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MORNING AND EVENING HARVEST EFFECTS ON ANIMAL PERFORMANCE

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ABSTRACT

Plants vary diurnally in concentrations of nonstructural carbohydrates (TNC). Delaying forage harvest until mid to late afternoon could result in increased TNC in forage. Ruminants can differentiate between PM-harvested and AM-harvested grass and alfalfa hays and eat more PM-harvested versus AM-harvested hay. In a related study, dairy cows ate about 10 % more total mixed ration containing 40% PM-harvested alfalfa hay versus the same ration containing AM-harvested hay, produced more milk, and gained rather than lost body weight. Afternoon harvest management could add $15/ton of alfalfa compared with morning harvesting.

Key Words: alfalfa, grass, harvest management, quality, preference, dry matter intake, milk production

INTRODUCTION

Plants accumulate sugars during the day via photosynthesis, but incur a net loss at night via dark respiration. This diurnal cycling reflects the concentration of total nonstructural carbohydrates (TNC) in forages. We posed the question could animals differentiate between forage harvested at sundown and that harvested at sunup? Further, would such selection increase energy intake and would that enhance animal production?

PROCEDURES

HiMag tall fescue (*Festuca arundinacea*) and Germain WL 322HQ alfalfa (*Medicago sativa*) were harvested with a crimper equipped swather at vegetative stages from irrigated fields near Kimberly in south central Idaho. Harvests were paired such that PM harvest was swathed at sundown (± 1 hour) and AM harvest swathed at sunup (± 1 hour). Swathing of six grass hays occurred on 20 (PM), 21 (AM&PM) and 22 (AM) August and 21(PM) and 22 (AM) September. Swathing of six alfalfa hays occurred on 8 (PM) and 9 (AM) July, 14 (PM) and 15 (AM) August, and 22 (PM) and 23 (AM) September. Hays were allowed to field dry (5 to 7 days), and paired cuttings were baled, and stored in a barn. Hay was trucked to Raleigh, NC where hay was fed to six cattle, six sheep, and six goats in a preference study. Bales were passed through a bale processor to cut hay into 4-inch lengths to facilitate random makeup of each meal. All possible pairs of PM- and AM-harvested grass hay (first study, Fisher, et al., 1997a, 1997b, and submitted) and alfalfa hay (second study, Fisher, et al., 1998a, 1998b) were fed in carefully

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randomized order to each animal. Samples of hay were taken at each feeding, composited by animal specie, and analyzed for various forage quality components. Preference was computed as the amount of hay eaten relative to the amount of hay available in each comparison and data analyzed by multidimensional scaling. Sufficient amounts of each hay were offered such that animals always had a choice among the two hays.

RESULTS

The PM-harvested grass hay compared with AM-harvested grass hay, had significantly higher crude protein (CP), mono- and disaccharides, total nonstructural carbohydrate (TNC), and *in vitro* dry matter digestibility (IVDMD) (Table 1). The PM-harvested grass hay had lower concentrations of NDF and ADF than AM-harvested hay. The PM-harvested alfalfa hay compared with AM-harvested hay had greater concentrations of mono- and disaccharides, greater TNC, and tended to have lower concentrations of both NDF and ADF (Table 2). Data on CP and IVDMD for alfalfa hay were not available at time of writing.

Cattle, sheep, and goats preferred PM-harvested hay to AM-harvested grass hay (Table 1) and alfalfa hay (Table 2), but data are shown only for cattle. Dry matter intake (DMI) of test meals is shown only for cattle (Tables 1, 2).

Forage quality parameters like NDF, ADF, TNC, and IVDMD were highly correlated ($r^2 > 0.88$) with DMI by cattle for PM- and AM-harvested grass hay. For alfalfa, lignin and NDF were highly correlated ($r^2 = 0.96$) with DMI of PM- and AM-harvested hay by cattle. Thus, current laboratory assessments of forage quality seem adequate to detect animal responses to PM-harvested versus AM-harvested forage

DISCUSSION

Diurnal differences in soluble sugar concentrations can be retained in PM- and AM-harvested forages. The magnitude will depend on level of respiration occurring in plants over night and amount occurring during post-harvest drying. We have shown that these differences can be retained following swathing, field drying, and storage. Ruminants are able to differentiate between two forages differing by less than 1% TNC. They have a remarkable ability to identify forage having a higher energy density like that of PM- versus AM-harvested grass and alfalfa hay. To humans, these hays look, smell, feel, and taste the same, but current laboratory tests are able to detect components of forage quality that relate to DMI of these ruminants.

Cattle, sheep, and goats are able to sense and then eat more PM- than AM-harvested hay. In a production test, lactating dairy cows ate 10% more total mixed ration (TMR) containing 40% alfalfa hay when that hay was PM-harvested rather than AM-harvested (Kim, 1995). During the 10-week study, these mid-lactation cows produced about 10% more milk and gained body weight while cows receiving the TMR with AM-harvested alfalfa continued to lose weight. We have estimated that this increased production was worth about $15/T of forage.

Forage producers will want to know the window of opportunity during which time harvesting

would capture maximum accumulated sugars in forage. Grass and alfalfa samples have been taken at frequent intervals throughout the day and night in hopes of identifying the accumulation rate and recommendations are forthcoming.

SUMMARY POINTS

- ✔ Forage grasses and alfalfa accumulate soluble sugars during day, but these are respired during night causing a diurnal cycling of TNC in forage.
- ✔ Forage cut at end of day has more soluble TNC than if cut early in day. This difference can be maintained through the drying process and continued through feeding.
- ✔ Ruminants prefer PM-harvested hay more than AM-harvested hay and eat more even when PM-harvested forage is part of TMR.
- ✔ Lactating cows fed a TMR containing PM-harvested versus AM-harvested forage will produce more milk.
- ✔ Factor(s) influencing ruminant animal behavior for PM-harvested hay are measurable with current forage quality tests.
- ✔ PM-harvesting of alfalfa hay could add $15/T compared to AM-harvesting.

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Table 1. Intake and composition of tall fescue grass hays used in experiment with cattle.

Hay	ADF	NDF	Saccharides		TNC	CP	IVDMD	Intake
			Mono-	Di-				
	----------	----------	----------	% ----------	----------	----------	----------	g/meal
PM-20 Aug	26.0	49.6	2.45	3.45	8.15	22.2	84.7	987
AM-21 Aug	27.1	52.0	1.67	2.65	6.21	21.7	82.4	544
PM-21 Aug	26.8	51.5	2.12	3.28	7.73	21.7	83.1	788
AM-22 Aug	28.2	53.5	1.71	2.72	6.71	19.9	82.1	427
PM-20 Sept	22.4	43.5	2.83	5.76	11.82	20.6	88.8	1460
AM-21 Sept	24.3	47.0	2.42	3.49	9.33	19.9	87.5	1310
PM	25.1	48.2	2.47	4.16	9.28	21.5	85.5	1078
AM	26.5	50.8	1.98	2.93	7.42	20.5	84.0	760
Contrast:				Probability (P>F)				
PM vs AM	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 2. Intake and composition of alfalfa hays used in experiment with cattle.

Hay	ADF	NDF	Saccharides		TNC	Intake
			Mono-	Di-		
	----------	----------	%	----------	----------	g/meal
PM-8 July	31.1	40.7	1.20	1.53	4.29	1022
AM-9 July	32.8	42.7	0.93	1.24	3.49	842
PM-14 Aug	32.0	41.9	1.31	2.09	5.16	619
AM-15 Aug	32.5	42.0	1.01	1.55	3.97	324
PM-22 Sept	27.9	36.6	1.66	3.22	6.55	1320
AM-23 Sept	28.5	37.2	1.27	2.66	5.46	1107
PM mean	30.3	39.7	1.39	2.28	5.33	987
AM mean	31.2	40.6	1.07	1.82	4.31	758
Contrast:			Probability (P>F)			
PM vs AM	0.3	0.2	<0.01	<0.01	<0.01	<0.01