Influence of (9Z)-12-hydroxy-9-dodecenoic acid and methyl jasmonate on plant protein phosphorylation

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Abstract
The products of the lipoxygenase pathway, methyl jasmonic acid (MeJA) and (9Z)-12-hydroxy-9-dodecenoic acid (HDA), hardly changed the relative level of phosphorylated polypeptides (RLPPs) during 2 h of incubation: 15 and 17 kDa RLPPs were enhanced by HDA, but decreased by MeJA. RLPPs of 73 and 82 kDa were increased by both compounds. MeJA and HDA treatment induced specific and unspecific effects in some RLPPs. It was shown that HDA and MeJA increased protein kinase activity in the presence of 1 μM cAMP.

Introduction
The activation of the lipoxygenase signal system under biotic and abiotic stressors induces the formation of different types of oxylipin, including jasmonic acid and methyl jasmonic acid (MeJA). It has been shown that the main product of linoleate oxidation in pea leaf homogenate is (9Z)-12-hydroxy-9-dodecenoic acid (HDA), which possesses high physiological activity [1]. The important components of all known signalling systems in cells are protein kinases, which catalyse protein phosphorylation for switching the cellular pathways in response to changing circumstances. There is not enough information about jasmonic acid and MeJA, especially regarding HDA action on protein kinase activity and protein phosphorylation. The aim of this work was to study the effect of MeJA and HDA treatment on protein phosphorylation.

Key words: lipoxygenase pathway, methyl jasmonic acid, pea, Pisum sativum.
Abbreviations used: MeJA, methyl jasmonic acid; HDA, (9Z)-12-hydroxy-9-dodecenoic acid; RLPPs, relative level of phosphorylated polypeptides.
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Experimental

Etiolated 3-day-old pea seedlings were the object of investigation. Protein kinase activity was routinely assayed at 30 °C by precipitation of 32P-labelled phosphorylated protein on to paper discs in 10% trichloroacetic acid [2]. Protein phosphorylation in vivo was assayed by 2 h incubation of separated seeds with [32P]orthophosphoric acid (185 PBq/mol) and effectors. The crude extract of leaves were then analysed by SDS/PAGE (6–16% gels) [3] with further autoradiography.

Results and discussion

The results of the study showed that 0.1 μM MeJA, HDA and cAMP increased protein phosphorylation by 0.5–2.5 times in vivo during 2 h incubation of etiolated pea seedlings. The greatest effect was made by HDA in comparison with MeJA and CAMP. MeJA and HDA hardly changed the relative level of phosphorylated poly-peptides (RLPPs; Figure 1). Note that HDA increased 15 and 17 kDa RLPPs, and at the same time MeJA decreased them (Figure 1). As with HDA, MeJA increased the RLPPs of 72 and 83 kDa.

We have assumed that products of the lipoxygenase pathway can also activate the adenylate cyclase system. Our data showed that MeJA and HDA increased the protein kinase activity in the presence of 1 μM cAMP from 5970 ± 100 to 8126 ± 92 and 7963 ± 150 pmol/mg of protein per min, respectively. The reprogramming of protein phosphorylation by MeJA and HDA could point to the inclusion of these compounds in the functioning of the lipoxygenase signal system in plant cells, induced by pathogens, elicitors and abiotic stressors.

This work was supported by grant 98-04-48973 from the Russian Foundation of Research and grant 00-15-97904 (Program for the Support of Leading Scientific Schools).

References


Received 27 June 2000

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Differential signalling and plant-volatile biosynthesis

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Abstract

At least two different signalling pathways have been identified that result in clearly distinguishable volatile profiles in response to pathogens and herbivores in the lima bean Phaseolus lunatus. Alamethicin, a voltage-gated ion-channel-forming peptide from Trichoderma viride, is a potent inducer of volatile biosynthesis in the lima bean. Unlike elicitation with cellulysin or herbivore damage, which act through the jasmonic acid pathway and result in a complex pattern of volatile compounds, the emitted blend comprises only the two homoterpens, 4,11-dimethylhexadec-3,7,11-triene and 4,8,12-trimethyltrideca-1,3,7,11-tetraene, and methyl salicylate. Both pathways, represented by jasmonic acid and alamethicin, depend on lipid-derived signalling compounds, set off by the activation of a phospholipase A and further processing by lipoxygenase activity. The alamethicin-induced signal-transduction pathway interferes with the octadecanoid cascade, probably due to increased salicylic acid levels, resulting in an inhibition of the typical jasmonic acid-induced volatile profile.

In response to pathogens and herbivores the lima bean Phaseolus lunatus emits characteristic blends of volatiles. We have identified at least two different signalling pathways resulting in clearly distinguishable volatile profiles. Alamethicin, a voltage-gated ion-channel-forming peptide from...