Propanal May Be a Precursor of Ethylene in Metabolism

Abstract. *Propanal, a product of the decomposition of peroxidized linolenate, is a very effective precursor of ethylene in the copper-catalyzed ethylene-forming model system. This aldehyde also stimulates production of ethylene in slices of tissue of mature green tomatoes. We suggest that propanal is a precursor of ethylene in metabolism.*

We have postulated two pathways for biosynthesis of ethylene in plant tissues (*1, 2*): one involves the degradation of methionine; the other is associated with the breakdown of peroxidized linolenic acid or its methyl ester. Both pathways originally derived from studies using model reaction systems catalyzed by cuprous ions in phosphate or acetate buffers at 25° to 30°C (*3*).

Table 1. Production of ethylene by various substances in the copper-catalyzed model system. System consisted of 400 μmole of acetate or phosphate buffer at *p*H 4.5 and 7.0, respectively; 5 μmole of precursor substance (except where acetate is indicated as the precursor substance in acetate buffer); 5 μmole of copper; and 50 μmole of ascorbate in a total volume of 5 ml. These substances were incubated for 1 hour at 30°C in a closed system. Blank value for system is about 20 μl C_2H_4 in acetate buffer and virtually zero in phosphate buffer. Ethylene was detected by gas chromatography in a manner described (*1*). In the absence of the catalyst there is no spontaneous breakdown to ethylene of the compounds used as precursors.

Precursor substance	Ethylene (× 100 μl/hr) from buffer at:	
	*p*H 4.5	*p*H 7.0
Alcohols		
Methanol	5	5
Ethanol	160	70
1-Propanol	240	140
1-Butanol	150	40
Aldehydes		
Acetaldehyde	5	5
Propanal	10	530
Butanal	5	25
Pentanal	15	5
Hexanal	15	15
Heptanal	15	20
Acids		
Acetic	20	10
Propionic	7	5
Butyric	4	12
Epoxides		
Ethylene oxide	10	3
Propylene oxide	2	5
Butylene oxide	3	2
Ethers		
Ethyl ether	175	85
Proply ether	200	150
Butyl ether	25	10
Related unsaturated and carbonyl compounds		
Acrolein	12	105
Acrylic acid	7	5
Acetone	8	5
Pyruvate	108	8

The general mechanism by which methionine is converted to ethylene in the model system has been described, and the conversion has also been demonstrated in tissues (*1*). However, the mechanism of formation of ethylene from peroxidized linolenate is not clear, and there is little direct evidence of its involvement in tissues. We now report the identity of a breakdown product of peroxidized linolenate that forms ethylene very efficiently in the copper-catalyzed model system, and also stimulates production of ethylene in slices of tomato tissue. This substance is propanal, a major product in the dismutation of hydroperoxides formed during the peroxidation of linolenate (*4*); it has been identified as a metabolic product in fruit tissues (*5*).

Since it is known that hydroperoxides formed in the autoxidation of linolenate readily decompose to aldehydes and various carbonyl compounds (*6*), we tested the effectiveness of several substances as precursors of ethylene in our copper-catalyzed ethylene-forming model system. Among the compounds tested, propanal was outstanding as a precursor of ethylene (Table 1). Furthermore propanal was detected as a major product of the oxidative breakdown of linolenate (*7*).

Slices of tissue of mature green tomatoes, incubated with propanal, were stimulated in their production of ethylene by about 60 percent in comparison with the control (*8*). Stimulation by propanal was much greater than that produced by methionine (20-percent increase), which had been shown to be a precursor of ethylene in tissue slices (*1*).

Although definitive evidence is not yet available, our evidence is sufficient to suggest that propanal, which derives from the dismutation of peroxidized linolenate, can be a precursor of ethylene in metabolism. A related aldehyde, methional, also has been implicated in the methionine ethylene-forming system (*1*). However, current evidence does not support the possibility that propanal is an intermediate between methionine and ethylene (*9*). It now appears that the linolenate-propanal-ethylene system and the methionine-methional-ethylene system are independent pathways.

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References and Notes

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3. The model systems produced methane, ethane, propane, and higher homologues of hydrocarbon gases, both saturated and unsaturated, in addition to ethylene.
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6. A. M. Gaddis, R. Ellis, G. T. Currie, *J. Amer. Oil Chem. Soc.* **38**, 371 (1961).
7. In the model system, the yield ratio of ethylene from peroxidized linolenate and from propanal is 1 : 51,600 (300 μmole of peroxidized linolenate, which consumes 290 μmole of oxygen, produces 0.1 mμmole of ethylene per hour; 5 μmole of propanal produces 86 mμmole of ethylene per hour).
8. Ten grams of tissue slices (0.5-cm squares) were incubated in 10 ml of 0.1*M* phosphate and 0.1*M* citrate (*p*H 4.5; previously found to be an optimum buffer for ethylene production with slices of green tomato tissue), with and without addition of propanal ($10^{-3}M$) or *l*-methionine ($10^{-3}M$). These samples yielded 184, 296, and 220 mμl of ethylene per hour per gram of tissue for control, propanal-treated, and methionine-treated samples, respectively. The tissue was incubated for 5 hours at 30°C in 100-ml Warburg-type flasks containing 1 ml of 15-percent KOH, with filter-paper wicks in the side arms. Propanal, acrolein, and propyl ether do not stimulate production of ethylene in slices of green tomato tissue.
9. In the model system, rates of production of ethylene from methional are considerably greater than from propanal.

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Audiogenic Seizure Susceptibility Induced in C57B1/6J Mice by Prior Auditory Exposure

Abstract. *Pronounced susceptibility to audiogenic seizures was produced in highly resistant C57B1/6J mice after earlier exposure to a loud electric bell. There is a critical period between initial acoustic presentation and subsequent testing for susceptibility; this suggests a minimum age and a minimum lapse of time during which this "priming" is effective.*

Many studies of audiogenic seizures with inbred strains of mice have attributed differences in susceptibility to specifically defined genetic backgrounds. Mice of the C57B1/6J strain are highly resistant to sound-induced convulsions, and those of the DBA/2J strain are extremely susceptible to them (*1*). This behavior has been ascribed to differences between these two strains in (i) oxidative phosphorylation and adenosine triphosphatase which are involved in energy metabolism (*2*); (ii) concentration in the brain of norepinephrine and serotonin, which