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ETIOLATED BARLEY AND
OAT SEEDLINGS

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INFLUENCE OF ILLUMINATION ON REDUCING SUGAR CONTENT OF ETIOLATED BARLEY AND OAT SEEDLINGS

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Increased rate of carbon dioxide production following illumination of etiolated barley seedlings was observed by Weintraub and Johnston (1944). A possible mechanism for this effect is suggested by the finding of Parija and Saran (1934) of increased reducing sugar content caused by brief illumination of starved *Aralia* leaves, in conjunction with the numerous reports in the literature of an intimate relation between respiratory rate and reducing sugar content of plants. In order to test this possibility experiments have been conducted to ascertain whether changes in the reducing sugar content of etiolated cereal seedlings are produced by illumination of relatively short duration.

"Seeds"² of barley (varieties Hannchen and Sunrise) and of oats (variety Markton) were planted on filter-paper-covered porous stone wicks and allowed to germinate at room temperature in total darkness. At suitable ages, seedlings were exposed to the unfiltered radiation from a frosted tungsten filament lamp for periods of 60 to 200 minutes, at the end of which they were harvested.

For the sugar analyses, the shoots were severed just above the seeds, cut rapidly into small pieces with scissors, and placed in light-tight aluminum cans for weighing. Unilluminated plants were similarly sampled at the same time, the operations being performed in absence of light. The fresh weights were determined as rapidly as possible and the tissues transferred quickly to boiling 95-percent ethyl alcohol. Tests showed that reducing substances were removed completely after three additional extractions with boiling 80-percent alcohol; this procedure was followed throughout. The alcohol was removed from the combined extracts on a water bath and replaced by water.

Reducing power was estimated with the copper-iodometric reagent #50 of Shaffer and Somogyi (1933). In some experiments total

¹ Now with the Department of the Army, Camp Detrick, Frederick, Md.

² Kindly supplied by Merritt N. Pope and T. Ray Stanton of the U. S. Department of Agriculture.

reducing substance was measured after clearing the aqueous solutions by treatment with neutral lead acetate and potassium oxalate. In others, only the fermentable reducing substance was determined, from the difference between analyses before and after treatment of the unclarified solutions with various yeasts.³ In either case sugar was responsible for all, or very nearly all, the reducing power found and, as shown by the fermentation tests, consisted practically entirely of glucose or fructose, or both.

TABLE I.—*Influence of illumination on reducing sugar content of etiolated seedlings*

Exp.	Species	Age (days)	Illumination		Mgm. glucose equivalents per gm. fresh weight	
			Intensity (f. c.)	Duration (min.)	Before illumination	After illumination
1...	<i>Hordeum vulgare</i> var. Hannchen	6	20	60	18.0 2.0 ^a	18.1 2.1 ^a
2...	<i>Hordeum vulgare</i> var. Sunrise	7	25 150	200 200	19.6 19.6	18.7 19.0
3...	<i>Hordeum vulgare</i> var. Sunrise	7	25	165	18.5	16.8
4...	<i>Hordeum vulgare</i> var. Sunrise	8	25	195	12.6	12.6
5...	<i>Avena sativa</i> var. Markton	6	25	180	21.2	21.0
6...	<i>Avena sativa</i> var. Markton	6	20	60	22.4 ^b	22.3 ^b
7...	<i>Avena sativa</i> var. Markton	7	20	60	23.8	23.8

^a Mgm. sucrose per gm. tissue.

^b Leaf blades only.

In a few experiments sucrose also was estimated from the increase in reducing power after hydrolysis by invertase.

Table I summarizes the results obtained with seedlings such as had been found previously to exhibit increased carbon dioxide production after illumination. Each figure represents the average of two or three lots of plants. The values are expressed in terms of fresh weight of tissue. Substantially the same relative results were found if calculated on the basis of dry weight of the extracted tissue.

The data show that, under the experimental conditions employed, the content of reducing sugar is not increased by illumination. Hence

³ We are indebted to Dr. Lynferd J. Wickerham, of the Northern Regional Research Laboratory, U.S.D.A., for cultures of yeasts with specific fermentative ability.

the observed stimulation of carbon dioxide evolution by light does not appear to be attributable to increased sugar content.

These results are not necessarily contradictory to those of Parija and Saran as the nature and condition of the plant material were quite different in the two investigations. The sugar content of the detached *Aralia* leaves was only about one-hundredth as great as in the week-old grass seedlings, and it is not unlikely that metabolism follows a different path under such a condition of starvation. Oat seedlings grown in darkness for a longer time (2 to 3 weeks) were found to exhibit a rapid decline in reducing sugar and in some experiments showed appreciable increases following illumination. This was the case also with old detached tomato shoots which had been kept in the dark for a few days. However, as such plants generally have an unhealthy appearance and show a considerable degree of variability, the significance of this finding is not clear and the experiments have not been pursued.

Summary.—Sugar analyses indicate that the increased rate of carbon dioxide production which follows illumination of etiolated barley seedlings is not due to an increased content of reducing sugar or sucrose.

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