 6 (▲) mm in thickness. Each curve represents the mean of three composite samples consisting of seven 2-mm, five 4-mm, or four 6-mm slices cut from three matched fruits. The vertical bars indicate estimates of the standard deviation of the population. The first measurements of oxygen uptake were made 20 min after cutting.

The respiratory climacteric usually began in 10–14 days (Fig. 3), but it sometimes began in 4–5 days or as late as 4 weeks after cutting. These differences reflected variations in the maturity of the fruit since the climacteric in slices occurred at about the same time as in whole fruits under the same conditions. The magnitude and duration of the climacteric in slices was similar to that in whole fruit (Fig. 3). The climacteric (and associated ripening changes) could be induced at any time by treatment with ethylene. The respiratory quotient of whole fruits and of the slices was approximately 1 until well past the climacteric.

Vacuum infiltration of "aged" slices caused an immediate increase in the respiration rate [Figs. 3(*c*) and 3(*f*)]. Several days were required for respiration to return to the pre-infiltration level. Infiltration of freshly cut slices did not change the respiratory patterns [Figs. 3(*b*) and 3(*e*)]. When ripening of freshly cut slices was induced with ethylene (15 p.p.m.), infiltration during the first 36 hr of treatment caused a short increase in respiration but had no effect on ripening behaviour. When aged 6-mm slices were subjected to the same evacuation in the absence of water, the respiration rate was unchanged. Infiltration of mannitol solutions of 8 and 12 atm pressure [corresponding to the osmotic pressure of pre-climacteric and early climacteric bananas (Von Loesecke 1950)] reduced the respiratory response by about 40%.

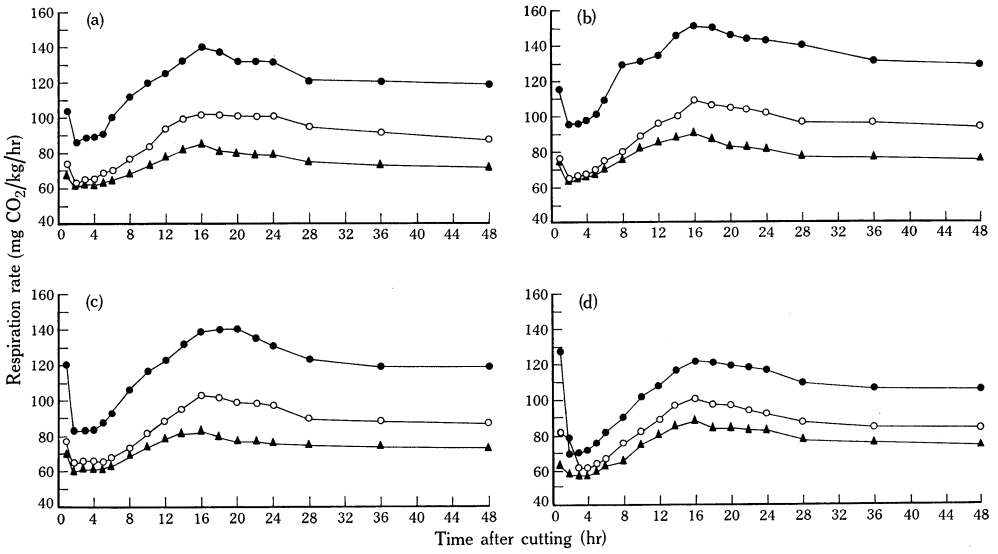

Fig. 2.—Carbon dioxide production by slices 2 (●), 4 (○), and 6 (▲) mm in thickness, ventilated with air (*a*) or with gas streams containing 30 (*b*), 40 (*c*), or 60% (*d*) oxygen. Each curve represents the mean of two composite samples consisting of eight 2-mm, six 4-mm, or four 6-mm slices cut from eight matched fruits. The whole fruit respiration rate in air was 20·3 mg CO_2/kg/hr.

Occasionally, slices cut from green bananas ripened immediately or showed atypical respiration patterns. Investigation showed that this atypical behaviour occurred when the bananas were sliced within 4 days of the beginning of the endogenous climacteric rise in respiration. Examples of the respiration patterns of slices cut at four different times before and once during the climacteric rise are shown in Figure 4. Slices cut on days 7 and 11 were normal although ripening tended to be delayed compared with slices cut on the first day of the experiment (day 0). Slices cut on day 14 showed a protracted climacteric rise and the change from green to yellow in the peel lagged further than usual behind the swelling of the pulp. Cutting of slices 1 day before the climacteric peak (day 18) resulted in an initial burst of respiration followed by a declining rate.

(*b*) *Appearance and Changes during Ripening of Slices*

The 4- and 6-mm slices maintained their original colour and shape until the climacteric, although slight darkening of the cut surfaces was sometimes noticeable during the first few days of incubation. Slices 2 mm in thickness tended to curl and were more difficult to handle, and the time to the beginning of ripening tended to be more variable than in thicker slices. The pulp developed a thin, dry "skin" during

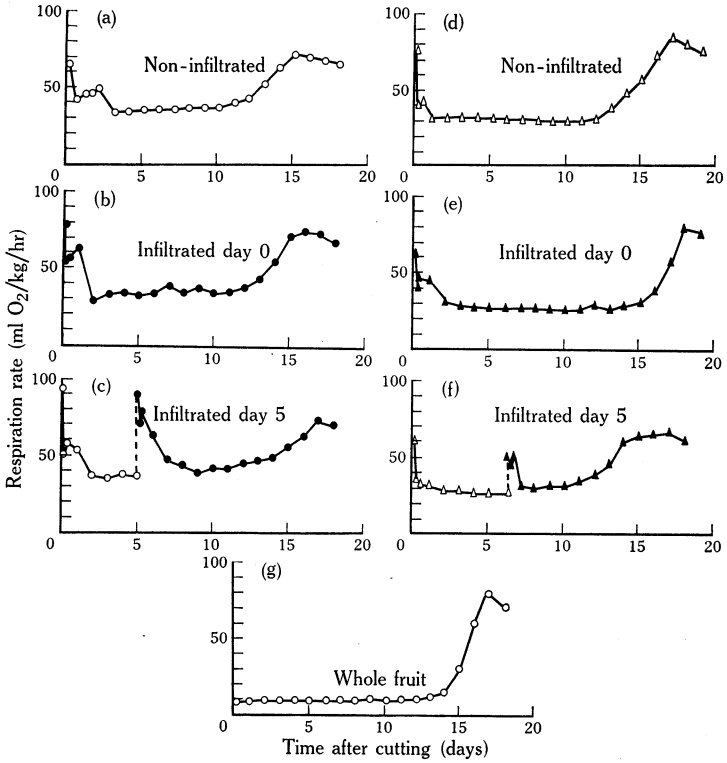

Fig. 3.—Effects of vacuum infiltration with water (26 inHg for 2 min), at cutting time and after aging for 5 days, on oxygen uptake and time to ripen by 2-mm (*a–c*) and 6-mm (*d–f*) slices. Each curve represents the mean of two composite samples, consisting of eight 2-mm or four 6-mm slices, cut from four matched fruits. The respiratory trends of comparable whole fruit is shown in (*g*). The estimate of the standard deviation of the population ($n = 9$) for the time taken by whole fruit to reach the climacteric peak of respiration was ± 2 days.

incubation. Iodine staining revealed that starch hydrolysis began in the placental region of the slices shortly after the climacteric peak, and 4–5 days later, when the peel was yellow, starch was detectable only in a thin band on the surface of the pulp. Presumably these outer cells died as a result of cutting and the surface skin consisted of the dried contents of these dead cells, including the unhydrolysed starch.

The sugar content (total soluble solids) of the slices increased sharply as the starch was hydrolysed, closely following the pattern in whole fruits (Fig. 5).

The slices remained typically hard and crisp until the onset of the climacteric. Then they softened progressively as ripening proceeded. Soon after the climacteric peak the pulp in the slices swelled. The swelling apparently arose solely from uptake of water; examination under the microscope showed no evidence of cell proliferation. Slices incubated with their lower surfaces in agar or water became highly swollen and near the climacteric tended to split, coincident with development of erratic respiration.

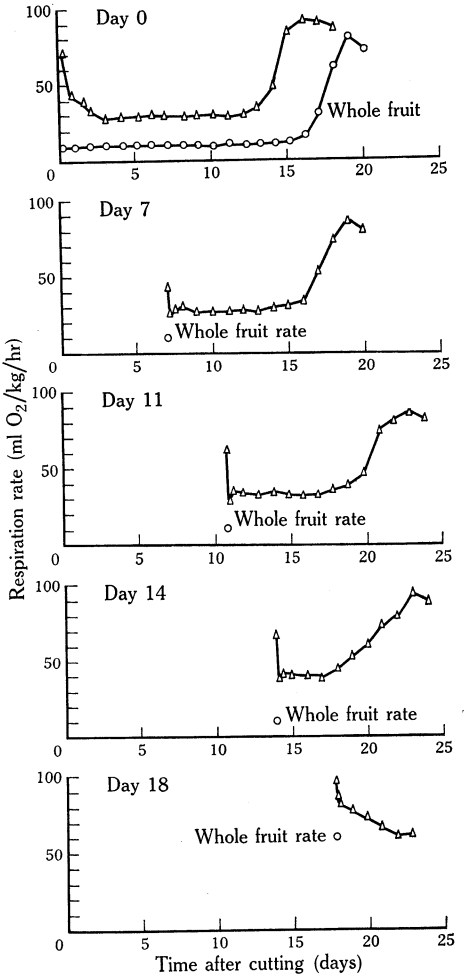

Fig. 4.—Respiratory responses of slices, cut from whole fruit at various times before and during the climacteric rise. Each curve is the mean of two samples, each containing four 6-mm slices cut from a single fruit. The data were obtained with fruit from the same lot used in Figure 3. The curve for whole fruit respiration is repeated from Figure 3.

A typical banana aroma developed in the slices as the peel became fully yellow. Gas chromatograms of the head-space vapour surrounding the slices revealed the

presence of a complex mixture of volatile constituents. No attempt was made to identify these volatiles, but the pattern was similar to those reported earlier for ripening bananas (McCarthy *et al.* 1963).

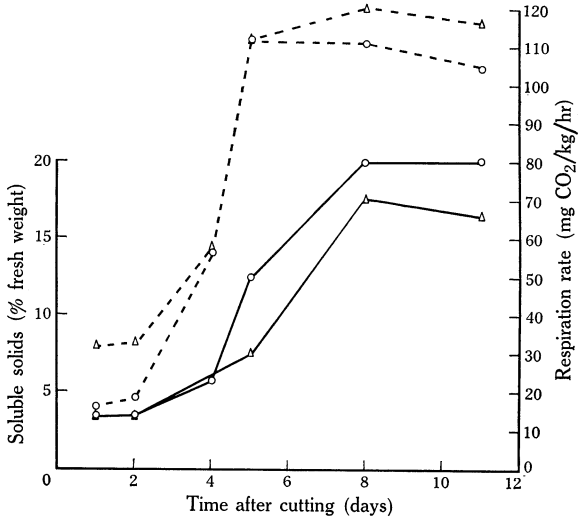

Fig. 5.—Changes in soluble solids (as an estimate of total sugars) (———) and respiration (– – –) in whole fruit (○) and slices (△) during the respiratory climacteric. Yellowing of the peel was apparent at day 7, and the peel was fully yellow at day 11.

(*c*) *Microbial Contamination*

Unripe slices remained free of obvious microbial growth, even when cut without the normal aseptic procedure. Microbial growth (usually fungi) occasionally appeared on fully ripe slices. Incipient infections could usually be detected by a sharp increase in respiration rate prior to the appearance of this growth.

When freshly cut slices were placed on nutrient agar at 25°C for 24–48 hr, only a few colonies developed, mostly at the periphery. Aerobic viable counts showed that green slices had less than 50 organisms/slice just after cutting. During incubation at 20°C for 2–5 days, the microbial population on some slices remained stationary while on others it increased to 10^4–10^6 organisms/slice. By contrast, slices cut from non-sterilized green bananas had almost 10^6 organisms/slice just after cutting. The counts on ripening slices rose rapidly, in one case approaching 10^7 organisms/slice in 6 days while comparable green slices had only 10^2–10^4 organisms/slice. Examination revealed that the microbial populations were almost entirely bacterial in nature.

(*d*) *Vacuum Infiltration of Test Solutions*

Preliminary trials demonstrated that little [U-^{14}C]α-methyl-D-glucoside was absorbed by green banana slices from aqueous solutions applied to the cut surfaces. Uptake was only slightly improved when one surface of the slice was immersed in the test solution.

Vacuum infiltration resulted in an 8–10% increase in fresh weight. Infiltrated eosin dye distributed evenly. The results with eosin were confirmed with [U-^{14}C]α-methyl-D-glucoside (Table 1).

TABLE 1

DISTRIBUTION OF [U-^{14}C]α-METHYL-D-GLUCOSIDE IN BANANA SLICES FOLLOWING INFILTRATION

The statistical limits are estimates of the standard deviation of the population

	Mean Fresh Weight (g) after Infiltration*	Distribution Index†
Outer peel	1·0285	0·99±0·17
Outer pulp	0·9443	1·07±0·06
Outer septa and axil	0·6959	0·89±0·04
Inner peel	1·0217	0·86±0·13
Inner pulp	0·8498	0·93±0·20
Inner septa and axil	0·6959	0·89±0·04

* Increase in weight by infiltration was 8·3±1·4% (n = 3). The two sets of data for outer slice tissue have been combined.

† The distribution index is the ratio of the percentage of ^{14}C recovered in each subsample to the percentage of the fresh weight of the whole slice in each subsample.

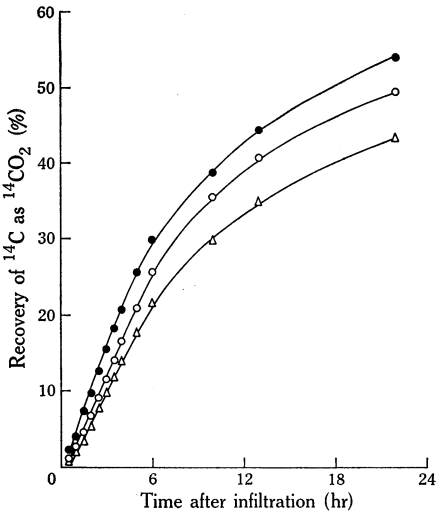

Fig. 6.—Percentage recovery of ^{14}C as $^{14}CO_2$ evolved by 2-mm (●), 4-mm (○), and 6-mm (△) slices infiltrated with [1-^{14}C]acetate at cutting time. The infiltration solution contained 685,000 disintegrations/min/ml, the specific activity of the acetate being 29 mCi/m-mole. Estimates of the standard deviation of the population are given in the text.

[1-^{14}C]Acetate and 2,4-dinitrophenol were infiltrated into freshly cut slices to see if they entered the cells. Labelled acetate was readily metabolized by freshly cut slices (Fig. 6).

The statistical limits (estimates of the standard deviation of the population) of the data in Figure 6 are given in the following tabulation:

Thickness of slices (mm)	2	4	6
No. of slices	3	3	2
Initial weight (g)	1·91±0·25	3·45±0·28	5·14±0·29
Weight increase (%)	9·0 ±0·2	7·6 ±0·9	7·8 ±0·4

Substantial amounts of $^{14}CO_2$ were evolved during the first 30 min and the rate of evolution of $^{14}CO_2$ was constant over the period $1\frac{1}{2}$–$2\frac{1}{2}$ hr after infiltration. The respiration rate of slices was almost constant during this interval. The rate of evolution of $^{14}CO_2$ per gram fresh weight and the percentage of the infiltrated acetate converted to CO_2 were higher for thinner slices. The general pattern of evolution of $^{14}CO_2$ by slices infiltrated with [1-^{14}C]acetate after aging for 4 days was similar to that shown in Figure 6 but the weight increases were more variable. Infiltration of 2,4-dinitrophenol (10^{-4}M) into freshly cut slices resulted in a 35% increase in respiration rate. This increase persisted throughout the subsequent ripening of the slices.

IV. Discussion

The use of 2- to 6-mm slices of green fruit does not entirely overcome the objections inherent in studies with thin slices, namely changes in respiration and other metabolic patterns. Cutting still stimulates an increase in respiration but the effects are much reduced as the slice thickness is increased (Figs. 1 and 2) and the thicker slices "recover" from the effects of cutting in 3–4 days (Fig. 3). In contrast, respiration rates of thin slices of other plant tissues tend to remain high (ap Rees 1966) or to increase for several days after cutting (Ben-Yehoshua 1964). Thin slices of celery petiole are an exception; they also appear to recover (ap Rees 1966). However, there is no simple explanation for the observation that the respiration rate of slices stabilizes at a level two and a half to three times the rate of whole fruit. Although banana slice tissue is undoubtedly better ventilated, ripening in slices does not occur sooner than in whole fruit.

Vacuum infiltration affects respiration in aged slices but it has no effect on respiration of freshly cut slices (Fig. 3) and normally it has no significant effect on ripening behaviour, even when solutions are infiltrated during the first 36 hr of treatment with 15 p.p.m. of ethylene. Apparently the increased respiration in infiltrated aged slices is an expression of some form of "wound respiration" involving the presence of water or aqueous solutions in intercellular spaces. The effect is not entirely due to osmotic stress because infiltration with isotonic or hypertonic solutions of mannitol reduced the respiratory response by about 40% only.

For studies on ripening there seems little advantage in aging the slices; the best compromise is to infiltrate test substances into freshly cut 6-mm slices and immediately induce ripening with ethylene. Under these conditions, the respiratory response to cutting is relatively small and the effect of test substances on the climacteric and subsequent ripening changes is readily apparent within a week. A 6-mm slice is also easier to handle as it maintains its shape during incubation, an adequate number of comparable slices can be cut from a single fruit, and a single

slice provides adequate tissue (about 4 g) for chemical and physical analyses. Uptake and distribution of infiltrated substances is satisfactory with 6-mm slices (Table 1 and Fig. 6). With vacuum infiltration test substances are introduced into the tissues instantaneously and zero time can be specified accurately.

The atypical respiration rates and ripening behaviour of 6-mm slices cut from fruit just before or during the climacteric rise in respiration (Fig. 4) support the suggestion that such slices are not really representative of the whole fruit. However, the deviations in respiration rates were small compared to those reported by Ku, Murata, and Ogata (1965) for thin sections cut during the respiratory climacteric. Their measurements were made in the Warburg respirometer with the slices bathed in phosphate buffer. Mechanical damage can also be expected to become more severe, especially in thin sections, as the fruit begins to soften near the climacteric peak.

Freshly cut slices are virtually free of microbes, but the latter can increase subsequently to about 10^6 organisms/g fresh wt during incubation and ripening. The counts remain much lower on unripe slices, possibly because of an antibiotic substance present in green bananas (Simmonds 1963). The presence of these organisms does not affect the ripening behaviour of the slices and there is no deterioration as reported for melon tissues (McGlasson and Pratt 1964). MacDonald, Webley, and Bacon (1963) have reported that the presence of 10^8–10^9 organisms/g fresh wt did not alter the respiratory patterns or development of invertase activity in washed beet disks.

The data on the respiratory behaviour of green banana slices are also of interest in relation to studies on plant tissue slices in general. The sharp burst of respiration following cutting (Fig. 1) is a response to wounding which is common to most plant tissues (Burg 1962; McGlasson and Pratt 1964). Burg (1962) showed that part of the burst of carbon dioxide evolved by apples immediately after cutting was due to improved ventilation of the tissue. In banana slices the burst of oxygen uptake seems to be largely a direct response to injury, rather than the result of improved ventilation, since whole preclimacteric bananas at 20°C have been shown to have an internal atmosphere containing about 2% carbon dioxide and at least 14% oxygen (Leonard and Wardlaw 1941) which would not be expected to have much effect on the rate of respiration (Young, Romani, and Biale 1962).

The second increase in respiration which reaches a peak between 15 and 20 hr after cutting (Figs. 1 and 2) appears similar to the "induced" respiration described for slices of other plant tissues (Laties 1963; ap Rees 1966). Like induced respiration in potato tuber slices (Laties 1963), the magnitude of the second increase is inversely related to slice thickness. In thick banana slices induced respiration is not confined to the outer 1-mm layer of cells. If the outer 1-mm layers of 4- and 6-mm slices are together assumed to attain the same maximum respiration rate as a 2-mm slice (Fig. 1), calculation shows that the inner tissues of the 4- and 6-mm slices attain maximum respiration rates about three and two times higher respectively than the rate of intact fruit. In agreement with the findings of Laties (1963) but in disagreement with those of MacDonald (1968), who also worked with potato slices, the lower rate of respiration of inner tissue in thick banana slices does not reflect internal oxygen deficiency. Ventilation of slices with 30–60% oxygen did not increase the magnitude of induced respiration (Fig. 2). A response to increased oxygen would not be expected

since unripe banana tissue is well ventilated. Intercellular spaces in banana slices amount to at least 10% by volume based on weight increases following vacuum infiltration compared to about 1% in potato tubers (Burton 1950).

Despite the similarities in the respiration patterns following cutting, freshly cut banana slices readily metabolize [1-^{14}C]acetate (Fig. 6) whereas potato slices do not (Laties 1964). After 6 hr 2-, 4-, and 6-mm slices evolved as $^{14}CO_2$ 33, 25, and 22% respectively of the ^{14}C infiltrated as [1-^{14}C]acetate. These proportions, which are closely similar to the corresponding relative rates of respiration between 3 and 6 hr after cutting, indicate that the inner bulk tissue of the slices metabolized significant quantities of [1-^{14}C]acetate.

Further work is in progress on the effects of inhibitors and the fate of metabolites in banana fruit tissue in relation to the development of induced respiration and ripening.

V. Acknowledgments

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