Measurement of Selective Grazing of Tropical Pastures Using Esophageal Fistulated Steers[1]

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Highlight

Esophageal fistula samples of tropical forage contained 66.4% more crude protein and 7.7% less crude fiber than the average figure for the clipped pasture forage. The percentage crude protein of herbage leaves was approximately 55% higher and the percentage crude fiber was approximately 17% lower than the whole plant.

The importance of selective grazing by sheep was originally pointed out by Stapledon (1927) and by Fagan (1929) who stated further that cattle were selective as to parts of plants eaten. This conclusion was subsequently investigated and confirmed by Johnstone-Wallace (1937) and Johnstone-Wallace and Kennedy (1944).

In 63 grazing trials with cattle (Hardison, Reid, Martin, and Woolfolk, 1954) forage selected showed a higher percentage of crude protein and a lower percentage of crude fiber than analysis of clipped samples of the pastures would imply.

There is a greater potential for selection in tropical and subtropical areas because there is much wider variation in herbage than in temperate areas as shown by Juko and Bredon (1961) in their comparison of analyses of leaves and the whole plant of some common Uganda grasses.

Weir and Torell (1959) showed that forage collected by esophageal-fistulated sheep differs chemically from herbage clipped from the same areas.

The purpose of this study was to compare chemical composition of tropical forage collected by esophageal-fistulated indigenous steers with composition of herbage cut by mower and with individual species of plants and plant parts.

FIG. 1. Gregarious, esophageal-fistulated, Sanga-type steers grazing a mixed tropical grassland. Note plant-covered termite hills in background.

Methods and Materials

Twelve mature Sanga-type (longhorn Zebu) steers were fitted with esophageal fistulas and were allowed four weeks to heal before use. On sampling days steers were kept in an enclosure without feed for the night and at 9 A.M. plugs were removed, collection bags fitted, and the animals driven 200 yards to the 10-acre grazing area. The cattle were allowed 45 minutes of grazing before they were returned to the *boma* where the bags were removed. Five hundred to 1,000 g samples were collected in this length of time. The steers were then put back into the same pasture to continue grazing normally until the next collection period.

Fistula samples were squeezed in coarse cotton cloth; a 400 g sample of the fibrous portion was spread thinly on aluminum trays and placed in racks within a steel building where there was air circulation but no direct sunlight. The forage took 24 to 36 hr to dry, after which time it was weighed and placed in polyethylene bags to be taken to the laboratory for analyses.

The herbage was cut with a sickle bar mower to within 2 inches of ground level starting six days prior to the fistula collection in 24, 5-square-yard, L-shaped plots. They were grouped according to the predominance of species as there was considerable variation between valley and hilltop locations (Fig. 1). The grass communities were as follows: *Themeda triandra, Beckeropsis uniseta-Cymbopogon af-*

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ronardus, Themeda triandra-Cymbopogon afronardus, Cymbopogon afronardus-Themeda triandra, Loudetia kagerensis-Cymbopogon afronardus, Themeda triandra-Loudetia kagerensis respectively. Four replicates from each were collected. Samples were air dried in the shade, milled, and subsampled.

The main species of herbage were collected each fistula-collecting day by cutting the plant within 2 inches of the ground. Leaves were separated from the stems in one-half of each species; the other half were kept as whole plants. The samples were air dried in shade and weighed.

All herbage samples and fistula samples were analyzed chemically as follows: Dry matter was determined at 105 C, crude protein was determined by the semi-macro Kjeldahl method, crude fiber by the method prescribed in the Fertilizers and Feeding Stuffs Act (1926) and a correction factor used to compensate for lower boiling point due to altitude (Todd, 1951), ether extract according to Feeding Stuffs Act (1926), and ash by dry ashing.

Regression equations used to calculate the digestible dry matter and digestible crude protein were calculated from the equations published by Bredon, Harker and Marshall (1963). Total digestible nutrients and starch equivalent were calculated from the following regression equations:

TDN = 1.3033 x % crude protein of sample + 42.266; r = 0.9057.

SE = 1.5310 x % crude protein of sample + 18.632; r = 0.9213.

These equations were based on results published by Bredon, Harker and Marshall (1963) but were especially calculated for this work (Bredon, Marshall, unpublished data).

Results

Composition of pasture.—The average composition of 24 cuts of 5 yd² each was compared with average composition of individual grasses and the results are presented in Table 1, together with the composition of esophageal-fistula samples.

Grasses collected were at the flowering stage and, although sampling was not repeated over an extended period of time, it was not expected that the chemical composition of the grass would change to any degree during 14 days. This assumption was based on a study of the pattern of growth of grasses by Bredon and Horrell (1961).

There was very little difference between the averages for grass from the cuts and individual grasses. The slightly higher average for crude protein of grass from the cuts was attributed to the inclusion of some bottom leafy grasses which were not all included in the individual grasses because of difficulty of collection. With the rather high standard deviations of both groups the difference is insignificant. Nevertheless it is obvious that under African conditions, unless a considerable number of samples are collected as in this case, the figures obtained for crude protein are unreliable.

There is absolute agreement between the average crude fiber figures for the two groups and the standard deviation is proportionally smaller.

Chemical composition of individual grass communities is shown in Table 2. Analysis of variance shows no significant differences between zones except for crude fiber (1%). There were no significant differences within zones.

Crude protein, crude fiber, and nitrogen-free extract for leaves and whole plants of various species are presented in Table 3.

In all cases leaves contained higher percentages of crude protein and lower percentages of crude fiber than whole plants. Taking the average composition of all grasses which were separated into consideration, the percentage crude protein of leaves was approximately 55% higher than the whole plant and the percentage crude fiber of the leaves was approximately 17% lower. Details of percentage differences between leaves and whole plant are shown in Table 4. There are considerable differences between species and, depending on selection of species and parts of plants, there could be considerable difference in nutritive value of herbage consumed.

Table 5 shows a comparison of chemical composition and nutritive values of herbage eaten by fistulated animals and that of clipped samples. Digestible crude protein was calculated by use of the formula published by Glover and French (1957): Digestibility coefficient C.P. = 5 + log C.P. − 0.33 C.F.

Table 5 shows that there was considerable increase in the intake of crude protein due to selection by cattle. This would be sufficient for maintenance and some production if it persisted throughout the day. Assuming that 2% digestible crude protein and 24% starch equivalent in forage is required for maintenance, the starch equivalent of both pasture and herbage eaten was above maintenance, but only 63% of the digestible protein necessary for maintenance was present in clipped samples. This is of considerable importance in this type of pasture where, for

Table 1. Percent crude protein and crude fiber of collected herbage.

Item	Crude protein Mean	Crude protein S.D.[1]	Crude fiber Mean	Crude fiber S.D.
Individual grasses	4.07	1.53	38.96	3.09
5-yd² cuts	4.28	1.22	38.93	2.15
Esophageal fistula	7.04	0.71	35.93	1.92

[1] S.D.=Standard deviation.

Table 2. Chemical analysis of herbage from different plant communities.

Community	C.P.	E.E.	C.F.	Total Ash	N.F.E.
Themeda	3.74	1.33	39.99	7.65	47.29
Backeropsis-Cymbopogon	4.81	1.29	37.77	11.61	44.52
Themeda-Cymbopogon	3.97	2.34	41.23	10.56	41.88
Cymbopogon-Themeda	4.60	2.43	37.57	7.63	47.77
Loudetia-Cymbopogon	3.10	1.23	40.43	8.01	47.23
Themeda-Loudetia	5.18	1.91	36.60	9.41	46.90

Table 3. Chemical analysis (percent) of various plants and parts of plants.

GRASS	LEAVES			WHOLE PLANT		
	Crude protein	Crude fiber	Nitrogen free extract	Crude protein	Crude fiber	Nitrogen free extract
Andropogon dummeri				4.17	37.33	45.95
Beckeropsis uniseta	4.83	36.71	43.28	2.85	41.68	40.69
Bothriochloa insculpta	5.75	33.30	46.65	2.77	40.20	46.72
Brachiaria brizantha				3.10	37.99	48.93
Brachiaria decumbens	8.26	25.77	52.24	5.39	36.09	46.14
Brachiaria platynota				4.70	37.66	44.47
Chloris gayana	6.81	34.12	46.80	4.93	42.52	41.92
Cymbopogon afronardus	4.25	32.42	50.30	3.51	40.03	47.61
Digitaria maitlandii				4.26	34.32	51.35
Hyparrhenia dissoluta	5.27	33.37	51.55	2.63	44.24	45.66
Hyparrhenia filipendula	4.53	34.27	50.38	2.62	40.31	50.26
Legume	16.31	27.32	46.54	9.18	34.13	47.37
Loudetia kagerensis	4.23	38.04	47.17	3.59	41.65	48.83
Setaria plicatilis	9.40	33.51	40.65	7.33	36.85	40.64
Setaria sphacelata				4.70	37.35	46.92
Sporobolus pyrimidalis				3.75	41.12	47.93
Themeda triandra	4.89	35.19	49.84	3.22	39.44	49.37
Average	6.78	33.09	47.76	4.28	39.00	46.57

Table 4. The percentage difference of the nutrients of leaves to those of whole plants.

Species	Crude protein	Crude fiber	Nitrogen free extract
Beckeropsis uniseta	+ 69.47	−11.92	+ 3.84
Bothriochloa insculpta	+107.58	−17.16	− 0.15
Brachiaria decumbens	+ 53.25	−28.60	+13.22
Chloris gayana	+ 38.13	−19.75	+11.64
Cymbopogon afronardus	+ 21.08	−19.01	+ 5.65
Hyparrhenia dissoluta	+100.38	−24.57	+12.90
Hyparrhenia filipendula	+ 72.90	−14.98	+ 0.24
Legume	+ 77.67	−19.95	− 1.75
Loudetia kagerensis	+ 17.83	− 8.67	− 3.40
Setaria plicatilis	+ 28.24	− 9.06	Nil
Themeda triandra	+ 51.86	−10.08	+ 0.95

Table 5. A comparison of chemical composition (percent) and nutritive values (percent) of herbage clipped and collected by fistula.

Item	Crude protein	Crude fiber	Digestible dry matter	Total digestible nutrients	Starch equiv.	Digest. crude protein
Fistula	7.04	35.93	53.29	51.42	29.41	3.10
Clipped	4.23	38.93	48.71	47.74	25.11	1.26
% increase or decrease	+66.4	—7.71	+9.40	+7.71	+17.2	+146.03

most of the year, the average protein content is very low. From the results for forage eaten it appears that, provided there is sufficient bulk from which to select, cattle are able to balance their ration for at least maintenance requirements and a small amount of production.

Our figures vary considerably from the average figures of Hardison, Reid, Martin, and Woolfolk (1954) who obtained much lower increases of protein intake and larger decreases of fiber intake when comparing composition of a sward to the forage eaten by cattle. They are, however, consistent with what could be expected from figures in Table 4 where the percentage differences between the crude protein of leaves and whole plants in proportionally larger than the crude fiber differences.

Our findings explain why cattle survive or even put on weight during the dry season in various parts of Africa when chemical analyses of the pasture suggest that there are not enough nutrients for maintenance.

The high crude protein figure in fistula samples demonstrates the highly selective characteristic of grazing animals. Since the leaves of only a few grass species contained as high as 7% crude protein, the animals must have selected for the legume leaves which contained 16.3% protein.

Discussion and Conclusions

The Ankole area of Uganda has an undulating terrain with many plant communities in a small area, depending upon soil type and depth, at an altitude of approximately 5,000 ft. The pasture used in this study was chosen because of its terrain and number of plant communities in the small area.

Because of predators such as lion, all animals in this district are gathered at approximately 5 PM and put into a thornbush corral or *boma* until about 8 AM, when most of the dew is off the foliage. Even though the fistula steers were treated the same as other cattle in the district, this procedure could affect grazing selection (Arnold et al., 1964).

The steers started to graze immediately when released into the paddock and during the collection period they did not go more than 100 yd up the slope, though they did graze right up to the top of the slope during the afternoon. Some of their grazing was done on termite hills which were covered with *Setaria plicatilis* of high crude protein content and with browse plants, though they were not observed to eat the latter.

It is shown in Table 5 that the steers selected forage which contained 66.4% more crude protein and 7.71% less crude fiber than the average figures for the available pasture forage. This is a remarkable commentary on how inaccurate the clipping method can be when used to assess the value of pastures of the type found in Uganda.

The system of sampling in which measured areas are clipped (in this case 5 yd^2) inevitably includes *Cymbopogon afronardus* to a varying degree depending upon the site. This grass is rarely eaten by cattle particularly when mature but as its chemical composition other than ether extract is about equal to the average of the other pasture grasses, its presence in the samples was not apparent. Nevertheless the inclusion of a grass which can be a very large proportion of the samples and which does not form part of the animals' diet is most unsatisfactory.

The extreme variability of the crude protein of replicates of clipped samples has produced a nonsignificant result for crude protein in the various zones while the results are significant for crude fiber.

There was no significant difference between daily figures for crude fiber of the fistula samples but daily protein differences were significant (Torell et al., 1967; Table 1). There were no significant differences between animals.

Summary

Techniques described by Marshall et al. (1967) were used in a field trial situated in Ankole Kingdom, Uganda. Twelve Sanga-type steers were fitted with esophageal fistulas and were used for sampling a paddock typical of the area.

The pasture was also sampled by means of clipping. Twenty-four areas of 5 yd^2 each were collected and analyzed. In addition samples were collected of the more common individual grass species; some of these were halved and one-half separated into leaves and stems.

Average chemical composition of pasture clippings and chemical composition of fistula samples are compared.

Results clearly show the possibilities of the use of fistulated animals for the evaluation of pasture and emphasize the inadequacies of the clipping method.

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