While these parallelisms are not conclusive evidence that the material in cobalt plasma is identical with that in anemic plasma, they suggest that both types of plasma contain erythropoietic factors with grossly similar properties (*10*).

EUGENE GOLDWASSER
LEON O. JACOBSON
WALTER FRIED, LOUIS PLZAK
Argonne Cancer Research Hospital and *Departments of Biochemistry* and *Medicine, University of Chicago, Chicago, Illinois*

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5 March 1957

Control of Arrested Fruit Growth in Tomato by Gibberellins

In recent months, several reports have shown that the gibberellins, when applied to higher plants, are effective in promoting the elongation both of dwarf mutants of corn (*1*) and of normal plants of several additional species (*2*). The gibberellins also promote the expansion of etiolated leaves (*3*), reverse the red-light-induced inhibition of pea internode growth (*4*), break the dormancy of red-light-requiring lettuce seed (*5*), and effectively substitute for the cold (*6*) requirement of biennial *Hyoscyamus*.

The afore-mentioned results suggested that the gibberellins might also be effective in alleviating the condition of arrested fruit growth and development (which is essentially a condition of dormancy) in commercial tomatoes. This condition is particularly characteristic of the fruits of the Marglobe variety grown in the field under the high light and temperature of summer or in the greenhouse in early fall at College Station, Tex. (*7*). The condition of "summer dormancy" in tomato in essence amounts to a very marked reduction of growth of both vegetative and reproductive structures. The leaves fold inward toward the petiole; the whole petiole and attached leaflets then fold upward toward the stem, and the internodes of the stem become progressively shorter as the season proceeds. Even though some viable pollen may be produced and fertilization may occur, the fruits remain very small (0.5 to 2.0 mm in diameter) until some external factor breaks their "dormancy." It has been shown that this summer-induced dormancy of tomato fruits can be caused by far red irradiation in the winter (*8*) and that cool temperatures, auxins, or red light are capable of reversing it. However, none of these methods serves as a practical means of control in the field.

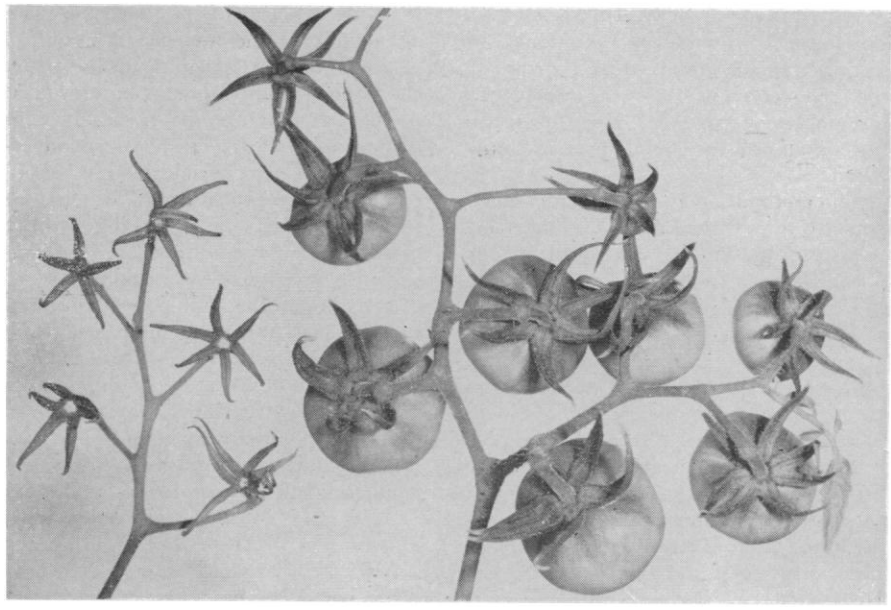

Fig. 1. (Left) Marglobe tomato fruit spur with small, dormant, pollinated fruits. (Right) Spur with enlarging fruits following five applications of a 25-μg/lit gibberellic acid spray to the sepals.

Seedlings of Marglobe tomatoes were potted in individual containers on 15 Aug. 1956 and treated in October and November. The green sepals of the dormant fruits were sprayed until run-off on alternate days for a total of five sprayings with water or gibberellins (*9*) at 25 or 250 μg/lit. The sprayed fruits, approximately 2 mm in diameter before spraying, were allowed to develop for 15 days following the initial spraying before the experiment was terminated.

Both 25 and 250 μg of gibberellin per liter produced an appreciable number of enlarged fruits as compared with controls. Thus, of the 121 fruits on control plants, only nine (7 percent) had broken dormancy and grown to at least 5-mm diameter, whereas 63 of 135 (46 percent) and 30 of 128 (23 percent) of those treated with 25 and 250 μg/lit, respectively, had increased to this size. The higher concentration appeared to be slightly toxic, for a number of young dormant fruits turned brown after application of the spray; this condition was not apparent in either the controls or at the 25 μg/lit level. Figure 1 shows the striking effect of gibberellins on the development of dormant tomatoes.

These results are not in agreement with the negative results on normally developing fruits reported by Marth *et al.* (*2*). However, it is possible that there is no basis for comparing dormant fruit and normally developing fruit. The mechanism of action of the gibberellins in this system is not known. On the basis of experiments with leaf disks conducted in this laboratory (*3*), it would not seem that the gibberellins replace the red light. This is more unlikely when it is considered that auxins and cool weather also break the dormancy of tomato fruits. A more plausible explanation would seem to be that all these factors affect the same biochemical pathway, but at different reaction steps or in a different manner. A full understanding of the action of the gibberellins in this system as well as in other systems reported must await further experimentation (*10*).

J. L. LIVERMAN
S. P. JOHNSON
Departments of Biochemistry and Nutrition and *Plant Physiology and Pathology, Texas Agricultural and Mechanical College System, College Station, Texas*

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Effect of Iodoacetate and Iodoacetamide on Oxygen Uptake of Heart Mitochondria

Iodoacetate and iodoacetamide have been used as specific inhibitors of the Embden-Meyerhof pathway of glycolysis, the site of inhibition being at the triose-phosphate dehydrogenase. Early reports (*1*) indicated that iodoacetate at low concentrations inhibited anaerobic glycolysis and respiration with glucose but not the oxygen uptake induced by addition of pyruvate or lactate. More recent studies (*2*) have shown that the oxidation of pyruvate may be reasonably sensitive to iodoacetate. A study of the direct effects of iodoacetate and iodoacetamide on the aerobic oxidation of pyruvate and cycle intermediates by mitochondria would provide more information on their effects on respiration and give a basis for the judicious use of a particular concentration of these inhibitors to inhibit specifically the glycolytic pathway.

The preparation of the rat heart mitochondrial suspension and the manometric measurement of oxygen uptake were made according to the methods of Montgomery and Webb (*3*). The results are summarized in Table 1. Both inhibitors at a concentration of 1.0 m*M* produced distinct inhibition with all substrates, the strongest inhibition being observed in the oxidation of pyruvate and α-ketoglutarate, which may indicate the sensitivity of systems involving coenzyme A and lipoic acid. However, the lower concentrations also produced definite inhibitions which cannot be ignored in respiratory studies. It may be noted that iodoacetate was generally more effective than iodoacetamide. In order to produce complete inhibition of triose-phosphate dehydrogenase and glycolysis, concentrations of 0.2 to 0.5 m*M* must be used in most cases, and thus the present results indicate that a complete inhibition of glycolysis is usually accompanied with some effect on respiration (*4*).

Table 1. Effects of iodoacetate and iodoacetamide on the mitochondrial oxidation of various substrates. The reaction medium contained 121 m*M* KCl, 20 m*M* potassium phosphate buffer (*p*H 6.8), 0.01 m*M* cytochrome *c*, 5 m*M* $MgCl_2$, 1m*M* adenosine monophosphate, 0.5 m*M* adenosine triphosphate, and 5 m*M* substrate. The temperature was 37°C. The mitochondrial suspension was incubated for 10 minutes with the inhibitors in the medium, and the oxygen uptake was determined over a period of 1 hour.

Substrate	Change (%) at various concentrations		
	0.01 m*M*	0.10 m*M*	1.0 m*M*
Iodoacetate			
α-Ketoglutarate	− 6.3	−33.3	−75.6
Malate	− 7.4	−20.0	−63.9
Pyruvate + malate	− 4.3	−43.0	−85.6
Succinate	− 3.8	− 8.0	−61.2
Citrate	+ 4.6	− 8.1	−34.6
Isocitrate	+15.0	−15.3	−35.0
Iodoacetamide			
α-Ketoglutarate	− 6.4	−17.2	−76.3
Malate	− 1.0	−21.0	−35.3
Pyruvate + malate	− 9.4	−12.6	−79.7
Succinate	− 2.5	−17.0	−43.1
Citrate	−16.1	−14.9	−44.1
Isocitrate	−12.0	− 7.3	−29.1

WILLIAM C. YANG

Department of Pharmacology, School of Medicine, University of Southern California, Los Angeles

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Carbon-14 Activity of Some Heat-Degradation Products of Milk Containing Lactose-1-C^{14}

The course of heat-induced lactose-protein interaction in milk has been followed with the aid of lactose-1-C^{14} (*1*). Use of labeled lactose also appeared attractive for investigation of the sugar's decomposition under these conditions. Of the many fragments known to be formed (*2*), formic acid, furfuryl alcohol, and maltol (3-hydroxy-2-methyl-pyrone-4) were evaluated in these experiments. It has been proposed that formic acid is derived from carbon atom No. 1 and furfuryl alcohol from carbon atoms 2 through 6 in the glucose moiety of lactose (*3*). Maltol results rather uniquely from the heat-induced interaction of reducing disaccharides with amino compounds (*2*). It has been detected in evaporated milk, baked cereals, bread crust, and roasted malt, among other places (*4*).

Table 1. Levels of C^{14} activity found in some heat-degradation products of skim milk containing lactose-1-C^{14}.

Compound	Carbon (atom/mole)	Activity of $BaCo_3$ (Count/min mg)		Lactose/product C^{14} ratio
		Found	Theory*	
Lactose	12	8.7		
Formic acid	1	53	104	1/0.51
Maltol	6	14	17.4	1/0.81
Furfuryl alcohol	5	0.8	20.9	1/0.04
Naphthyl urethane	16	0.0	6.5	
3,5-Dinitrobenzoate	12	0.0	8.7	

* Based on molar transfer of 1 atom of C^{14}.

The three compounds in question were recovered and purified from heated (121°C for 4 hours) condensed skim milk (30 percent total solids) to which lactose-1-C^{14} (National Bureau of Standards) had been added. Steam distillation was used to isolate the compounds from the heated milk. Maltol and furfuryl alcohol were recovered from this distillate by ethyl ether extraction and were purified as described elsewhere (*3, 5*). Formic acid was recovered by neutralizing a portion of the distillate to *p*H 7.5 and evaporating the solution to dryness under vacuum (*6*). The crude formate was selectively converted to CO_2 by the method of Osburn *et al.* (*7*). This CO_2, samples of furfuryl alcohol and its derivatives, maltol and lactose, the latter from the unheated product, were converted to $BaCO_3$ (*8*). Radioactivity in these preparations was determined with a windowless flow gas Geiger-Müller counter and decade scaling unit.

The data thus secured (Table 1) reveal that carbon atom No. 1 of lactose is involved in the formic acid and maltol, but not in the furfuryl alcohol. A preliminary experiment yielded essentially the same findings with the exception that some activity was detected in the furfuryl alcohol (*9*). Further investigation of the alcohol and two carefully authenticated derivatives of it, as shown in Table 1, revealed that it had no activity.

Under the rigorous heating conditions employed in these experiments, a number of carbon sources could contribute to formate; however, carbon 1 of lactose