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Growth inhibition of plant pathogenic fungi by hydroxy fatty acids

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Hydroxy fatty acids are plant self-defense substances (Masui *et al, Phytochemistry* 1989). Three types of hydroxy fatty acids: 10-hydroxystearic acid (HSA), 7*S*,10*S*-dihydroxy-8(*E*)-octadecenoic acid (DOD), and 12,13,17-trihydroxy-9(*Z*)-octadecenoic acid (THOA) were tested against the following plant pathogenic fungi: *Erysiphe graminis* f sp *tritici* (common disease name, wheat powdery mildew); *Puccinia recondita* (wheat leaf rust); *Pseudocercosporella herpotrichoides* (wheat foot rot); *Septoria nodorum* (wheat glume blotch); *Pyricularia grisea* (rice blast); *Rhizoctonia solani* (rice sheath blight); *Phytophthora infestans* (potato late blight); and *Botrytis cinerea* (cucumber botrytis). At a concentration of 200 ppm, both HSA and DOD showed no fungal disease control activity. However, THOA at the same concentration showed weak activity and provided disease control (percent) of the following plant pathogenic fungi: *Erysiphe graminis* 77%; *Puccinia recondita* 86%; *Phytophthora infestans* 56%; and *Botrytis cinerea* 63%. The position of the hydroxy groups on the fatty acids seems to play an important role in activity against specific fungi. *Journal of Industrial Microbiology & Biotechnology* (2000) **24,** 275–276.

Keywords: hydroxy unsaturated fatty acids; antifungal activity; plant pathogenic fungi; plant disease control

Introduction

Plant systems produce hydroxy fatty acids, which are important industrial materials. The hydroxyl group gives a fatty acid special properties, such as higher viscosity and reactivity compared with other fatty acids. Microorganisms also can produce three types of hydroxy fatty acids, which are monohydroxy, dihydroxy, and trihydroxy fatty acids by biotransformation of unsaturated fatty acids [1–11,16,20]. A review on the microbial production of hydroxy fatty acids has been published [2,6].

We have been investigating the production of value-added products from soybean oil. Our efforts have led to the discovery of many novel hydroxy fatty acids [3–5,7–9,14,15,17,18]. Since the chemical structure of the new trihydroxy unsaturated fatty acid [3,9] resembles that of plant self-defense substances [12,13,19], we tested the three types of hydroxy fatty acids for anti-plant pathogenic fungal activity. The results are reported here.

Materials and methods

10-Hydroxystearic acid, 7*S*,10*S*-dihydroxy-8(*E*)-octadecenoic acid, and 12,13,17-trihydroxy-9(*Z*)-octadecenoic acids were prepared as described in our previous papers [3,7,16]. Two hundred-ppm concentrations of each test compound were suspended in a mixture of acetone/water 1:1 (v/v) and were sprayed on the test plants with an air-assisted nozzle. Fifteen milliliters of a 200-ppm concentration test compound solution were sprayed per plant. The concentration of 200 ppm was chosen for screening because it was 1× the use rate of the weakest standard and 200× the rate of the most active standard. Eight plants were used for each test compound. Included in the tests were replicated standards, two for each pathogen. After 24 h the plant was inoculated with the pathogenic fungi. Obligate pathogens were grown on the host plant. Spores were collected, put into a titered solution based on the pathogen and sprayed on the test plants. All other pathogens were grown *in vitro* on agar (pathogen-dependent), harvested, titered and sprayed on the test plants. Test plants were then incubated for a period of 24–48 h (pathogen-dependent) after which it was placed in a growth chamber. Plants were rated 4–5 days after inoculation and the data were reported as percent disease control. Phytotoxicity was rated but recorded only if present.

Results and discussion

The chemical structures of the three hydroxy fatty acids are shown in Figure 1. The biological activity of these three acids at 200 ppm concentration were tested against the following plant pathogenic fungi: *Erysiphe graminis* f sp *tritici* (common disease name, wheat powdery mildew); *Puccinia recondita* (wheat leaf rust); *Pseudocercosporella herpotrichoides* (wheat foot rot); *Septoria nodorum* (wheat glume blotch); *Pyricularia grisea* (rice blast); *Rhizoctonia solani* (rice sheath blight); *Phytophthora infestans* (potato late blight); *Botrytis cinerea* (cucumber botrytis). Both HSA and DOD showed no disease control activity against these plant pathogenic fungi. However, at the same concentration, THOA controlled, although weakly, the disease expressed by the following fungi (expressed in percent growth disease control): *Erysiphe graminis* f sp *tritici* 77%;

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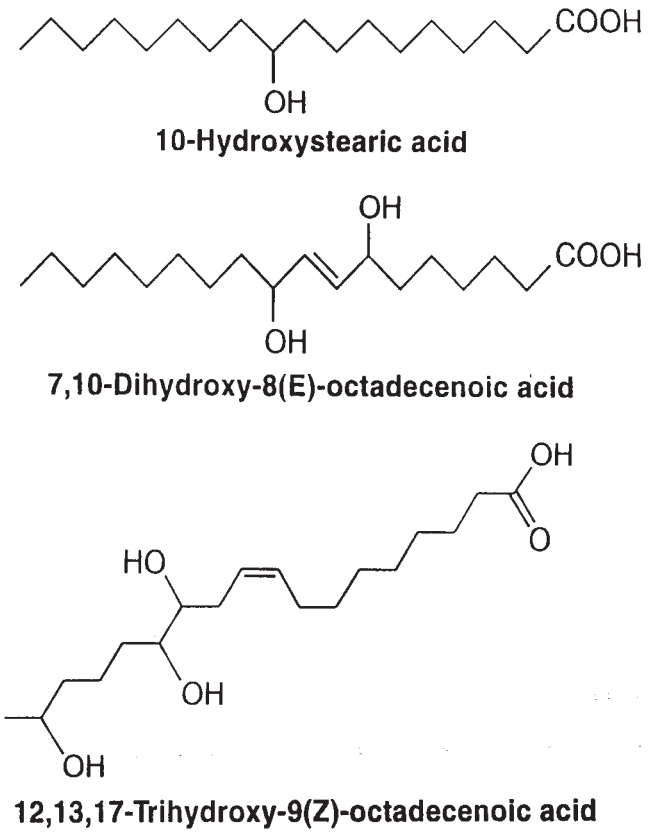

Figure 1 Hydroxy fatty acids produced by microbial transformation.

Puccinia recondita 86%; *Phytophthora infestans* 56%; and *Botrytis cinerea* 63%.

Recently, 9*S*,12*S*,13*S*-trihydroxy-10-octadecenoic acid and 9*S*,12*S*,13*S*-trihydroxy-10,15-octadecadienoic acid [12,13] were isolated from the *Sasanishiki* variety of rice plant which suffered from rice blast disease and were shown to be active against the fungus [12]. 9,12,13-Trihydroxy-10(*E*)-octadecenoic acid was also isolated from *Colocasia antiquorum* inoculated with *Ceratocystis fimbriata*, and showed anti-black rot fungal activity [19]. Our THOA, with its hydroxy groups at positions different from the compounds mentioned above did not inhibit the growth of rice blast fungus. It appears that the specificity of trihydroxy fatty acids against certain plant pathogenic fungi may depend on the location of the hydroxy groups on the trihydroxy fatty acid molecule.

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