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Investigation on the Role of Enzymes in Jasmonates Biosynthesis (A Review Study)

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ABSTRACT

In this paper, we investigate on Jasmonates as a growing class of lipid-derived signaling molecules with diverse functions ranging from the initiation of biotic and abiotic stress responses to the regulation of plant development. Jasmonate biosynthesis initiates from polyunsaturated fatty acids in chloroplast membranes. At the first, we present an introduction to jasmonate biosynthesis, and then we discuss on the Allene oxide synthase (AOS) and then on Allene oxide cyclase (AOC), followed by 12-Oxophytodienoate reductase 3 (OPR3).

Keywords: Jasmonates, biosynthesis, Allene oxide cyclase , Allene oxide synthase.

1. INTRODUCTION

Plants are sessile, but have to adapt to changes of abiotic factors such as light, salt, nutrient deficiency, water deficit or cold. Additionally, biotic interactions with pathogens, herbivores, nematodes or symbiotic microorganisms occur. Jasmonic acid (JA) and its isoleucine conjugate (JA-Ile) are among the most important signals of these different stress responses and are active in root growth, seed germination, stamen development or senescence.
Beside formation of JA via octadecanoids, these branches lead to leaf aldehydes and alcohols, as well as divinyl ether-, epoxy hydroxy-, hydroxy-, and keto-polyunsaturated fatty acids (PUFAs) [1]. Oxygenation by LOXs takes place at carbon atom 9 (9-LOX) or carbon atom 13 (13-LOX). 13-LOX are active with esterified or free fatty acids. In case of Arabidopsis, galactolipids contain esterified OPDA at different positions, collectively called arabidopsides. They are prominent examples for esterified substrates of 13-LOXs. The JA branch within the LOX pathway requires 13-LOXs and the subsequent steps of JA formation have been elucidated by Vick and Zimmermann in 1984.

Polyunsaturated fatty acids (PUFAs) including linoleic acid (18:2), linolenic acid (18:3) and hexadecatrienoic acid (16:3) are abundant in chloroplast membranes and are readily oxidized to yield the corresponding fatty acid hydroperoxides. Under condi-tions of oxidative stress, fatty acid hydroperoxides are formed by free-radical-catalyzed oxidation of PUFAs and may be further oxidized non-enzymatically to generate phytoprostanes, which are considered to be archetypal mediators of oxidative stress responses (Mueller, 2004). Alternatively, fatty acid hydroperoxides are synthesized enzymatically involving lipoxygenase (LOX) or a-dioxygenase (DOX) activities.

The committed step of JA biosynthesis (Fig. 1) is catalyzed by allene oxide synthase (AOS), an unusual cytochrome P450 which does not bind molecular oxygen but uses already oxygenated fatty acidhydroperoxide substrates as oxygen donor and as source for reducing equivalents (Howe and Schilmiller, 2002; Werck-Reichhart et al., 2002). The dehydration of 13(S)-hydroperoxy-octadecatrienoic acid (13-HPOT) by AOS results in the formation of an unstable allylic epoxide (allene oxide), 12,13(S)-epoxy-octadecatrienoic acid.