Formation of 4-hydroxy-2-alkenals in barley leaves

H. Weichert*, A. Kolbet†, C. Wasternack‡ and I. Feussner*

*Institute of Plant Genetics and Crop Plant Research, D-06466 Gatersleben, Germany, and †Institute of Plant Biochemistry, D-06120 Halle/Saale, Germany

Abstract

In barley leaves 13-lipoxygenases are induced by jasmonates. This leads to induction of lipid peroxidation. Here we show by in vitro studies that these processes may further lead to autoxidative formation of (2E)-4-hydroxy-2-hexenal from (3Z)-hexenal.

In barley leaves 13-lipoxygenases (13-LOXs) are induced by salicylate and jasmonate. We showed by metabolic profiling that upon salicylate and jasmonate treatment free linolenic acid and linoleic acid accumulated in a 10:1 ratio, reflecting their relative occurrences in leaf tissues. Furthermore, and hydroperoxide lyase branch of the LOX pathway, leading mainly to accumulation of 13-HOT and (3Z)-hexenal. During jasmonate treatment, as for salicylate treatment no accumulation of products of other branches of the LOX pathway has been found. Besides accumulation of (3Z)-hexenal, another hydroperoxide lyase-derived product, 4-hydroxy-(2E)-hexenal (HHE), has been found to accumulate in jasmonate- or sorbitol-treated leaves [2], and the HHE-derivative 4-

Key words: Hordeum vulgare, hydroperoxide lyase pathway, lipoxygenase pathway, peroxygenase.

hydroxy-(2E)-nonenal is formed by protein homogenates of soya bean cotyledons [3]. However, until now it is still under discussion as to whether these aldehydes are formed in plants exclusively by the action of enzymes [3] or whether they are at least partially the result of autoxidative processes, i.e. originating from the corresponding (3Z)-aldehydes.

To address this question, we incubated (3Z)-hexenal (Figure 1) or (3Z)-nonenal (results not shown) with the recombinant barley LOX-100 [4]. This LOX form is induced in jasmonate-treated leaves and is located together with hydroperoxide lyase in chloroplasts of barley leaves [5]. Furthermore, we incubated (3Z)-hexenal or (3Z)-nonenal with oxidizing chemicals, such as the corresponding fatty acid hydroperoxides already detected in barley leaves under the same conditions, or with \( \text{H}_2\text{O}_2 \) or with both. For both aldehydes similar results were observed. As shown for HHE formation (Figure 1), no differences were found when (3Z)-hexenal was incubated either alone with \((13S,9Z,11E)-13\text{-hydroperoxy-9,11-octadecadienoic acid}\) (13-HPOD)/T or in combination with LOX-100. In contrast to earlier findings, these results may suggest that the formation of 4-hydroxy-(2E)-alkenals in plants may be due to autoxidation and not the conversion of these aldehydes by LOXs, as suggested before [3].

References