オーチャードグラス主体の草地に放牧した去勢牛の採食量におよぼす牧草の化学組成の影響

誌名	日本草地学会誌
ISSN	04475933
著者	菊地, 正武 柴田, 章夫
巻/号	21巻4号
掲載ページ	p. 265-270
発行年月	1975年12月

J. Japan Grassl. Sci., 21 (4): 265~270 (1975)

The Influence of the Chemical Composition of Herbage on the Intake of Steers Grazed on Orchard Grass Dominant Pasture

Masatake KIKUCHI and Fumio SHIBATA

Faculty of Agriculture, Nagoya University (Nagoya 464)

Introduction

As the beef demand in Japan increases gradually, Holstein male calves have been regarded to be important for beef production rather than their veal utilization. There seems to be insufficient of studies concerned with rearing or fattening of Holstein steers on orchard grass sward which is most widely found in the upland pastures of central Japan. A recent information from Palmerston North, New Zealand[1], shows a high grazing performance of Holstein steers on a ryegrass dominant pasture, well-managed, achieving about 1.4 kg of daily gain in spring and early summer. On the other hand, the previous works[2,3] indicated that when Holstein steers were grazed on orchard grass dominant pasture, average daily gain was not over 1.0 kg even in spring. Weight gain of grazing cattle was, generally, influenced by the feed efficiency of grazed herbage and the herbage intake. There are several studies concerned with the voluntary intake of cattle grazing on orchard grass pasture[2,3] and with the herbage yield of orchard grass sward in Japan[4,5,6]. In addition to these studies, to define the relationship of voluntary intake to the chemical composition of the herbage grazed is considered to be important.

The purposes of this experiment are to measure the chemical composition of actually consumed herbage and also to determine the relationship of herbage intake to the chemical composition of herbage when Holstein steers are grazing on orchard grass dominant pasture.

Materials and Methods

Experimental Pasture and Animals: A pasture in Kitashitara, Aichi, used in this experiment was composed of orchard grass (about 70%), red top (about 20%) and others (about 10%). Fertilizer dressing on this pasture was at an annual rate of 254 kg N, 65 kg P and 97 kg K per ha. The pasture was divided into four paddocks (29.7, 28.5, 28.5 and 29.7 a) arranged in a semicircular manner from a watering place in which a container of salts-block was set.

Three steers were fistulated in the rumen prior to the experiment and they were rotationally grazed on the paddocks from September to October in 1973, from June to July and from October to November in 1974. A grazing period on each paddock was five to seven days. Remaining forbs were mowed immediately after transfering the

steers to the other paddock.

Experimental Procedures: To estimate herbage intake of the steers on the sward, a herbage-cutting technique was employed. Ten protect cages (1 m^2) were set on a paddock randomly and the setting points were changed during each grazing period. After grazing, the herbages in the protect cages were cut 3 cm high above the ground, and the herbage was named 'whole' herbage. The 'residual' herbage in a quadrate (1 m^2) just near the protect cage was also cut in the same manner. The whole and the residual herbage were weighed, oven-dried and stored till analysis. The herbage intake was estimated from the difference in yield between the whole herbage and the residual herbage. This was named 'grazed' herbage. The chemical composition of the stored samples were analyzed by standard A.O.A.C. procedures[7]. On the third day after letting the steers into a paddock, about 50 ml of rumen contents were withdrawn from the rumen fistula at 10:00 a.m. and 3:00 p.m. These samples were filtered through the doublefolded surgical gauze and NH_3 concentration was determined by the distillation method.

Results and Discussion

The chemical compositions of the 3 herbages which has been nominated in the experimental procedure and mean values of differences and correlation coefficients between chemical components of the whole herbage and the grazed herbage are shown in Table 1. Chemical composition of the grazed herbage was calculated from the following formula. WH stands for the whole herbage and RH for the residual herbage.

$$\text{Component of the grazed herbage} = \frac{\text{a component of WH (kg/a)} - \text{a component of RH (kg/a)}}{\text{DM of WH (kg/a)} - \text{DM of RH (kg/a)}} \times 100$$

Table 1. Chemical composition of the herbages and differences and correlation coefficients between chemical components of the whole herbage and the grazed herbage. (n=15)

Herbage	DM yield (kg/a)		Chemical composition (% DM)									
			Crude fiber		NFE		Crude protein		Crude ash		Ether extract	
	Mean	SD	Mean	CV	Mean	CV	Mean	CV	Mern	CV	Mean	CV
Whole	19.5	5.8	27.3	12.7	41.7	12.2	17.7	15.4	8.1	11.5	5.2	23.5
	(11.7-33.3)[a]		(21.8-33.6)		(33.3-50.7)		(12.0-21.3)		(6.3-9.8)		(3.5-8.6)	
Residual	12.0	4.8	26.9	10.6	45.8	10.1	15.0	14.7	8.0	9.9	4.4	31.6
	(6.5-24.6)		(21.6-31.4)		(39.5-53.9)		(10.1-17.7)		(6.1-9.3)		(3.1-8.9)	
Grazed	7.5	3.1	27.9	18.7	35.1	19.0	22.0	18.4	8.3	25.9	6.9	26.5
	(4.9-11.8)		(18.9-35.5)		(26.4-47.0)		(15.1-30.9)		(3.5-13.2)		(3.6-9.1)	
Difference[b]			0.6 ± 0.8		6.6 ± 0.8**		4.3 ± 0.7**		0.2 ± 0.4		1.3 ± 0.3*	
Correlation coefficient			+0.909**		+0.876**		+0.769**		+0.852**		+0.648**	

a) range of values
b) mean and SE
* significance ($p<0.05$)
** significance ($p<0.01$)

The grazed herbage was significantly higher in crude protein ($p<0.01$) and ether extract ($p<0.05$) and lower in NFE ($p<0.01$) than the whole herbage. A result that the steers grazed a herbage of more narrow nutritive ratio than the whole herbage in pasture has to be noticed on feeding of grazing steers. Hardison et al.[8] reported that crude protein, ether extract and mineral contents of the grazed herbage were higher than those of the whole herbage in various pastures. They explained that the differences were due to the selection by cattle. It was considered from the observations of the present experiment that voluntary intake of herbage containing high nitrogen and low NFE was due to a consumption of the upper portion of herbage and a choice of the young herbage by steers rather than a choice of herbage species. However, as shown in Table 1, the animal behaviour increased the values of coefficient of variation of each chemical component of the grazed herbage.

When the chemical components of the grazed herbage were compared with those of the whole herbage, there were significantly positive correlations between all chemical components of the grazed herbage and the whole herbage ($p<0.01$). These results indicated that chemical composition of the herbage, actually consumed by steers, was different from the composition of the sward, but the composition of the grazed herbage was influenced substantially by the composition of the sward.

Mean values and range of values for DM intake, rumen NH_3 concentration, grazing intensity, mean body weight of three steers and CP/NFE ratio of the grazed herbage are shown in Table 2. The rumen NH_3 concentration was shown by the mean value of six values estimated at 10:00 a.m. and 3:00 p.m. for three steers. The grazing intensity was calculated from the following formula.

$$\text{Grazing intensity } (\%) = \frac{\text{DM of WH (kg/a)} - \text{DM of RH (kg/a)}}{\text{DM of WH (kg/a)}} \times 100$$

Table 2. Mean values and range of values for DM intake, rumen NH_3 concentration, grazing intensity, mean body weight of three steers and CP/NFE ratio of the grazed herbage.

	Mean	SD	Min.	Max.
DM intake (g/W $^{0.75}$ kg/day)	105	27.7	60.3	134.7
Rumen NH_3 (mg/dl)	21.2	6.8	9.9	31.7
Grazing intensity (%)	39.5	9.3	27.9	54.0
Body weight (kg)	491	76	361	567
CP/NFE ratio (%)	66.8	21.5	34.9	107.3

Mean DM intake (105 g/W $^{0.75}$ kg/day) coincided with the requirement for sufficient growth of steer (mean body weight 491 kg)[9].

Maximum rumen NH_3 concentration was 31.7 mg/dl. This concentration might reflect the intake of high nitrogen and low NFE feed, although it did not amount to the toxic level for cattle[10].

Grazing intensity was negatively correlated to the difference between the whole herbage and the grazed herbage in crude protein content and in NFE content ($r=-0.845$ in

crude protein and $r=-0.527$ in NFE). There seems likely that the difference between chemical composition of the whole herbage and the grazed herbage is reduced by an increase of the grazing intensity.

Correlation coefficients between DM intake and chemical components of the grazed herbage, rumen NH_3 concentration, grazing intensity and body weight, and correlation coefficients between rumen NH_3 concentration and chemical components of the grazed herbage are shown in Table 3.

Table 3. Correlation coefficients between DM intake and the components of grazed herbage, rumen NH_3 concentration, grazing intensity and body weight and correlation coefficients between rumen NH_3 concentration and components of grazed herbage. (n=15)

	Correlation coefficients (r)	
	DM intake	Rumen NH_3
Crude fiber	+0.230	−0.068
NFE	+0.629*	−0.674**
Crude protein	−0.699**	+0.659**
Crude ash	−0.517*	+0.090
Ether extract	−0.690**	+0.556*
CP/NFE ratio	−0.746**	+0.706**
Rumen NH_3	−0.581*	—
Grazing intensity	+0.073	—
Body weight	−0.436	—

* $p<0.05$ ** $p<0.01$

DM intake of steers was positively correlated to NFE content of the grazed herbage ($p<0.05$), and negatively correlated to crude protein ($p<0.01$), crude ash ($p<0.05$) and ether extract ($p<0.01$) contents and to CP/NFE ratio ($p<0.01$) of the grazed herbage. There are no correlationships between DM intake and body weight or grazing intensity of steers.

It is generally accepted that when a ruminant is fed a high protein and low energy diet, the rumen ammonia remarkably increases. In the experiment, the rumen NH_3 concentration of steers was negatively correlated to NFE which is an easily available energy source in herbages, and positively correlated to crude protein content or to CP/NFE ratio of the grazed herbage. The correlation coefficients were highly significant ($p<0.01$).

It has been found that there are higher correlations between CP/NFE ratio and DM intake or rumen NH_3 concentration, and moreover there is a significant correlation between the rumen NH_3 concentration and DM intake. This finding indicates that CP/NFE ratio in herbage has a direct influence on the rumen ammonia, and suggests that the herbage intake of grazing steer may be regulated by CP/NFE ratio of the grazed herbage or by rumen ammonia concentration, although physiological mechanisms are still uncertain.

Contrary to the results obtained in the present experiment, ROTH and KIRCHGESSNER[11] reported that no relationship was found between, cruce proten, NFE and crude fat of herbage and fodder uptake of milking cows grazing on a ryegrass-white clover sward. There is no argument countered to the report, but it may be assumed that a discrepancy between the two evidences is due to the differences of experimental animals and/or of kind of swards. To make it clear, further experiments should be necessary.

From the depressing effect of CP/NFE ratio of a herbage on the herbage intake of grazing steers, it was considered that high N fertillization on the sward was not always advantageous to the growth of grazing steer, because the more N was fertilized, the higher N content and the lower carbohydrate content of herbage resulted[12].

We suspect that since there are some differences in the chemical composition of herbage among species and strains, the grasses containing relatively low nitrogen and high carbohydrate or NFE are desirable for beef production by grazing on a intensive pasture. BLASTER[12] reported that ryegrass was lower in nitrogen and higher in carbohydrate than orchard grass. Therefore, it is expected that ryegrass is better than orchard grass for beef production. However, according to experience, the upland pasture of central Japan does not seem to be suitable for ryegrass production due to its lower yield compared to orchard grass.

It has been assumed that a supplement of high energy-low nitrogen feed during grazing on orchard grass pasture may reduce the CP/NFE ratio of whole ingesta and improve not only the feed efficency but also the herbage intake in orchard grass pasture.

Summary

The purposes of this experiment are to measure the chemical composition of actually grazed herbage and to determine the relationship of herbage intake to the chemical composition of herbage when Holstein steers are grazed on orchard grass dominant pasture.

DM intake of grazing steers was determined by a herbage-cutting technique. The chemical composition of the grazed herbage was estimated from the difference between the chemical composition of the whole herbage in protect cage and that of the residual herbage after grazing.

The grazed herbage was higher in crude protein ($p<0.01$) and ether extract ($p<0.05$) and lower in NFE ($p<0.01$) than the whole herbage. There were significantly positive correlations between all components of the grazed and the whole herbage ($p<0.01$). These results indicated that chemical composition of the herbage, actually consumed by steers, was different from the composition of the sward, but the composition of the grazed herbage was influenced substantially by the composition of the sward.

DM intake of grazing steers was negatively correlated to crude protein ($r=-0.690$), ether extract ($r=-0.690$), crude ash ($r=-0.517$) and CP/NFE ratio ($r=-0.746$) of the grazed herbage, and was positively correlated to NFE ($r=+0.629$) of the grazed

herbage. Furthermore, the rumen NH_3 concentration of steers was negatively correlated to DM intake ($r=-0.581$) and to NFE of the grazed herbage ($r=-0.674$) and positively correlated to crude protein ($r=+0.659$) and CP/NFE ratio ($r=+0.706$) of the grazed herbage. These results indicated that herbake intake of grazing steer on orchard grass dominant pasture was influenced by the chemical composition of the herbage, especially crude protein and NFE contents, and that the rumen NH_3 concentration was also influenced by these two components of the herbage and might affect the herbage intake of grazing steers.

References

1) Brougham, R. W.: Personal communication (1974)
2) Kikuchi, M. and I. Tasaki: *J. Japan. Grassl. Sci.* **18**, 166 (1972)
3) Lee, K., I. Tasaki and M. Kikuchi: *Japan. J. Zootech. Sci.* **45**, 603 (1974)
4) Sato, T., H. Sakai, K. Fujiwara and S. Kawanabe: *J. Japan. Grassl. Sci.* **18**, 1 (1972)
5) Nishimura, N. and K. Nitta: *J. Japan. Grassl. Sci.* **20**, 43 (1974)
6) Kubota, F., W. Agata and E. Kamata: *J. Japan. Grassl. Sci.* **19**, 292 (1973)
7) A. O. A. C.: Official Method of Analysis. 19th ed. Washington, D. C. pp. 73–96 (1960)
8) Hardison, W. A., J. T. Reid, C. M. Martin and P. G. Woolfolk: *J. Dairy Sci.* **37**, 89 (1954)
9) National Academy of Sciences-National Research Council: Nutrient requirements of beef cattle. 4th rev. ed. Washington, D. C. (1970)
10) Word, J. D., L. C. Martin, D. L. Williams, E. I. Williams, R. J. Panciera, T. E. Nelson and A. D. Tillman: *J. Anim. Sci.* **29**, 786 (1969)
11) Roth, F. X. and M. Kirchgessner: *Wirtschaftseigen Futter*. **18**, 194 (1972)
12) Blaster, R. E.: *J. Anim. Sci.* **23**, 246 (1964)

(Recieved on Sept., 3, 1975)

オーチャードグラス主体の草地に放牧した去勢牛の採食量におよぼす牧草の化学組成の影響

菊地正武・柴田章夫
名古屋大学農学部（名古屋市千種区不老町）

要　約

オーチャードグラス主体の草地にホルスタイン種去勢牛を放牧した場合において，実際に採食される牧草の化学組成の測定，および，採食草の化学組成と採食量の関係を求める目的で本実験を実施した。

放牧牛の乾物採食量は刈取法によって測定した。採食草の化学組成はプロテクトケージ内の全草と放牧後の残食草の化学組成の差から求めた。

採食草は生草に比して，粗蛋白質量と粗脂肪量が高く（$p<0.01$, $p<0.05$），NFE 量は低かった（$p<0.01$）。採食草と全草の全ての組成量間に有意な正の相関が認められた（$P<0.01$）。これらの結果は去勢牛によって採食される草採食草と全の化学組成は草地の草のその組成と異なるが，草地の草の化学組成に影響されることを示した。

放牧去勢牛の乾物採食量は採食草の粗蛋白質量（$r=-0.699$），粗脂肪量（$r=-0.690$），粗灰分量（$r=-0.517$），CP/NFE 比（$r=-0.746$）と有意な負の相関があり，採食草の NFE 量と有意な正の相関（$r=+0.629$）があった。さらに，放牧牛の第一胃アンモニア濃度は乾物採食量（$r=-0.581$）および採食草の NFE 量（$r=-0.674$）と有意な負の相関があり，採食草の粗蛋白質量（$r=+0.659$）および CP/NFE 比（$r=+0.706$）と有意な正の相関があった。これらの結果は，オーチャードグラス主体の草地に放牧した去勢牛の採食量は牧草の化学組成，特に粗蛋白質と NFE 量に影響されることを示し，その第一胃アンモニア濃度は牧草のこの2成分量に影響を受けると共に採食量に影響を与える可能性のあることを示した。

（日草誌 21(4)：265～270 (1975)）