SHORT COMMUNICATIONS

EFFECT OF BENZOIC ACID AND ITS DERIVATIVES ON PLANT METABOLISM*

VIII. EFFECT OF AMINO DERIVATIVES OF BENZOIC ACID ON RESPIRATION OF STARVED AND SUCROSE-FED ETIOLATED BARLEY LEAVES

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In a previous paper (Naguib 1962) the author reviewed the literature on the classification of benzoic acid derivatives into growth-inhibiting and growth-promoting substances. Salama (1959) discussed the effects of *p*-aminobenzoic acid on the respiration of the fungal mats of *Rhizoctonia solani* and concluded that very low concentrations of this substance (0·4 and 3·2 p.p.m.) caused inhibition of respiration, despite the fact that this substance was regarded as a growth promoter for lower organisms and a constituent in the biological synthesis of folic acid (Hotson 1952).

Most of the data on the biological effects of aminobenzoic acid derivatives is concerned with *p*-aminobenzoic acid and its action as a competitive inhibitor of sulpha drugs on the growth of bacteria and higher plants, but little has been published on the effects of these substances on the general metabolism of higher plants. The following experiments demonstrate the effects of *o*-, *m*-, and *p*-aminobenzoic acids on the respiration of barley leaves.

Experimental

Barley grains (*Hordeum hexasticum* cv. Club Maruit) were germinated for 6 days under conditions already described (Naguib 1962) and the harvested leaves were subdivided into 10-g lots. These lots were immersed for 24 hr in 400 ml of each of the following solutions:

Distilled water (control);

Sucrose, concentration 1% (control);

o-, *m*-, and *p*-Aminobenzoic acids (at concentrations of 10^{-3}M and 10^{-2}M);

o-, *m*-, and *p*-Aminobenzoic acids (at concentrations of 10^{-3}M and 10^{-2}M, and to which sucrose at a final concentration of 1% had been added in each case).

These solutions were contained in special glass chambers which were connected to an apparatus similar to that described by Said and Naguib (1955). The carbon dioxide output was measured over 12-hr periods. Each experiment was repeated in duplicate.

Qualitative analyses of the media for benzoic acid and related compounds were carried out by the methods of Bray *et al.* (1950) and Feigl (1958). These, together with pH determinations, were made initially and at the end of the experiment.

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Results and Discussion

Mean values of CO_2 production by the leaves under the indicated treatments are presented in Table 1. The addition of sucrose increased the CO_2 output—as might be expected—in this experiment by some 40%. However, each of the three aminobenzoic acids decreased the CO_2 output, the reduction being more prominent in the second 12-hr period.

TABLE 1

MEAN VALUES OF CARBON DIOXIDE PRODUCTION BY ETIOLATED BARLEY LEAVES TREATED WITH *o*-, *m*,- AND *p*-AMINOBENZOIC ACIDS WITH AND WITHOUT ADDED SUCROSE

Results expressed as grams CO_2 per 100 g fresh weight of leaf tissue. Values in parenthesis are percentages of controls for the relevant periods

Derivative Used	Concn. (M)	Without Sucrose			With Sucrose (1%)		
		0–12 Hr	12–24 Hr	0–24 Hr	0–12 Hr	12–24 Hr	0–24 Hr
o-Aminobenzoic acid	10^{-3}	0·613 (89)	0·407 (65)	1·020 (77)	0·830 (93)	0·805 (84)	1·635 (88)
	10^{-2}	0·640 (93)	0·341 (54)	0·981 (74)	0·576 (63)	0·362 (38)	0·938 (50)
m-Aminobenzoic acid	10^{-3}	0·613 (89)	0·678 (108)	1·291 (98)	0·856 (96)	0·654 (68)	1·510 (81)
	10^{-2}	0·554 (80)	0·490 (78)	1·044 (79)	0·469 (52)	0·341 (35)	0·810 (44)
p-Aminobenzoic acid	10^{-3}	0·678 (98)	0·371 (59)	1·049 (80)	0·730 (81)	0·529 (55)	1·259 (68)
	10^{-2}	0·640 (93)	0·405 (64)	1·045 (79)	0·533 (60)	0·448 (43)	0·981 (53)
Distilled water (control)		0·689 (100)	0·629 (100)	1·318 (100)			
1% sucrose (control)					0·895 (100)	0·959 (100)	1·854 (100)

In the absence of sucrose, the reduction was about 20% and neither the concentration of acid (with the exception of *m*-aminobenzoic acid) nor position of substitution greatly affected the result. This may indicate that these substances all act at one step of the respiration cycle.

In the presence of sucrose, the relative reduction in CO_2 output was greater than in its absence (with the possible exception of *o*-aminobenzoic acid at 10^{-3}M), and here the higher concentration of acid uniformly had greater effect than the lower. Here, also, the position of substitution was without effect, and at 10^{-2}M the reduction in CO_2 output was about 50%.

The initial pH values of the aminobenzoic acid solutions were about 3·2 and 4·1, at 10^{-2}M and 10^{-3}M respectively, irrespective of position of substitution. The pH of the distilled water and sucrose solutions remained steady at pH 6·2, but that of the aminobenzoic acid solutions rose by 0·7–0·9 units during the experiment. In spite of this slight rise, the depression in CO_2 output, as noted above, was greater in the second 12-hour period, suggesting that the aminobenzoic acids had some irreversible effect on the enzymes.

The qualitative analyses of the media provided no evidence for the presence of benzoic acid or benzoic acid derivatives or related substances other than the aminobenzoic acids originally present. It can reasonably be inferred that no isomerization or deamination occurred at the surfaces of contact, that the amino acids as such entered the tissues, and that the effects described are due to them. These effects are generally in agreement with similar inhibitory effects reported for amino and monohydroxy derivatives of benzoic acid (Bernheim and De Turk 1951; Balogh *et al.* 1952; Salama 1959; Naguib 1962).

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