Forage Quality Parameters vs. Mycotoxin Content of Silages at Miner Institute

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Situation

Mycotoxins are toxic metabolites produced by naturally occurring fungi in food and feedstuffs. Until recently, mycotoxin analysis was done by wet chemistry and because of the cost--$80-$130 per sample--was only done when the presence of a mycotoxin was strongly suspected. Now, however, there is a much less expensive test available, an immunoassay (ELISA). More testing will be necessary to determine whether this test can provide accurate quantitative analyses for mycotoxins in forages including silages. However, it can be used as an indicator of management problems, and thereby may be a useful diagnostic tool. Current research at the University of Vermont indicates relatively good agreement between the immunoassay and analysis by high-pressure liquid chromatography although immunoassay vomitoxin levels were consistently higher. A literature search revealed that while there has been considerable research on the use of immunoassays in grains, little has been done with forages.

In 1994, the University of Vermont Plant Diagnostic Laboratory, under the direction of Dr. Alan Gotlieb, began testing forages for the mycotoxins zearalenone, T-2, and vomitoxin (DON). Forages from over 200 Vermont dairy farms with suspected mycotoxin problems (278 samples) were tested using the immunoassay, and vomitoxin was found in 63% of the samples. The laboratory is currently analyzing over 1500 samples per year, and are detecting vomitoxins in 50% of the samples. In several cases, the use of sodium bentonite as a feed additive in herds with high forage vomitoxin levels has resulted in dramatic improvements in herd health and milk production. Dr. Gotlieb and his associates estimate that Vermont dairy farmers could be losing $4.5 to $9.0 million per reduced milk production and increased herd health problems due to mycotoxins. There has been no routine screening of silages on a particular farm, however, nor has there been an attempt to relate silage quality parameters to mycotoxin levels.

Objectives

1. Determine if the silages produced at Miner Institute have detectable levels of vomitoxin (DON), the most commonly found mycotoxin in forage crops.

2. Determine the variability of vomitoxin levels over by time and by type of crop.

3. Determine if there is a relationship between any silage quality parameters and vomitoxin levels.

Procedures

Beginning in June, 1995, the silages being fed at Miner Institute were sampled monthly for one year and submitted to the Northeast Dairy Herd Improvement Forage Laboratory in Ithaca, NY for forage analysis. Duplicate samples were sent to the University of Vermont Plant Diagnostic Clinic in Burlington, Vermont for vomitoxin analysis using immunoassay. Silage sampled included corn silage in a 15 meter wide x 50 meter long x 3 meters high bunker silo, alfalfa-grass silage in two bunker silos 8 meters x 50 meters x 3 meters each, and grass silage in a plastic silage tube 40 meters long x 2.5 meters diameter. At the same time, additional samples were taken of visibly spoiled silage from each silo and submitted for forage and vomitoxin analysis. This sample did not include the black spoilage typically found at the top of an uncovered silo, but was the discolored portion which, while abnormal, is fed by many farmers rather than separated and discarded.

Deliverables

1. Analysis and evaluation of vomitoxin status of each forage, including discussion of any meaningful differences between silage types and over time.

2. Correlation of silage quality parameters and vomitoxin level, including discussion of any parameters which mat be an indicator of potential pathological problems and which would suggest the need for mycotoxin screening.

3. Discussion of vomitoxin levels in silage spoilage vs. levels in properly fermented silage.

Results and Discussion

Corn Silage

Spoiled silage is often both aerobically deteriorated and leached from rain and melting snow. Soluble nutrients can be leached out, leaving cell walls and other relatively insoluble fractions. Neutral detergent fiber (NDF) levels were higher (P=.064), and nonstructural carbohydrate (NSC) levels were lower (P=.004) in the spoiled corn silage than in the normal corn silage. Silage pH was also significantly higher in spoiled silage (P=.023), 4.0 vs 5.9. The higher and less desirable pH levels in the spoiled corn silage were probably due to leaching of acids after fermentation was completed rather than a sign of poor initial fermentation. Percent protein equivalent from ammonia was not different for normal vs spoiled corn silage. There were time effects for both NDF and NSC, but this probably was because two harvest seasons of corn silage were fed during the test period, and 1995 corn silage was higher in quality than 1994 corn silage.

It has been suggested by Canadian researchers that silage iron levels may be an indicator of poor fermentation and/or possible mycotoxin contamination. While no reason is known by the authors for this possible correlation, it is interesting that spoiled corn silage contained over twice as much iron (160 ppm vs 70 ppm, P=-.053) as normal corn silage.

Vomitoxin levels were higher (P=.034) in spoiled corn silage, 3.3 ppm vs 1.9 ppm. Vomitoxin levels were 4.0 ppm or higher in 50% of the spoiled samples vs only 10% of the normal samples. There was a trend toward higher vomitoxin levels with time (P=.024).

Alfalfa-grass silage

Similar to the corn silage samples, spoiled alfalfa-grass silage had higher NDF values (P=.023) and lower NSC (P=.057) than normal alfalfa-grass silage. Silage pH was also different (P=.008), with normal silage having much lower pH values. There were no differences in DON or iron levels between normal and spoiled silages; however, the iron level in the spoiled alfalfa-grass silage was 251 ppm vs 183 ppm in the fresh alfalfa-grass silage. Like corn silage, DON levels increased with time (P=.033). Percent protein equivalent from ammonia was not different for normal vs spoiled alfalfa-grass silage, but there was a time effect (P=.045).

Grass silage

There were not enough samples of grass silage for statistical analysis. Also, no spoilage was found in the grass silage in the silage tubes, so comparisons of normal vs. spoiled grass silages are not possible. DON levels tended to be lower for grass silage (averaging 1.1 ppm for six unspoiled samples) than for either alfalfa-grass silage (2.8 ppm) or corn silage (1.9 ppm).

Forage Quality

Corn silage and alfalfa-grass silage

	Corn Silage	CS Spoilage	Alf-grass Silage	Alf-Gr Spoilage
NDF, %	43.4	50.2*	35.6	55.2**
NSC, %	42.2	29.2**	21.5	17.2*
Ammonia, %	0.37	1.09	1.27	2.05
pH	4	5.9**	4.7	5.5***
Iron, ppm	70	160*	183	251
DON, ppm	1.9	3.3**	2.8	2.7

* P<.10
** P<.05
***P<.01

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