

Influence of Corn Smut on the Palatability and Digestibility of Corn Silage

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Summary

Two trials were conducted to determine the effects of corn smut on the palatability and digestibility of corn silage. Corn was hand harvested, divided into corn with smut and corn without smut, chopped, and ensiled for 8 weeks in 30-gallon plastic barrels lined with air-tight plastic bags. The three treatments were 0% smut, 100% smut, and 50% smut (a 50:50 mixture of 0 and 100%). In the palatability trial, six lambs were fed 50% silage diets (DM basis). Lambs were fed two diets during each period as follows: 1) 0 and 50% smut, 2) 0 and 100% smut, and 3) 50 and 100% smut. Feed intakes were recorded for 7 days. In the digestion trial, 12 lambs (four/treatment) were fed 76% silage (DM basis) diets. Fecal samples were obtained over a 5-day period, and digestibility was determined using acid insoluble ash as an internal marker. Corn smut did not adversely affect the palatability of the corn silages. Silage infested with smut had higher fiber and crude protein content but lower non-structural carbohydrate content. Both in vivo and in vitro digestibility decreased as the proportion of smut in the silage increased. These results indicate that corn smut does not adversely affect the palatability of corn silage; however, corn smut decreases the digestibility of corn silage.

Introduction

The incidence of common corn smut varies from year to year depending on environmental conditions. In 1998, an unusually large amount of corn in the Southern High Plains was infested with this fungus. Corn smut infects the stalk and ear of the plant but is most noticeable as grayish black smut galls on the ear. Galls less than 2 inches in diameter can decrease grain yields by approximately 9%, whereas galls greater than 3 inches in diameter can decrease yields 40% or more (Ullstrup, 1977). The fungus is composed of numerous races that may differ in cultural behavior and pathogenicity.

Most galls seem to be a result of infection by primary inoculum that survived in the soil from the previous growing season. Some observations suggest that high humidity favors smut infection, although most reports indicate that dry, warm weather is important.

The effects of common corn smut on the palatability and nutritive value of corn silage made from the corn is not known. Therefore, we determined the effects of common smut on the ensiling characteristics, palatability, and nutritive value of corn silage.

Objectives

1. To determine the effects of corn smut on the ensiling characteristics of whole corn plants.
2. To determine the effects of corn smut on the palatability of corn silage.
3. To determine the effects of corn smut on the digestibility of corn silage.

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²The mention of trade or manufacture names is made for information only and does not imply an endorsement, recommendation, or exclusion by USDA-Agricultural Research Service.

Methods

General. Three trials were conducted. In Trial 1, the in vitro digestibility and nutrient content of silage made from corn infested with common smut was determined. In Trial 2 the effects of corn smut on the palatability of corn silage was determined with mature wethers. In Trial 3, the effects of corn smut on the in vivo digestibility of high corn silage diets was determined with mature weathers.

Whole corn plants were harvested by hand from research fields at the USDA-ARS Conservation and Production Research Laboratory at Bushland, TX. Individual plants were obtained by cutting the stalks approximately 6 inches above the soil surface. At harvesting, the plants were divided into corn that was visually infested with smut and corn that was not visually infested with smut. The corn was chopped in a forage chopper and packed into 30-gallon plastic barrels lined with double plastic bags. The bags were partially sealed and air was removed using a vacuum pump. The bags were then sealed and ensiled for 8 weeks in a greenhouse. The three treatments were ensiled corn with 0% smut, 100% smut, and 50% smut (a 50:50 mixture of 0 and 100%). At the conclusion of the ensiling process, samples were obtained from at least 10 barrels of each silage, composited, and frozen for later laboratory analysis.

Trial 1. Samples collected from each of the ensiling barrels were mixed, and five composite samples were obtained. One composite was shipped to the Dairy Herd Improvement Forage Lab in Ithaca, NY for laboratory analyses. One composite sample was shipped to the USDA-ARS Dairy Forage Research Laboratory in Madison, WI for analysis of volatile fatty acids, lactic acid, and ethanol by high-pressure liquid chromatography. A third composite sample was dried to a constant weight at 60° C, and ground in a Wiley mill. In vitro dry matter (DM) digestibility (24, 48, and 72 h) of the three silages was determined using the methods of Ankom (Ankom Tech. Corp., Fairport, NY).

Trial 2. In the palatability trial, six lambs (avg bodyweight = 121 lb) were used in a replicated 3 x 3 Latin square with 28 days per period. Lambs were given ad libitum access to two diets that contained 50% silage (DM basis; Table 1) during each period. The corn silage in the diets contained the following quantities of smut infested silage: 1) 0 and 50%, 2) 0 and 100%, or 3) 50 and 100%. Feed offered and refused was recorded for the last 7 days of each period.

Trial 3. In the digestion trial, 12 lambs (four/treatment: avg bodyweight = 130 lb) were fed 75% silage (DM basis) diets that contained 0, 50, or 100% smut infested silage (Table 1). After a 2-week adaptation period, fecal grab samples were obtained from each lamb at five times over a 5-day period. Digestibility was determined using acid-insoluble ash as an internal marker (VanKeulen and Young, 1977).

Results and Discussion

Trial 1. The chemical composition of the silages is presented in Table 2. Silage infected with corn smut seemed to have lower DM, organic matter, and non-structural carbohydrate (NSC) content, and higher crude protein, neutral detergent fiber (NDF), and acid detergent fiber (ADF) content. Because of the lower NSC, and higher fiber content, smut-infested silage had lower calculated TDN, NEm, and NEg contents. Mineral composition of the silages were similar, although smut-infested silage seemed to have higher potassium, iron, zinc, and molybdenum content. None of the silages had high concentrations of ammonia or nitrate.

Corn smut did not seem to alter the ensiling characteristics of the corn. All silages had similar pH values and concentrations of acetic acid and lactic acid. As the proportion of smut increased, the ethanol concentration seemed to increase.

In vitro DM digestibilities of the silages are presented in Table 3. At 24, 48, and 72 h, in vitro

DM digestibility decreased (linear effect; $P < .05$) as the smut infestation increased.

Trial 2. Average daily DM and organic matter intakes are presented in Table 4. When lambs were offered a choice between diets containing >clean= silage or diets containing smut-infested silage, they ate more ($P < .05$) of the smut-infested silage. When offered diets containing silage with 50% or 100% smut infestation, wethers ate similar amounts of both silages.

Trial 3. In vivo nutrient digestibilities are presented in Table 5. Digestibilities of DM, organic matter, NDF, ADF, crude protein, and phosphorus all decreased ($P < .05$) as the proportion of smut in the silage increased.

Implications

Results of the palatability trial indicate that corn smut does not adversely affect the palatability of corn silage. In fact, the intakes of silage infested with smut were greater than intakes of non-infested silage. It is not clear whether the greater intake resulted from a Δ taste or Δ odor effect or from the higher fiber and lower starch content of silage infested with smut. However, the digestibility of smut-infested silage was lower than Δ clean silage. When formulating diets containing smut-infested silage, nutritionists may need to take into account the higher fiber content and lower digestibility of silage made from smut-infested corn.

Literature Cited

- Ullstrup, A. J. 1977. Diseases of corn. In (G. F. Sprague, Ed.) Corn and Corn Improvement. American Soc. of Agronomy, Madison, WI, pp 462-465.
- VanKeulen, J. and B. A. Young. 1977. Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci. 70:1719-1723.

Table 1. Composition of diets in the palatability (Trial 2) and digestion (Trial 3) experiments. (Dry matter basis)

Ingredient	Trial 2	Trial 3
Corn silage	50	76
Corn, dry rolled	29.5	11
Cottonseed meal	5	11
Alfalfa, pelleted	5	--
Molasses	4	--
Fat	3	--
Limestone	0.5	--
Supplement ^{a,b}	3	2

^a Supplement in Trial 1 contained 63% ground sorghum, 15.6% ammonium sulfate, .02% copper sulfate, .35% iron sulfate, .37% manganese sulfate, 6.2% potassium chloride, 12.5% salt, .47% zinc sulfate, .19% Vitamin A and E premix, .4% Tylan, and .59% Rumensin.

^b Supplement in Trial 2 contained 25% ammonium sulfate, .002% cobalt chloride, .025% copper sulfate, .004% potassium iodide, .56% iron sulfate, 41.4% ground limestone, .6% manganese sulfate, 10% potassium chloride, 20% salt, .002% sodium selenite, .75% zinc sulfate, .3% Vitamin A & E, .65% Tylan, and .94% Rumensin.

Table 2. Chemical composition of silages.^a

Item	0% smut	50% smut	100% smut
Dry matter, %	40.4	39.4	30.0
Organic matter, %	95.21	94.54	91.36
NDF, %	32.6	35.3	38.7
ADF, %	18.9	21.4	23.1
NSC, %	52.3	43.3	38.8
Lignin, %	3.2	3.4	2.6
Crude protein, %	7.51	7.82	8.5
Soluble CP, % of CP	49	50	49
NDF CP, %	0.9	1.1	1.1
Ammonia, %	0.01	0.22	0.01
Nitrate, %	0.04	0.03	0.03
Crude fat, %	3.0	3.7	3.0
pH	3.82	3.83	4.02
Acetic acid, mM	46.0	14.1	25.7
Ethanol, mM	12.6	21.5	45.9
Lactic acid, mM	145.3	96.4	156.8
Calcium, %	0.23	0.22	0.28
Phosphorus, %	0.25	0.23	0.24
Magnesium, %	0.14	0.12	0.16
Potassium, %	1.28	1.31	1.52
Sodium, %	0.026	0.003	.011
Sulfur, %	0.10	0.10	0.10
Iron, ppm	288	236	765
Zinc, ppm	21	18	30
Copper, ppm	5	6	8
Manganese, ppm	45	48	62
Molybdenum, %	< 1	< 1	1.3
Calculated TDN, %	73	71	68
Calculated NEm, mcal/lb	0.78	0.74	0.70
Calculated NEg, mcal/lb	0.50	0.47	0.42

^a All values, except dry matter, are on a dry matter basis. NSC = non-structural carbohydrates. NDF = Neutral detergent fiber, ADF = Acid detergent fiber.

Table 3. In vitro dry matter digestibility of corn silages

Item	0 % smut	50% smut	100% smut
24 hour	56.6	55.0	51.4
48 hour	61.8	59.9	57.4
72 hour	70.5	69.4	66.0

Table 4. Average daily intakes of 50% silage diets by lambs offered ad libitum access to two diets (grams/day)

Item	0 vs 50% smut	0 vs 100% smut	50 vs 100% smut
Dry matter:			
0 % smut	535 ^a	538 ^a	---
50 % smut	675 ^b	---	639
100 % smut	--	677 ^b	591
Total	1210	1215	1230
Difference (Hi-Low)	140	138	-48
Organic matter:			
0 % smut	502 ^a	505 ^a	---
50 % smut	628 ^b	---	594
100 % smut	---	623 ^b	544
Total	1130	1128	1138
Difference (Hi-Low)	126	118	-50

^{a,b} Values in same column with different superscripts differ ($P < .05$).

Table 5. Digestibility of 76% corn silage diets.

Item	0% smut	50% smut	100% smut
DM intake, g/day	1047	1153	1235
Digestibility, %			
Dry matter	76.3 ^a	73.6 ^a	65.2 ^b
Organic matter	78.6 ^a	75.8 ^a	68.6 ^b
NDF	59.5 ^a	57.5 ^a	49.2 ^b
ADF	52.6 ^a	51.4 ^a	39.1 ^b
Crude protein	73.1 ^a	66.5 ^b	64.6 ^b
Phosphorus	25.8	18.5	16.1

^{a,b} Values in same row with different superscripts differ ($P < .05$)