Salivary Contamination of Forage Selected by Esophageal Fistulated Steers Grazing Sandhill Grassland¹

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Highlight

The effect of saliva contamination on chemical composition of forage collected from esophageal fistulated steers grazing sandhill grassland was studied over four different seasons. Salivary contamination of grazed forage significantly increased the ash component but did not change other chemical constituents calculated on an organic matter basis. The increase in ash attributed to saliva varied with species of plants and season of grazing.

Placing esophageal fistulae in grazing animals advanced range and pasture nutrition research; forage samples collected from the esophagus are

more representative of forage consumed than are hand-collected samples (Van Dyne and Torell, 1964). However, forage samples obtained from an esophageal fistula are changed by saliva and mastication. The amount of change in chemical components of forage eaten and collected by esophageal fistulae remains somewhat controversial. Therefore, we evaluated the extent of salivary contamination in cattle-grazed forage collected at different seasons of the year.

Consideration of the Problem

Salivary contamination of esophageal-collected samples probably varies with the whole complex of factors influencing rate and composition of salivary flow. The rate of salivary flow varies with different types of feed (Bailey and Balch, 1961) and with level of food intake (Putnam et al., 1966). The N (nitrogen) content of saliva varies among diets. In cattle (Bailey and Balch, 1961) and sheep (Lewis, 1957), urea N levels in saliva varied with the level of ammonia produced by different diets. With low N intake, ruminants conserve N by reducing the excretion of urinary urea (Elliot et al., 1965), by recycling substantial amounts of urea N in saliva (Kay, 1966), and by direct infusion of urea from blood to the rumen (Houpt, 1959).

Minerals are the primary contaminant in fistula forage samples. Several workers have compared feeds of known composition with samples of the same feed collected from esophageal fistulae of cattle and sheep (Table 1). The ash content of forage eaten increased about 1 to 4%. Ash contamination increased with an increase in dry matter or fiber content because dry and fibrous diets stimulated greater salivary flow (Kay, 1963). N and fiber percentages of forage generally were not changed by salivary contamination (Table 1).

Some of the controversy regarding salivary contamination arises from the calculation of constituent percentages on a dry matter as opposed to an organic matter basis. Since minerals are the main contaminant from saliva, percentage of organic constituents decrease with an increase in amount

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of contamination when expressed on a dry matter basis, but may remain unchanged when expressed on an organic matter basis. The errors in interpretation with the dry matter basis are illustrated below:

Constituent	Dry matter basis		Organic matter basis	
	Clipped	Esophageal	Clipped	Esophageal
Ash (%)	8.0	11.0	—	—
Organic matter (%)	92.0	89.0	100.0	100.0
Protein (%)	8.9	8.4	9.7	9.4
Gross energy (kcal/g)	4.22	4.05	4.59	4.55
Fiber (%)	42.6	41.4	46.3	46.5
Lignin (%)	5.7	5.3	6.2	6.0

Most of the differences which appear in the data expressed on a dry matter basis are non-existent, or of much less magnitude when expressed on an organic matter basis. This very critical point appears to have been overlooked by several workers; thus, it is difficult to conclude whether some differences reported (Table 1) have any real meaning.

Relatively little is known concerning salivary secretion by ruminants at pasture. Salivary flow by grazing cattle has received virtually no attention. With sheep, Wilson (1963) found that salivary secretion varied with season on the same pasture. He estimated that daily flow rates could be as high as 30 liters on dry, mature forage. This estimate is two to five times greater than that presented by Kay (1963) for sheep fed hay and meal (6 to 16 l/day). Salivary flow increases during eating (Bailey and Balch, 1961); thus, the longer time spent grazing as opposed to eating harvested food (Graham, 1965) probably explains the greater salivary flow in grazing sheep.

Increased saliva secretion by animals at pasture (as indicated by Wilson, 1963) coincides with water turnover com-

parisons made with cattle (MacFarlane and Howard, 1966). The latter authors, using twin cattle with one member of each pair stall-fed and the other at pasture, found water turnover to be about three times greater in grazing cattle compared to those fed in stalls.

Experimental Procedure

The diets of cattle on eastern Colorado sandhill grassland were studied by collecting grazed forage from 8 esophageal fistulated steers during 5-day periods in June, July, September and December. Details regarding climate in the area, the experimental pasture, forage collection procedure, and chemical and analytical methods were given by Wallace and Denham (1970).

To determine the extent of saliva contamination in grazed forage the chemical composition of esophageal samples was compared with that of hand-collected forage during each sampling period. Esophageal samples were collected from a steer grazing mixed grass at the end of lead rope for 30 minutes. The composition of the steer's diet was duplicated as closely as possible by hand. The steer used in this manner was extremely docile and grazed normally with the other steers.

Differences in chemical composition between paired samples collected in the above manner could be due to salivary contamination or imperfect duplication. To eliminate errors due to imperfect duplication of diet by clipping, unselected samples were collected by hand each period and divided into two parts. One part was soaked in fresh steer saliva for 1.5 hours and dried in a forced-air oven for comparison with the unsoaked part as suggested by Cook (1964). Prior to soaking in saliva, the sample was passed four times through a Wiley mill with the screen removed to approximate mastication.

Table 1. Observed changes in forage samples collected from esophageal fistulae when diets of known composition were fed.

Reference	Location	Diet	Animal class	Primary contaminant	Other changes in ¹ dietary sample		Basis on comparison ²
					Increase	Decrease	
Arnold et al. (1966)	Australia	Different fresh herbages	Sheep	Ash	None	None	OM
Bath et al. (1956)	California	Chopped alfalfa	Sheep	Ash	None	None	DM
Campbell et al. (1968)	Oklahoma	Fresh Bermuda grass or native pasture mix	Cattle	Ash	None	N, NFE, EE	U
Cundy and Rice (1968)	Wyoming	Alfalfa hay, haylage and silage	Cattle	Ash	None	DM dig.	DM
Hoehne et al. (1967)	Nebraska	Prairie sandreed and blue grama grasses	Cattle	Ash	Cl, P	N, Ca, S, CHO	U
Langlands (1966)	Australia	Lucerne chaff and fresh herbage	Sheep	Ash	Na, P	K, OM dig.	OM
Lesperance et al. (1960)	Nevada	Different alfalfa and grass hays	Cattle	Ash	CF, P	GE, NFE	U
Lombard and Van Schalkwyk (1963)	S. Africa	Different hays and fresh herbages	Sheep	Ash	P	NFE	U
McManus (1961)	Australia	Various roughages	Sheep	Ash	None	None	OM

¹CF = crude fiber, NFE = nitrogen free extract, EE = ether extract, DM dig. = dry matter digestibility (in vitro), S. CHO = water-soluble carbohydrates, OM dig. = organic matter digestibility (in vitro), GE = gross energy.

²OM = organic matter basis, DM = dry matter basis, U = unspecified.

Table 2. Chemical composition of mixed grass forage collected by animal and by hand in different seasons.

Component ¹ and sample collection	Season				Avg.
	June	July	Sept.	Dec.	
Crude protein (%)					
Animal	13.7	7.6	5.8	4.1	7.8
Hand	13.3	7.5	6.9	4.2	7.7
Acid-detergent fiber (%)					
Animal	46.6	47.2	52.8	57.1	50.9
Hand	45.9	49.0	51.5	56.9	50.8
Lignin (%)					
Animal	4.9	5.1	8.5	9.2	6.9
Hand	5.1	7.2	7.5	8.9	7.2
Ether extract (%)					
Animal	1.4	1.6	3.0	3.0	2.3
Hand	1.4	1.7	2.7	2.9	2.2
Gross energy (kcal/g)					
Animal	4.40	4.56	4.53	4.67	4.54
Hand	4.49	4.60	4.57	4.50	4.54
Ash (%)					
Animal	8.0	7.5	9.5	10.4	8.8
Hand	7.1	6.4	7.5	8.6	7.4

¹ All components except ash are given on an organic matter basis.

Results and Discussion

Salivary contamination by steers grazing mixed grass increased the ash content of forage significantly ($P < 0.05$) (Table 2). Furthermore, the amount of ash added by saliva increased with advancing plant maturity. Consequently, the concentrations of all other constituents were expressed on an organic matter basis. In this way, forage eaten by animals differed from forage collected by hand only in ash content.

In Table 3 comparisons in chemical composition were made between clipped herbage soaked in saliva and that left untreated. Differences in components other than ash were non-significant; and with ash the increases due to ensalivation followed trends similar to those shown in Table 2. The increase in ash content caused by saliva contamination was about 1% greater when the forage was eaten by animals (Table 2) than when clipped and soaked in saliva (Table 3).

Our results, like those of Wallace et al. (1972), indicate that the main discrepancy in chemical composition between actual diet samples and those simulated by careful hand-clipping may arise through salivary ash contamination and not through imperfect diet duplication.

Dry matter content of clipped herbage varied from 38% in June to 90% in December, and of esophageal forage samples from 22 and 24%. Dry, mature forage had a greater absorbing capacity for saliva than less mature or green forage. Con-

Table 3. Chemical composition of mixed grass herbage collected by hand and soaked in saliva in different seasons.

Component ¹ and sample treatment	Season				Avg.
	June	July	Sept.	Dec.	
Crude protein (%)					
Soaked	12.4	7.3	5.4	3.3	7.1
Untreated	12.1	7.9	5.4	3.4	7.2
Acid-detergent fiber (%)					
Soaked	48.0	52.1	54.1	52.6	51.7
Untreated	49.2	52.0	53.8	53.2	52.0
Lignin (%)					
Soaked	5.6	7.3	7.9	7.9	7.2
Untreated	5.8	6.7	8.2	8.6	7.4
Ether extract (%)					
Soaked	1.8	1.7	2.1	3.2	2.2
Untreated	2.0	1.4	1.9	2.9	2.0
Gross energy (kcal/g)					
Soaked	4.64	4.53	4.60	4.51	4.57
Untreated	4.40	4.58	4.43	4.53	4.51
Ash (%)					
Soaked	9.1	7.7	9.3	8.0	8.5
Untreated	9.1	7.6	8.2	6.8	7.9

¹ All components except ash are given on an organic matter basis.

sequently, the ash contamination by saliva in grazed samples increased with advancing plant maturity (Tables 2 and 3). An increase in salivary flow with the consumption of drier forage (Wilson, 1963) was probably a contributing factor also.

In July, September, and December salivary contamination also was evaluated by grazing blue grama (*Bouteloua gracilis*). The amounts of ash contamination were consistently greater than when grazing the taller mixed grass. Increases in ash content of grazed forage over clipped samples were 1.6, 3.6 and 4.3% for July, September and December, respectively. The percentages of other chemical components, expressed on an organic matter basis, were unchanged by salivary contamination.

The large increases in ash content of blue grama forage collected from the esophageal fistulae during September and December are greater than expected by salivary contamination alone, and introduce an additional type of contamination resulting from grazing. The steers apparently consumed appreciable amounts of soil when grazing short, dry blue grama. Harris et al. (1967) also reported soil ingestion by cattle grazing short grass pastures.

The problem of correcting for ash contamination in grazed forage samples is not a simple one. The extent of such contamination appears to be related to maturity (or dry matter content) of herbage and to rate and composition of salivary flow. Reliable estimates of salivary flow and composition are difficult to ascertain (Kay, 1966). Thus, the

logical approach in dealing with chemical data representing forage collected from esophageal fistulae is to express results on an organic matter basis.

Summary

We studied changes in chemical composition of cattle grazed forage brought about through exposure to saliva. As compared to hand clipped forage samples, those exposed to saliva contamination were significantly higher in ash content. The increase in ash attributed to saliva was greater with mature, dry forage than with green, succulent forage; and it was higher on blue grama grass than on taller mixed grass. Other chemical constituents, expressed on an organic matter basis, were not changed by ensalivation.

We demonstrated the need for reporting chemical composition data of grazed forage on an organic matter basis and reviewed factors affecting rate and composition of salivary flow in cattle and sheep.

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