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Comparison of detergent fiber analysis methods for forages high in pectin

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Abstract

Pectin and ash can interfere with detergent fiber analysis of brassica forages. Non-sequential (NONSEQ) and sequential (SEQ) fiber analysis sequences were compared for amylase neutral (aNDF) and acid (ADF) detergent fiber with and without correction for acid detergent residual ash in individually (Experiment 1) and batch-processed samples (Experiment 2). Hemicellulose concentration was calculated as the difference between aNDF and ADF. Samples included brassica forage, legumes, CT containing legumes and grasses. Fiber analysis sequence and ash correction affected ADF and hemicellulose independently, with fiber analysis sequence having the larger impact. Forage groups differed in response to treatment for most variables. Compared to NONSEQ analysis, SEQ analysis reduced ADF of brassica forages by 41 and 34 g/kg in Experiments 1 and 2, respectively, reduced ADF of legume forages by 22 and 34 g/kg in Experiments 1 and 2 and gave comparable increases in hemicellulose for both forage groups in both experiments. Estimates of ADF and hemicellulose in grasses were unaffected by analysis sequence. Under individual processing, ash correction reduced ADF only for brassicas (205 g/kg *versus* 191 g/kg for uncorrected and ash-free), but under batch processing, ADF of all forage groups was reduced by ash correction (mean 282 g/kg *versus* 274 g/kg for uncorrected and ash-free, respectively). The difference between NONSEQ and SEQ ADF increased with pectin concentration ($r^2 = 0.30$, $P<0.001$). Sequential fiber analysis with correction for resid-

Abbreviations: AD, acid detergent; ADF, acid detergent fiber; ADFom, ADF corrected for residual ash; aNDF, NDF conducted using alpha amylase; aNDFom, aNDF corrected for residual ash; CE, catechin equivalent; CT, condensed tannin; ND, neutral detergent; NDF, neutral detergent fiber; NONSEQ, non-sequential analysis sequence; OM, organic matter; SEQ, sequential analysis sequence

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ual ash was preferred for high-pectin forage brassicas and non-tannin legumes, but non-sequential methods were acceptable for grasses.

Keywords: Ash; Fiber analysis; Filter bags; Forage brassica; Legumes; Pectin; Tannin

1. Introduction

Forage brassicas are readily digestible, high-energy forages for cattle (*Bos taurus*), sheep (*Ovis aries*) and goats (*Capra hircus*). The energy content of forage brassicas is due in part to a high concentration of pectin (Barry and Manley, 1985). Pectin is a readily fermentable carbohydrate that is found in higher concentrations in broadleaf than in monocotyledonous plants (Van Soest et al., 1991). Hatfield and Weimer (1995) suggested that high pectin improves forage quality, possibly because it may create more favorable rumen fermentation than a comparable amount of starch (Ben-Ghedalia et al., 1989). Unfortunately, pectin (Van Soest et al., 1991) interferes with detergent fiber analysis methods.

Pectins cause problems with detergent fiber analyses by forming quaternary detergent precipitate gels in the presence of Ca and acidity (Van Soest et al., 1991). These precipitates impart difficulty to filtering and washing of acid detergent (AD) residues through fritted glass crucibles and inflate acid detergent fiber (ADF) values if not removed by neutral detergent (ND) solution prior to ADF determination. As a result, sequential analysis of forage fiber has typically resulted in lower ADF values than direct analysis (Bailey and Ulyatt, 1970; Windham et al., 1987). Neither ND nor AD solution completely removed pectin from browse samples (Mould and Robbins, 1981), but retained pectin was lower in sequential than in non-sequential ADF residues. For some forages, non-sequential ADF values may exceed neutral detergent fiber (NDF) values (Mertens, 2003; Terrill and Koivisto, 2003). Because NDF is defined as ADF plus hemicellulose (Van Soest, 1982), such a result can only occur as the result of an analytical interference, such as when the acid-insoluble pectin concentration is higher than hemicellulose. Several authors have recommended that fiber analyses should always be completed sequentially on high-pectin forages (Windham et al., 1987; Van Soest et al., 1991), but the magnitude of potential error if this is not done is not documented for forage brassicas. Furthermore, brassica forage grown under conventional tillage is also likely to be contaminated with soil and contain high levels of mineral ash (Cassida, 1992) that can also interfere with fiber analyses (Crocker et al., 1998).

The objective of this study was to evaluate the influence of fiber analysis methods on fiber fractions and residual ash of forage brassicas in relation to grasses and legumes. We compared sequential and non-sequential fiber analysis with and without correction for acid detergent residual ash in forage brassicas, non-tannin legumes, a tannin-containing legume and grasses. The study was conducted twice, once with individual processing of samples in Gooch crucibles and once with batch processing in filter bags.