Ensilability of Whole-Plant Soybeans

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Introduction

In drought years, forage supplies are often limited. One means of increasing forage supplies for dairy farms is to grow soybeans, harvesting the whole plant for ensiling. Recently, Dr. T.E. Devine with ARS in Beltsville, MD has developed soybean lines that would be grown specifically for forage production. However, little information is available about the ensilability of whole-plant soybeans.

Methods

Three entries of soybeans [PA 10-1-2 (PA), OR 5-12-1T (OR) and FS 2602 (FS)] were grown in triplicate in a randomized block design. The first two entries were experimental forage lines from Dr. Devine and the latter a commercially available variety. Plots consisted of three 6 m rows spaced 75 cm apart and seeded at 14 seeds/m. A portion of the center row of each line was harvested by hand at approximately early pod (August 1), 50% pod filled (August 23) and physiologically mature (September 27) stages for the standard soybean variety (FS). Plants were wilted in a greenhouse to approximately 35% DM, chopped with a stationary chopper, inoculated with lactic acid bacteria at 10,000 bacteria/g soybeans (to ensure adequate numbers of fermenting bacteria), and ensiled in pint canning jars.

Each entry was staged at harvest. In addition, initial samples were taken for determination of pH, dry matter, nitrogen fractions, sugar content and buffering capacity. Silos were opened after 30 d ensiling. Silages were analyzed for pH, dry matter, nitrogen fractions and fermentation products.

Results and Discussion

Total analysis of the samples is not yet complete, but sufficient results are available to indicate trends. Table 1 provides a summary of silage quality for the three entries in each of the three harvests. At the earliest harvest, only OR had reasonable silage quality. The other two lines had high pHs and low levels of lactic acid relative to acetic acid. Although no butyric acid was present, pH and dry matter contents of the PA and FS silages were such that clostridial growth was possible. Hand harvesting, which would reduce soil contamination, and the short fermentation period most likely contributed to the lack of a clostridial fermentation in the PA and FS silages. Silage quality was improved in the later harvests, with higher lactic-to-acetic acid ratios and lower pHs across entries. Fermentation characteristics were similar to those typically found in alfalfa silage although pHs were somewhat high.

Within a harvest, there were few statistical differences in silage quality among entries. In the first harvest, OR had a significantly higher lactic acid content and lower pH than the other entries. In the second harvest, FS was significantly lower in acetic acid and higher in ethanol content. In the third harvest, FS silages were higher in dry matter, ethanol and butyric acid contents and lower in soluble nonprotein nitrogen, lactic and acetic acids. The substantial differences in the third harvest between the commercial and forage entries were most likely caused by differences in maturity.

Over the three harvests, OR had the best and most consistent fermentation characteristics with the lowest pH and highest level of lactic acid. With the exception of a low soluble nonprotein nitrogen content, FS had the poorest characteristics, having the highest ethanol content and a significant butyric acid content in the third harvest.

Conclusions

The two forage entries and the commercially available soybean variety ensiled well in the later harvests (August 23 and September 27). Only the one forage entry (OR) produced a silage of good quality in the earliest harvest (August 1). Because of the higher pHs in these silages in general, it will be important that soybeans be wilted to approximately 35% DM prior to ensiling in order to prevent clostridial fermentation.

Table 1. Characteristics of 30-day, whole-plant soybean silage ensiled at three maturities.

Variety	Stage	DM	pH	Sol. NPN*	Lactic acid	Acetic acid	Butyric acid	Ethanol
		%		% DM	% DM	% DM	% DM	% DM
Aug 1								
PA	R1	32.1	5.60	8.2	2.87	3.45	0.00	0.54
OR	R1	35.9	5.17	9.1	5.16	3.12	0.00	0.82
FS	R2	37.8	5.88	9.8	2.40	3.16	0.00	0.89
Aug 23								
PA	R2.7	31.1	5.29	8.1	4.37	3.42	0.00	0.80
OR	R3.3	31.6	5.16	7.4	5.02	3.14	0.00	0.84
FS	R5.7	32.7	5.22	9.1	4.85	2.56	0.00	1.71
Sep 27								
PA	R3	30.3	4.93	9.6	6.21	2.99	0.00	0.91
OR	R4	34.3	4.86	8.0	5.97	2.56	0.00	0.82
FS	R6	38.6	4.96	4.4	3.00	1.21	0.82	1.13

*Soluble nonprotein nitrogen.