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Summary

Ingestion and mastication of forage samples adds ash. Generally, levels of CP were lower and NDF and IVOMD were similar for post-ingested versus pre-ingested forage. Bag type (screen vs. solid) generally did not affect ash, NDF, or IVOMD. Bag did not affect CP of alfalfa but CP of grass samples from screen bags was lower than solid bags. More fresh than dry forage was recovered through the esophageal opening.

Introduction

Fistulated animals have been used extensively to quantify nutrient intake of grazing animals. This method accounts for the grazing animal's selectivity, which is not accounted for in clipped samples. Several factors inherent to using fistulated cattle may affect the degree to which forage masticate samples actually represent grazed animal diets. Changes in chemical composition of forage collected by this method have been attributed to mastication followed by salivary contamination and nutrient leaching. Salivary contamination and sample preparation technique could influence both the organic and inorganic components of grazed grass samples. Collection bags with screen bottoms have been used since the 1960s and allow for drainage of excess saliva, which speeds sample drying time. Nutrients leach from the forage into the saliva and are lost with the loss of the saliva from the bag. Forages of different quality may be affected to differing degrees. Previous research (*2012 Nebraska Beef Cattle Report,* pp. 49-50) has shown a higher loss of nutrients for fresh forage compared with hay or dormant forage. Therefore, objectives of this study were to compare the nutrient composition of forage fed to cattle with that of masticate samples collected through esophageal fistula and to determine the influence of collection bag type (screen vs. solid) on the nutrient composition of vegetative (FRESH) or dry (HAY) alfalfa or meadow grass masticate samples collected from esophageally fistulated cattle.

Procedure

Ten esophageally fistulated cattle were fitted with either solid (SOL; N = 5) or screen (SCR; N = 5) bottom collection bags. On day 1, cattle were presented with 0.90 lb (DM) grass hay (7.1% CP, 80% NDF) and allowed to completely consume it (15-20 minutes). Masticate was removed from the bag and cattle were then offered 0.38 lb (DM) vegetative grass (15.1% CP, 56% NDF) harvested immediately before being presented to the animals. Both hay and vegetative grass were harvested from the same sub-irrigated meadow and had similar grass species composition. On day 4, cows were offered 0.92 lb (DM) alfalfa hay (19.5% CP, 49% NDF) and allowed to completely consume it (15-20 minutes). Masticate was removed from the bag and cattle were then offered 0.24 lb (DM) fresh alfalfa (19.1% CP, 40% NDF) harvested immediately before presentation. Pre-ingested forage was sub-sampled for chemical analysis. Amount of each forage offered was chosen to ensure the forage would be completely consumed by the animal. No orts remained in the feed pan for any forage. Masticate samples were collected and weighed to calculate percentage of forage offered that was recovered in the collection bag. All masticate and pre-ingested forage samples were immediately frozen and stored until lyophilized. Samples were analyzed for CP, NDF, and IVOMD. Values for CP and NDF were expressed on an OM basis.

Results

No two-way or three-way interactions were present ($P > 0.10$) among bag type (solid vs. screen), forage harvest status (fresh vs. dry), and ingestion status (pre vs. post) within forage type (grass or alfalfa). Ingestion status (pre-ingested (PRE) vs. post-ingested (POST)) affected levels of ash (10.1% vs. 15.0% ash for PRE vs. POST, respectively; $P < 0.001$, Table 1). The higher ash content POST is in agreement with results reported by several others in the refereed literature. The post ingestion increase in ash content of forage samples may be adjusted for by expressing the other chemical components on an organic matter basis. The addition of minerals by the saliva makes samples collected through the esophageal fistula unacceptable for determination of mineral composition of the forage.

Crude protein levels were generally higher for PRE vs. POST ($P < 0.1$, Table 1) but were similar for grass hay (7.6% vs. 7.8% CP for PRE vs. POST, respectively; $P > 0.1$). This is in agreement with previous research (*2012 Nebraska Beef Cattle Report,* pp. 49-50) which reported a larger difference in CP between pre-ingested and post-ingested samples of higher quality than for lower quality forage samples.

Levels of NDF were similar for PRE vs. POST ($P > 0.1$, Table 1) except for fresh alfalfa (43.9% vs. 49.9% NDF for PRE vs. POST respectively;

Table 1. Nutrient composition of pre-ingested and post-ingested fresh or dry alfalfa or grass.

	Fresh		Hay			*P*-values		
	Pre	Post	Pre	Post	SE[1]	Type[2]	Ingest[3]	T x I[4]
Alfalfa								
Ash, % DM	9.4[c]	17.4[a]	10.6[c]	14.0[b]	0.9	0.21	< 0.001	0.01
CP, % OM	21.1[a]	19.3[b]	21.8[a]	19.8[b]	0.5	0.18	< 0.001	0.85
NDF, % OM	43.9[c]	49.9[b]	55.3[a]	52.7[ab]	1.5	< 0.001	0.17	0.002
IVOMD, %	68.3[a]	68.5[a]	62.0[b]	63.4[b]	1.0	< 0.001	0.44	0.61
Grass								
Ash, % DM	13.2[b]	18.0[a]	7.1[d]	10.4[c]	0.8	< 0.001	< 0.001	0.37
CP, % OM	17.5[a]	14.8[b]	7.6[c]	7.8[c]	0.2	< 0.001	< 0.001	< 0.001
NDF, % OM	64.8[b]	62.8[b]	86.1[a]	83.3[a]	1.6	< 0.001	< 0.14	0.81
IVOMD, %	77.8[a]	76.8[a]	55.7[c]	61.1[b]	0.9	< 0.001	0.004	< 0.001

[1]Standard error of the simple effect mean.
[2]Main effect of forage harvest status.
[3]Main effect of forage ingestion status.
[4]Forage harvest status by ingestion status interaction.
[a-c]Within rows, values with different superscripts differ ($P \leq 0.10$).

Table 2. Nutrient composition of fresh or dry alfalfa or grass masticate samples collected in screen (SCR) or solid (SOL) bottom bags from esophageally fistulated cattle.

	Fresh		Hay			*P*-values		
	SCR	SOL	SCR	SOL	SE[1]	Type[2]	Bag[3]	T x B[4]
Alfalfa								
Ash, % DM	14.5[b]	20.8[a]	13.5[b]	14.5[b]	1.3	0.04	0.02	0.07
CP, % OM	19.4	19.2	19.9	19.7	0.7	0.44	0.71	0.99
NDF, % OM	47.4[b]	53.1[a]	52.8[a]	52.7[a]	2.4	0.05	0.03	0.40
IVOMD, %	70.0[a]	66.5[ab]	63.1[b]	63.7[b]	1.9	0.02	0.37	0.34
Grass								
Ash, % DM	18.3[a]	17.6[a]	9.7[b]	11.1[b]	1.5	0.001	0.81	0.51
CP, % OM	15.0[a]	14.6[a]	8.0[b]	7.6[b]	0.2	< 0.001	0.02	0.88
NDF, % OM	64.3[b]	61.2[b]	83.7[a]	82.8[a]	2.9	< 0.001	0.39	0.76
IVOMD, %	77.6[a]	76.2[a]	59.5[b]	62.6[b]	1.6	< 0.001	0.48	0.25

[1]Standard error of the simple effect mean.
[2]Main effect of forage harvest status.
[3]Main effect of collection bag.
[4]Forage harvest status by collection bag interaction.
[ab]Within rows, values with different superscripts differ ($P \leq 0.10$).

Table 3. Amount of fresh or dry alfalfa or grass offered to esophageally fistulated cows recovered in collection bag.

	Fresh		Hay			*P*-values		
	Alfalfa	Grass	Alfalfa	Grass	SE[1]	Type[2]	Forage[3]	T x F[4]
Recovery, % DM	68.2[a]	63.8[ab]	53.1[ab]	48.8[b]	0.1	0.01	0.43	0.99
Recovery, % OM	74.5[a]	66.4[ab]	55.1[b]	50.4[b]	0.1	0.01	0.31	0.79

[1]Standard error of the simple effect mean.
[2]Main effect of harvest status (fresh vs. hay).
[3]Main effect of forage (alfalfa vs. grass).
[4]Harvest status by forage interaction.
[ab]Within rows, values with different superscripts differ ($P \leq 0.10$).

$P < 0.1$). Musgrave et al., (*2012 Nebraska Beef Cattle Report*, pp. 49-50) reported an increase in NDF of higher quality forages while lower quality forages remained unchanged. Cell solubles from fresh, vegetative forage may go into solution more rapidly than those of the dry hay, possibly accounting for some of the difference observed.

In general, IVOMD was not affected by ingestion status ($P > 0.1$, Table 1), except for grass hay (55.7% vs. 61.1% IVOMD for PRE vs. POST, respectively; $P = 0.01$).

Bag (SCR vs. SOL) did not affect ash and NDF ($P > 0.1$, Table 2) except for fresh alfalfa (14.5% vs. 20.8% ash; $P = 0.02$ and 47.4% vs. 53.1% NDF; $P = 0.03$ for SCR vs. SOL, respectively). Bag did not affect CP of alfalfa ($P = 0.71$) but did affect grass CP (11.5% vs. 11.1% CP for SCR vs. SOL, respectively; $P = 0.02$). Digestibility was not affected by bag (67.3% vs. 67.6% IVOMD for SOL vs. SCR, respectively; $P > 0.1$).

Forage type (FRESH vs. HAY) influenced the amount of the diet that was recovered through the esophageal opening (70.5% vs. 52.8% OM for FRESH vs. HAY, respectively; $P = 0.01$, Table 3).

Overall, masticate samples of high quality forage were lower in CP, whereas lower quality forage masticate samples were similar to pre-ingested forage values, which agrees with the findings of Musgrave et al., (*2012 Nebraska Beef Cattle Report,* pp. 49-50). Masticate NDF and IVOMD were similar to pre-ingested forage. Ash levels were higher in masticate than pre-ingested forage, likely due to the minerals added in the saliva. Lower recoveries suggest masticate samples may not always be representative, especially when dry forages are being consumed.

These data suggest forage samples collected through the esophageal fistula may underestimate the amount of CP present in high quality forages but be similar to CP levels in mid or low quality forages. In general, masticate samples appear to adequately represent the levels of NDF and IVOMD of forages sampled. Due to increased levels of ash, all values should be reported on an OM basis.

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