Influence of Maize Dwarf Mosaic Virus Infection on the Sugar and Sorbitol Contents of Sweet Corn Kernels

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ABSTRACT

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The effect of maize dwarf mosaic virus infection on the kernel sugar and sorbitol contents of the sweet corn (*Zea mays*) cultivars Gold Cup and Seneca Scout was investigated. Fructose, glucose, sucrose, maltose, and sorbitol levels in kernels from ears of healthy and virus-infected plants were measured 21, 35, and 50 days after pollination. Maize dwarf mosaic virus infection had no detectable effect on kernel sugars and sorbitol at any stage of development.

Maize dwarf mosaic is a serious virus disease of sweet corn (*Zea mays* L.) in the midwestern and northeastern United States (6,7). In susceptible sweet corn cultivars, the disease reduces yield and ear quality. Some of the effects of maize dwarf mosaic virus (MDMV) infection on ear quality are decreased ear diameter, length, weight, kernel fill, and marketability (6). Kernel sweetness is an important component of overall ear quality in sweet corn (2,5), but the effect of MDMV infection on kernel sweetness has not been reported.

Many virus diseases interfere with the carbohydrate metabolism of their host plants, often blocking translocation of photosynthetic assimilates (4). This study was initiated in conjunction with a breeding program concerned with both sweet corn quality and disease resistance. Our objective was to determine if MDMV infection has an effect on the sugar and sorbitol components of developing and mature sweet corn kernels.

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MATERIALS AND METHODS

Two sweet corn (*Z. mays*) cultivars, Gold Cup and Seneca Scout, were planted on 28 May 1980 at the Agriculture Experiment Station, Vegetable Crops Farm, University of Illinois. The experimental design was a split plot with cultivars as main plots and treatments as subplots. Each plot was replicated three times. Seeds were planted 33 cm apart in 97-cm rows. Plants at the three- to four-leaf stage were inoculated on 20 June with a 1:1 mixture of MDMV strains A and B (6). Equal amounts of freshly harvested maize tissue infected with MDMV strain A and MDMV strain B were ground in chilled 0.05 M sodium phosphate buffer (pH 7.0) at a rate of 1 g of maize tissue per 5 ml of buffer. The homogenate was strained through three layers of cheesecloth and a layer of Miracloth. Before inoculation, 22-μm Carborundum was added to the inoculum at a rate of 15 g/L. Plants were inoculated with a Wren artist's airbrush (Binks Manufacturing Co., Franklin Park, IL) with air supplied by an air compressor operating at 4.9 kg/cm^2. Visual ratings of MDMV symptoms 10 days after inoculation showed nearly 100% infection.

Plants were self-pollinated at anthesis. Ears were harvested only from symptomatic plants. Three ears were harvested from each subplot 21, 35, and 50 days after pollination. Ears harvested 21 and

Table 1. Effect of maize dwarf mosaic virus (MDMV) infection on the kernel sugars and sorbitol of two sweet corn cultivars at three stages of kernel development

Days after pollination	Cultivar[a]	Treatment[b]	Percent dry weight ± SD[c]				
			Sorbitol	Fructose	Glucose	Sucrose	Maltose
21	GC	C	0.75 ± 0.15	1.40 ± 0.38	0.63 ± 0.11	10.06 ± 3.79	0.12 ± 0.04
		V	0.74 ± 0.10	1.17 ± 0.11	0.57 ± 0.08	8.95 ± 1.62	0.15 ± 0.02
	SS	C	0.62 ± 0.12	1.04 ± 0.22	0.87 ± 0.06	7.33 ± 1.59	0.20 ± 0.03
		V	0.81 ± 0.08	1.22 ± 0.09	1.16 ± 0.12	8.94 ± 1.18	0.22 ± 0.05
34	GC	C	0.13 ± 0.04	0.41 ± 0.08	1.00 ± 0.02	2.94 ± 0.67	0.04 ± 0.01
		V	0.28 ± 0.09	0.64 ± 0.11	1.13 ± 0.30	3.92 ± 0.38	0.08 ± 0.02
	SS	C	0.24 ± 0.07	0.57 ± 0.12	1.49 ± 0.45	4.38 ± 0.77	0.11 ± 0.02
		V	0.17 ± 0.03	0.43 ± 0.08	1.03 ± 0.12	3.20 ± 0.46	0.08 ± 0.03
50	GC	C	0.01 ± 0.00[d]	0.03 ± 0.01	0.37 ± 0.06	2.57 ± 0.31	0.01 ± 0.00
		V	0.01 ± 0.00	0.04 ± 0.01	0.40 ± 0.11	2.17 ± 0.17	0.01 ± 0.00
	SS	C	0.01 ± 0.00	0.02 ± 0.00	0.27 ± 0.04	3.31 ± 0.14	0.02 ± 0.01
		V	0.01 ± 0.00	0.02 ± 0.01	0.26 ± 0.05	3.35 ± 0.13	0.01 ± 0.00

[a]The two sweet corn cultivars used were Gold Cup (GC) and Seneca Scout (SS).
[b]The two treatments consisted of a non-MDMV-infected control (C) and kernels from ears infected with strains A and B of MDMV (V).
[c]Data are means of three ears, one from each of three plots.
[d]Values presented as 0.01% of dry weight were less than or equal to 0.01% of dry weight.

35 days after pollination were frozen immediately in liquid nitrogen and transported on dry ice to storage in a freezer maintained at −20 C. Ears harvested 50 days after pollination had reached the mature dry stage and were stored at room temperature before analysis.

Sugars were extracted and analyzed by gas-liquid chromatography as described earlier (1,3). Sugars were extracted from the frozen kernels by grinding with 80% (v/v) ethanol, and the extracts were clarified by centrifugation. Portions of the extracts were dried, and TMS-oxime derivatives of the sugars were prepared with reagents from Pierce Chemical Company. The derivatives were chromatographed on an OV-17 column with helium as carrier gas.

RESULTS AND DISCUSSION

The quantities of sorbitol and sugars in kernels from virus-infected and healthy sweet corn plants are presented in Table 1. MDMV infection did not cause major alterations in the sugar or sorbitol profiles at the edible and later developmental stages. Sucrose was the predominant sugar at all stages of development and was highest at the edible stage (21 days after pollination). MDMV infection did not reduce the level of sucrose in either cultivar at the edible stage.

MDMV infection has marked effects on sweet corn plants (6), but our study revealed that constituents contributing to kernel sweetness are not altered by this virus. Hence, evaluation of the kernel sugars of sweet corn breeding materials should not be confounded by the MDMV disease status of the plants assayed.

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