Animal Feed Science and Technology 210 (2015) 17–25

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Corn silage analysis as influenced by sample size collected

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ARTICLE INFO

Article history:
Received 5 May 2015
Received in revised form 21 August 2015
Accepted 11 September 2015

Keywords:
Forage
Fiber digestibility
Methods
In vitro
Ensiling

ABSTRACT

Impact of sample size of chopped corn on nutritive quality following ensiling was evaluated. Seven corn hybrids were sampled at four locations in New York State, each with four field replicates. Material from each chopped plot was mixed and approximately 10 kg of material was collected. Samples were thoroughly mixed and 50, 100, 150, 200, 400 g, and two 600 g subsamples were removed for further processing. One 600 g sample was immediately dried, while the remaining samples were vacuum-sealed into polyethylene bags for 30 days. Samples were then evaluated for pH, dried, and ground to pass a 1-mm screen. Samples were analyzed for crude protein (CP) and starch, and analyzed in duplicate for neutral detergent fiber (aNDF) and acid detergent fiber (ADF), and digestions for 30 h in duplicate were used to determine in vitro true digestibility (IVTD) and neutral detergent fiber digestibility (NDFD). Experimental design was a randomized complete block, with a split–split plot feature, with locations as the main plot and corn hybrids as the subplot, and sample size as the sub-subplot. The pH of ensiled samples indicated that the ensiling process was adequate. Ensiled samples differed ($P < 0.001$) from fresh corn forage for all parameters, with a 90 g/kg difference for NDFD. Hybrid × location interactions ($P < 0.05$) for all parameters except NDFD were due to hybrid germplasm sources responding differently to different environments. All parameters displayed small but significant ($P < 0.01$) linear trends due to sample size. Neutral detergent fiber, ADF, CP, and NDFD all increased with decreasing sample size, while IVTD and starch decreased with decreasing sample size. Analysis of coefficients of variation and a power analysis indicated that variability was relatively consistent down to a 100 g sample size for all parameters except starch. Only the 50 g sample size appeared different from other sample sizes in minimum detectable contrast at a power value of 0.8. The size of a collected corn forage sample can be as low as 100 g without greatly increasing sample variability, but the smaller sample sizes influenced the absolute value of parameters. Sample size could be as small as 400 g with a negligible change in sample variability, and without a biologically significant change in nutritive value concentrations.

Abbreviations: ADF, acid detergent fiber; aNDF, neutral detergent fiber; CP, crude protein; DM, dry matter; IVTD, in vitro true digestibility; NDFD, neutral detergent fiber digestibility; RM, relative maturity.

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http://dx.doi.org/10.1016/j.anifeedsci.2015.09.006
0377-8401/

1. Introduction

Representative sampling of chopped corn forage is an essential first step for accurately comparing nutritive value of corn hybrids. Chopped corn forage will contain as much as 50% grain on a dry weight basis, and a coarsely chopped mass has the potential to segregate into morphological components to some extent (Cherney and Cherney, 2003). Due to the effort required to grind and process corn silage samples, commercial laboratories prefer to have a minimum amount of sample submitted for analysis. Grain and stover greatly differ in nutritive value, the primary concern when collecting small corn silage samples is correctly representing the grain to stover ratio in these samples.

The minimum amount of chopped corn forage that will provide a representative sample for analysis may be influenced by the particle size distribution of the sample. Optimum particle size distribution in corn silage is influenced by dry matter concentration, maturity of the silage, and the proportion of the ration that is corn silage. The particle size distribution must allow for sufficient packing of the silage to ensure proper fermentation. The most popular method of determining particle size distribution is the Penn State particle separator (Kononoff et al., 2003). Guidelines for corn silage particle size distribution were developed for the modified Penn State particle separator, which includes 19.0-, 8.0-, and 4.0-mm sieves (Kononoff and Heinrichs, 2012).

Laboratory silos are a practical method of comparing a large number of entries in an experiment (Cherney et al., 2006). Vacuum-sealed polyethylene bags have been demonstrated to be an effective method of ensiling both grasses and corn forage (Cherney et al., 2006, 2004). Evaluation of corn silage quality should consider the factors impacting digestibility and intake (Allen et al., 2003). Neutral detergent fiber digestibility increasingly is considered an important quality parameter, and is typically evaluated using a 30 h digestion for corn silage.

A primary concern with sampling chopped corn forage is accurately representing the grain fraction of the forage. Corn grain differs greatly in density and particle size from chopped stover, making it more difficult to generate a uniformly mixed sample, and reducing the chances of selecting a representative sample for analysis. If grain proportion is misrepresented in the sample collected, the effect on concentration of a given nutritive value parameter will depend on the relative concentrations in grain versus stover. The greater the relative difference between grain and stover for a quality parameter, the greater the impact will be on whole plant concentrations. Therefore, the order of impact of varying grain proportion on whole plant nutritive value parameter concentrations, ranked from highest to lowest impact, would be expected to be: starch, ADF, NDF, CP, IVTD, and NDFD. There is a slightly greater relative difference between grain and stover for ADF concentration, compared to NDF (Allen et al., 2003; Crasta et al., 1997).

Some studies indicate that to best simulate in vivo conditions, in vitro evaluation of feedstuffs (especially fermented silages with a high content of volatile components) should be completed using substrates as similar as possible to those that are fed (Calabrò et al., 2005b). Some research studies investigating either management or corn hybrid effects on nutritive value concluded that in vitro digestibility was not greatly impacted by the proportion of grain in a whole plant sample (Fairey, 1983), while other studies indicate that grain proportion significantly affects nutritive value (Coors et al., 1997; Cox et al., 1993). In general, nutritive value of the grain proportion is not affected by plant maturity, while stover quality declines significantly with maturation resulting in a decline in whole plant quality (Crasta et al., 1997; Hunt et al., 1989; Lewis et al., 2004). All these cases involve translocation of nutrients within the plant; a change in grain proportion was somewhat or mostly offset by a corresponding change in stover soluble carbohydrates. No studies were found that evaluated the effect on nutritive value of adding or subtracting grain from a whole plant sample, as might occur with unrepresentative sampling. Our objective was to evaluate the impact of size of a chopped subsample of corn forage collected on nutritive value analysis following ensiling.

2. Materials and methods

2.1. Sample processing

New York State corn silage trials were sown on 26 April in Cayuga County, 1 May in Livingston County, 3 May in Jefferson County and 2 May in St. Lawrence County. Fertilizer was applied as per soil test recommendations. Seven corn hybrids were common to all four sites and were selected for this study. Hybrids 1 and 2 originated from Company A, hybrids 3 and 4 were from Company B, and hybrids 5, 6 and 7 were from Company C. All hybrids were planted at 14,580 plants/ha. Plots were 8.3 m^2 with four field replicates. Replicated plots were harvested on 29 August in Cayuga County (125 days since sowing), 5 September in Livingston County (127 days since sowing), 9 September in Jefferson County (129 days since sowing), and 11 September in St. Lawrence County (132 days since sowing).

Plots were harvested with a retrofitted 3-row New Holland corn silage harvester with a weigh basket mounted on load cells. The harvester did not have a kernel processor. Material from each chopped plot was mixed and approximately 10 kg of material was collected. This bulk sample was further reduced in size in the field using a biomass shredder. Samples were refrigerated and brought to a laboratory within a few hours. Bulk samples were thoroughly mixed and 50, 100, 150, 200, 400 g and two 600 g subsamples were removed by hand. At three of the sites an additional 600 g subsample also was collected for particle size separation following ensiling. One 600 g subsample was immediately dried at 60 °C to provide a fresh (un-ensiled) sample for analysis. The remaining samples were vacuum-sealed into polyethylene bags (Nylon poly EVOH high barrier 3 mil 22 × 33 cm^2 vacuum pouches), using a single chamber vacuum packaging machine (model KVP-420T