A PROCEDURE TO REDUCE COLLECTED SAMPLE SIZE FOR NUTRIENT ANALYSIS OF HAY CORES

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ABSTRACT: When sampling large lots of hay for nutrient analyses, the number and quantity of cores required to obtain a representative sample often results in producers arbitrarily subsampling in order to reduce the volume of sample sent to a testing lab. This can bias results due to improper subsampling technique; consequently, we compared 2 methods of sampling 4 different baled hays from eastern Oregon (alfalfa, alfalfa/grass, grass, and grass seed straw) using a Penn State Sampler. We obtained 2 cores (A & B) from each bale, 13 cm apart, from 4 lots of 20 bales of each forage type. The A & B cores were grouped by forage type within lot. The first method used 100% of the A cores from each lot (CON) and the second method involved subsampling the B cores from each lot via a quadrant method (SUB) in which the cores were mixed well, spread out on a plywood sheet labeled with 9 quadrants (13 × 13 cm), and approximately 33% of the overall sample (the middle, vertical column of a tic-tac-toe arrangement) was obtained for analyses. Samples were dried (55°C; 96 h), ground (1-mm screen), and analyzed for CP, NDF, and ADF. In addition, TDN was estimated for all forages [82.38-(0.7515*ADF)]. Results were analyzed with the MIXED procedure of SAS and LSMEANS were separated using LSD protected by a significant F-test ($P \leq 0.05$). In tests of fixed effects, no differences were noted between CON and SUB (sampling method; $P > 0.30$) or the interaction of sampling method and forage type ($P \geq 0.09$) for NDF, ADF, TDN, and CP; differences were noted due to forage type ($P < 0.001$) for each nutrient. The take home message from this data is that CON and SUB LSMEANS for NDF (61.4 vs 61.2%), ADF (32.1 vs 31.9%), TDN (58.2 vs 58.4%), and CP (12.0 vs 12.1%) were not affected by sampling procedure. We do not recommend routine subsampling of cored hay samples; however, these data indicate that subsampling can be used to reduce sample size if proper attention to procedures is followed.

Key Words: forage testing, hay, sampling

Introduction

Hay sampling and nutritional analyses are important components of most nutritional programs for ruminant livestock. This information is critical for ration formulation, determining hay value, and allocating hays within an operation's inventory to the appropriate classes of livestock.

A common question when sampling hay is how many bales must be sampled to get a representative sample of the lot of hay. The National Forage Testing Association (NFTA; Putnam, 2011; Putnam and Orloff, 2011) recommends a minimum of 20 bales (one core sample per bale) with up to 35 bales for large lots (100 to 200 ton) or if hay nutritional quality is expected to be very variable. In addition, NFTA strongly recommends that core samples for each lot of hay are combined into a single sample, not subsampled, and sent to a laboratory for testing. Depending on the coring device, this can result in a large volume of sample collected. Nevertheless, NFTA also suggests that the sample of cores from each lot of hay weigh approximately 225 g (Putnam, 2011; Putnam and Orloff, 2011) which may not be possible when using some probes and/or with large lots of hay. Furthermore, most forage testing laboratories request that from 8 to 20 bales be sampled for each lot of hay and/or suggest that each group of cores from a lot of hay fit within a "gallon" bag. This is to minimize the volume of sample the laboratories must process prior to analysis. Consequently, with large lots of hay or hay that is assumed to be highly variable in nutrient content, individuals or laboratories often manually subsample when the number of cores collected yields greater than 225 g. This can result in improper subsampling and nutrient analyses that are not representative of the lot of hay.

Consequently, we designed a study to evaluate a subsampling procedure for cored hay samples. If successful, this procedure will allow for reduction of sample size while not affecting nutrient analyses compared with hay cores that are not subsampled.

Materials and Methods

We obtained core samples using a Penn State Sampler (Nasco, Fort Atkinson, WI) from 4 baled hays common to eastern Oregon. The hays were alfalfa (0.9 × 1.2 × 2.4 m bales), grass/alfalfa (2-tie small bales), Chewings fescue grass seed straw (0.9 × 1.2 × 2.4 m bales), and meadow foxtail (1.5 m diameter round bales). We obtained 2 cores (A & B) from each bale, 13 cm apart, from 4 lots of 20 bales of each hay type. Coring technique followed the procedure recommended by NFTA (Putnam, 2011). The A & B cores were grouped by hay type within lot.

The first sampling method used 100% of the A cores from each lot (CON) and the second method involved subsampling the B cores from each lot via a quadrant method (SUB) in which the cores were mixed well, piled in the middle of a plywood sheet labeled with 9 quadrants (13 × 13 cm) and spread to cover all quadrants, and approximately 33% of the overall sample (the middle, vertical column of a tic-tac-toe arrangement) was obtained for analyses. Samples were dried (55°C; 96 h), ground (1-

mm screen), and analyzed for CP (Leco CN-2000; Leco Corp., St. Joseph, MI) and NDF (Robertson and Van Soest, 1981) and ADF (Goering and Van Soest, 1970) using procedures modified for use in an Ankom 200 Fiber Analyzer (Ankom Co., Fairport, NY). In addition, TDN was estimated for all forages [82.38-(0.7515*ADF)].

Data were analyzed with the MIXED procedure of SAS (SAS Inst., Inc., Cary NC). The model included sampling method, hay type, and the resultant interaction with degrees of freedom calculated by the Satterthwaite procedure. In addition, replication within hay type was used to specify variation using the RANDOM statement. The LSMEANS were separated using LSD protected by a significant F-test ($P \leq 0.05$).

Results & Discussion

Differences in hay type were observed for CP, NDF, ADF, and TDN ($P < 0.001$; data not shown); however, no differences were noted for the interaction of method × hay type (Table 1; $P \geq 0.09$) or sampling method ($P > 0.30$). Consequently, overall CON and SUB LSMEANS for CP, NDF, ADF, and TDN were, on a DM basis, 12.0 vs 12.1% (SEM = 0.22), 61.4 vs. 61.2% (SEM = 0.28), 32.1 vs. 31.9% (SEM = 0.31), and 58.2 vs. 58.4% (SEM = 0.23), respectively. These data indicate subsampling using the procedure described herein is an acceptable method to reduce sample size without biasing results compared with cores that were not subsampled.

Nutrient analyses can only be as good as the sample collected. Therefore, it is critical to obtain a representative sample from each lot of hay. Unfortunately, there is no definitive recommendation for the number of bales to sample for nutrient analysis with respect to varying lot size and hay type. A study from Kansas State University provides sampling recommendations for 99%, 95%, and 80% confidence intervals for the CP content of alfalfa, prairie hay, and sorghum-sudan hay determined to within 1% or 0.5% CP of the actual mean (Blasi, 2011). The recommendations are specific to each forage type; however, the general recommendation is to sample 20% of the bales in a lot of hay to obtain a representative sample for CP analysis. However, the most commonly accepted recommendation by the forage industry is to use a minimum of 20 bales (one core per bale) and to sample more bales for larger lots of hay or if the hay is assumed to be very variable in nutrient composition (NFTA; Putnam, 2011; Putnam and Orloff, 2011).

The National Forage Testing Association recommends that the amount of sample obtained from each lot of hay be approximately 225 g to assure that the amount of sample is an easily managed and processed size (Putnam, 2011; Putnam and Orloff, 2011). This may not be possible for large lots of hay or hay that is highly variable in nutrient composition. Consequently, many hay growers, livestock owners, nutritionists, and forage testing laboratories subsample when samples from a lot of hay exceed 225 g. Even though this is not a recommended practice by NFTA (Putnam, 2011; Putnam and Orloff, 2011), our data suggests that the subsampling method described herein can be an acceptable practice with cored hay samples greater than 225 g.

Implications

Subsampling cored hay samples that are greater than 225 g by spreading the sample over 9 quadrants, arranged in a tic-tac-toe layout, and collecting 33% of the original sample volume (3 quadrants) does not bias nutritional results and is an effective way to reduce sample size for laboratory analysis.

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Table 1. Influence of sampling method[a] and hay type on nutrient concentration (DM basis)

	Hay					
Nutrient, %	Alfalfa	Alfalfa/Grass	Grass	Grass Seed Straw	SEM[b]	P-Value[c]
CP					0.22	0.70
Control	21.8	15.4	5.2	5.6		
Subsample	21.2	15.6	5.2	6.4		
NDF					0.28	0.31
Control	43.9	58.9	64.7	78.1		
Subsample	43.5	57.7	65.0	78.4		
ADF					0.31	0.42
Control	25.8	27.9	32.7	42.1		
Subsample	25.8	27.1	32.8	42.1		
TDN					0.23	0.42
Control	63.0	61.4	57.8	50.8		
Subsample	63.0	62.0	57.7	50.8		

[a] 2 cores (A & B) were obtained from each bale, 13 cm apart, from 4 lots of 20 bales of each hay type. The A & B cores were grouped by hay type within lot. The first method used 100% of the A cores from each lot (Control) and the second method involved subsampling the B cores from each lot in order to obtain approximately 33% of the original sample volume (Subsample).

[b] n = 4; Method Effect SEM

[c] Method Effect; no Method × Hay Interaction ($P \geq 0.09$).