Ipomeamarone Content in Diseased and Nondiseased Tissues of Sweet Potatoes Infected with Different Pathogens

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ABSTRACT

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Nonmarketable fleshy sweet potato roots infected naturally or by inoculation with individual pathogens were analyzed to quantitatively assess ipomeamarone in infected and noninfected tissues of the same potato. Ipomeamarone was not detected in tissues infected by *Meloidogyne incognita* or *Streptomyces ipomoea*. No more than 300 μg ipomeamarone/g was detected in tissues infected by *Monilochaetes infuscans, Rhizopus stolonifer,* and internal cork virus. Higher concentrations of ipomeamarone were detected in tissues infected by *Fusarium oxysporum, Sclerotium rolfsii, Diplodia tubericola, Ceratocystis fimbriata, Macrophomina phaseoli,* and *Plenodomus destruens*. Little or no detectable ipomeamarone was found on analysis of surrounding noninfected tissue.

Ipomeamarone was first reported in sweet potatoes infected with *Ceratocystis fimbirata* Ell. and Halst., in 1943 (3). The chemical structure of ipomeamarone was determined in 1953 (4). It was reported later in sweet potatoes infected with the fungus *Helicobasidium mompa* Tanaka (6), sliced and treated with mercuric chloride (7), injured by sweet potato weevil *Cyclas formicarius elegantulus* Sum. (1), and infected with *Fusarium solani* (Mart.) Appel and Wr. (8). Ipomeamarone was reported to be hepatotoxic for mice with an IP LD_{50} of 230 mg/kg (8). It is one of several toxic metabolites now known to occur in diseased sweet potatoes (8). Toxicity of these substances to warm-blooded animals is being evaluated (8). The present study determined the relative effectiveness of common sweet potato pathogens in production of ipomeamarone and the comparative ipomeamarone content in infected and surrounding noninfected tissues of the same sweet potato. Results were reported briefly (5).

MATERIALS AND METHODS

Sweet potatoes naturally infected with any one of the following pathogens were used: Root-knot nematode *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949; internal cork virus; soil rot fungus *Streptomyces ipomoea* (Person and W. J. Martin) Waks. and Henrici; scurf fungus *Monilochaetes infuscans* Ell. and Halst. ex Harter; soft rot fungus *Rhizopus stolonifer* (Ehr. ex Fr.) Lind.; surface rot fungus *Fusarium oxysporum* Schlecht.; and charcoal rot fungus *Macrophomina phaseoli* (Maubl.) Ashby. The naturally infected sweet potatoes were selected by the senior author from his storage or from commercial storage facilities. If there was any indication that a sweet potato was infected by more than one pathogen, that sweet potato was not selected for analysis. In addition, sweet potatoes artificially inoculated with the following pathogens were used; circular spot fungus *Sclerotium rolfsii* Sacc.; Java black rot fungus *Diplodia tubericola* (Ell. and Ev.) Taub.; black rot fungus *Ceratocystis fimbriata* Ell. and Halst.; and foot rot fungus *Plenodomus destruens* Harter. The fungi were introduced into small punctures made with a sterilized needle in sweet potatoes that showed no evidence of disease. Each sweet potato used for analysis was carefully examined and determined to be free of contaminating infections.

Ipomeamarone was extracted from sweet potato tissue with a mixture of chloroform, methanol, and water (2:2:1 by volume) and analyzed by gas chromatography (2). The amount of tissue extracted depended to some extent on the particular pathogen. For pathogens like the scurf fungus relatively little tissue was involved, whereas for others like the soft rot fungus large amounts of tissue were involved. Nevertheless, at least 3 g of diseased tissue per analysis and about 25 g of healthy tissue per analysis were used. Infected and noninfected tissues were determined by macroscopic examination.

RESULTS AND DISCUSSION

There was considerable variation in concentration of ipomeamarone in sweet potato tissue infected with different pathogens (Table 1). No ipomeamarone was detected in tissue of sweet potatoes infected with root-knot nematode, *M. incognita,* or with soil rot fungus, *S. ipomoea*. Concentrations of ipomeamarone were relatively low both in Goldrush sweet potatoes infected with internal cork virus, and in Centennial sweet potatoes infected with *M. infuscans* and *R. stolonifer*. Concentration of ipomeamarone was high in sweet potatoes infected with *S. rolfsii, D. tubericola, C. fimbriata, M. phaseoli,* and *F. oxysporum*. Certain pathogens, therefore, appear relatively ineffective in

TABLE 1. Ipomeamarone in diseased and healthy tissue of sweet potatoes infected with different pathogens

Pathogen	Cultivar	Sweet potatoes analyzed (no.)	Ipomeamarone in tissue[a]			
			Infected tissue		Noninfected tissue	
			(Range) (μg/g)	(Avg.) (μg/g)	(Range) (μg/g)	(Avg.) (μg/g)
Meloidogyne incognita	Centennial	2	ND		ND	
Streptomyces ipomoea	Centennial	3	ND		ND-15	8
Monilochaetes infuscans	Centennial	3	ND-60	22	ND	
Internal cork virus	Goldrush	4	ND-25	8	ND-15	6
Rhizopus stolonifer	Centennial	5	175-300	247	...	...
Fusarium oxysporum	Centennial	30	350-9,480	4,852	ND-60	12
Sclerotium rolfsii	Centennial	11	500-8,000	3,219	ND-48	7
	Jasper	1	7,300		50	
	LO-162	1	5,400		45	
	Ll-207	1	3,500		9	
Diplodia tubericola	Centennial	10	560-18,000	3,744	ND-40	7
Ceratocystis fimbriata	Centennial	6	220-10,300	5,520	ND-90	33
Macrophomina phaseoli	Centennial	3	460-10,000	4,303	1-15	6
Plenodomus destruens	Centennial	2	110-405	258	...	
	Jasper	1	510		...	
	LO-162	1	335		...	
	Ll-207	1	325		...	

[a]Less than 1 μg ipomeamarone per gram is not detectable (ND) by the method of analysis used. In the few cases where there were fairly high concentrations in the "noninfected" tissue, it is possible that there were infections that were not evident to the unaided eye. In some cases (···) all the tissue was infected or the noninfected tissue was not analyzed.

inducing production of ipomeamarone, whereas others are very effective. Thus, ipomeamarone production is not necessarily "a general reaction of sweet potato tissue in response to the injurious action of invading agents" as suggested earlier (7). Furthermore, the amount of sweet potato tissue invaded by a pathogen is no indication of the effectiveness of the pathogen in inducing ipomeamarone production. Among pathogens least effective in inducing ipomeamarone production *M. incognita, S. ipomoea,* and *M. infuscans* slowly invade very little tissue in causing disease, but internal cork virus, *R. stolonifer,* and *P. destruens* invade large amounts of tissue rapidly. Conversely, among pathogens most effective in inducing ipomeamarone production *C. fimbriata, S. rolfsii,* and *F. oxysporum* slowly invade relatively little tissue, whereas *D. tubericola* and *M. phaseoli* rapidly invade large amounts of tissue.

The wide range in ipomeamarone concentrations (Table 1) among the naturally inoculated sweet potato specimens infected with *F. oxysporum, S. rolfsii, D. tubericola,* and *M. phaseoli* probably was due largely to differences in length of infection time. Among the 30 sweet potatoes infected with *F. oxysporum* only four had less than 1,800 μg ipomeamarone per gram of diseased tissue; among the 11 specimens infected with *S. rolfsii* only three had less than 1,100 μg ipomeamarone per gram of diseased tissue; among the 10 specimens infected with *D. tubericola* only three had less than 1,200 μg ipomeamarone per gram of diseased tissue; and the three specimens infected with *M. phaseoli* had 460, 2,450, and 10,000 μg ipomeamarone per gram of diseased tissue. Sweet potatoes infected with *C. fimbriata* and analyzed 1, 2, 4, and 8 weeks after inoculation had 220, 600, 10,000, and 10,300 μg ipomeamarone per gram of diseased tissue, respectively.

Little or no ipomeamarone was detected in apparently healthy tissue that surrounded the diseased tissue (Table 1). This might account for lack of human poisoning from eating sweet potatoes, because visibly diseased portions are discarded when sweet potatoes are being prepared for consumption.

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