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Review Article

JASMONATES: MULTIFUNCTIONAL BIOMOLECULES IN PLANTS

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Abstract: Jasmonates (JA's) have been proposed to be affecting a variety of plant processes ranging from normal vegetative and reproductive development to even defense against various abiotic stresses JA's structurally are, cyclopentanone derivates of α-linolenic acid. The precursor is linolenic acid released from the membrane bound lipids which is then converted to jasmonic acid via a series of steps called octadecanoid pathway. Although there has been an increase in the interest regarding these molecules and their role in plants but these are certainly still underexploited biomolecules and more elaborate studies regarding their molecular mechanisms and physiological functions are required.
Keywords: Jasmonic acid, biosynthesis, linolenic acid, abiotic stress.

Introduction

The term Jasmonates (JA) broadly refers to all the biologically active intermediate molecules formed during the biosynthesis of Jasmonic acid along with its derivatives (Turner et al. 2002). Jasmonates have thus been proposed to be affecting a variety of plant processes such as fruit ripening, root growth, tendril coiling, photosynthesis reproductive development and defense against various biotic and abiotic stresses (Creelman and Mullet, 1997).

Structure

Jasmonates (JA), structurally are, cyclopentanone derivates (Fig. 1) of α-linolenic acid. It includes group of oxygentaed fatty acids called oxylipins. These occur universally in the plant kingdom along with some reports about production by fungi also. Its derivative, methyl jasmonate was first of all derived from jasmine oil (Demole et al. 1962), leading to the discovery of the molecular structure of jasmonates and their name.

Fig. 1: Structure of Jasmonic acid and its derivative Methyl Jasmonate.

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Biosynthesis

The precursor, as stated earlier, is linolenic acid, latter released from the membrane bound lipids and then converted to jasmonic acid via a series of steps called octadecanoid pathway. Biosynthesis occurs principally in two organelles, chloroplast and peroxisome (Fig.2). The key enzymes involved are lipoxygenase (LOX), allene oxide synthase (AOS), allene oxide cyclase (AOC) etc. An intermediate, 12-oxo-phytodienoic acid (OPDA), from linolenic acid is cyclized and transported to peroxisome (Vick and Zimmerman,1987) through ABC transporter where it is acted upon by the enzymes of β-oxidation pathway. Three cycles of β-oxidation pathway ultimately yield the final product i.e. jasmonic acid which is then released to cytosol (Wasternack et al. 2002).

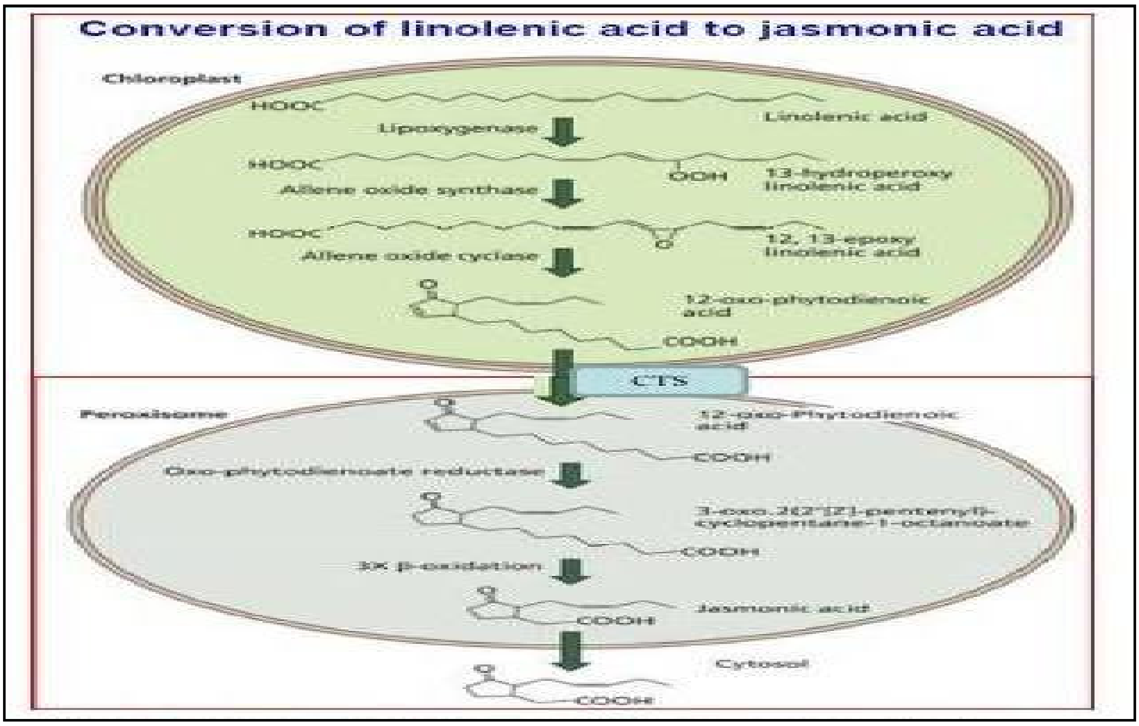

Fig. 2: Biosynthetic pathway of Jasmonic acid (Wasternack, 2004).

Functions in plants

As Jasmonates (JA's) have a well established and elaborate role in biotic stress, reviewed in detail by many workers already, so this review pertains to only abiotic stress mitigation. JA's have been proposed to be affecting a variety of plant processes ranging from normal vegetative and reproductive development to even defense against various abiotic stresses (Creelman and Mullet, 1997). JA maintain normal male and female gametophytic development (Browse 2005), as reported in tomato (*Lycopersicon esculentum*; Wasternack and House 2013) and rice (*Oryza sativa*; Cai et al. 2014). Jasmonates can inhibit germination whereas, at high concentration (> 50µM) promote senescence and leaf abscission (Koda 1991; Sembdner and Parthier, 1993). Senescence involves chlorophyll loss, degradation of crucial chlorophyll proteins and enzymes such as RUBISCO by affecting the translation of its large subunits (Reinbothe et al. 1992). Exogenous JA application effectively lowered lycopene levels and enhanced β-carotene, thereby confirming its role in the conversion of lycopene to β-carotene during fruit ripening (Saniewski and Czapski, 1983). Jasmonates can also effectively regulate root growth (Staswick et al. 1992) and tuber formation (Koda 1992).

Jasmonates have been proposed to play a protective role in various abiotic stresses (Bell and Mullet, 1991; Clarke et al. 2004). JA can bring about the accumulation of anthocyanins under the conditions of excessive illumination (Franceschi and Grimes, 1991). JA when applied to water-stressed soybean resulted in the expression of genes responsible for synthesis of some crucial proteins (Reinbothe et al. 1992). Clarke et al. (2004) proved the role of Jasmonates in conferring basal thermotolerance to *Arabidopsis thaliana* in association with salicylic acid. Jasmonic acid was also known to mitigate the harmful effects of heat stress as reported in grapes (Qin and Lin 2006). The treatment of grape seedlings with 50µM JA leads to up-regulation of antioxidant enzymes SOD, CAT and POD and inhibit the adverse effects of high temperature (42°C) stress. Exogenous MeJA (Methyl Jasmonate) application could ameliorate heat stress induced membrane damage in *Arabidopsis.* JA can also impede expression of photosynthesis-related genes thereby reducing carbon assimilation under conditions of excess light or carbon thereby balancing energy absorption and usage (Creelman and Mullet, 1997).

Conclusions

Jasmonates have an elaborate role in plant development and growth. Although there has been an increase in the interest regarding these molecules and their role in plants but these are certainly still underexploited biomolecules. More elaborate understanding regarding their molecular mechanisms and physiological functions will definitely pave path for the improved design of better plant defense in the times ahead.

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