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## THE EFFECT OF STORAGE TIME ON THE VOLUNTARY INTAKE OF SILAGE BY SHEEP

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### SUMMARY

Three experiments are described in which pasture herbage and the silages resulting from the ensilage of the herbage for 4 and 180 days were stored frozen and subsequently fed to sheep. The herbage ensiled for 4 days (4-Day silage), was of low pH and contained appreciable amounts of ammonia, lactic and acetic acids. Ensilage for 180 days (180-Day silage) increased total acid content by 60 to 80% without obvious change in pH except in one experiment where a high pH, butyric acid silage was formed. The voluntary intake of 4-Day silage was similar to that of the pasture herbage, that of the 180-Day silage 15 to 30% lower. Differences in the digestibility of the rations were significant but not consistent over the three experiments. Low palatability or changes in the osmolality and volatile fatty acid content of rumen liquor were considered not to explain the low intake of 180-Day silage.

A CHARACTERISTIC of unwilted pasture silage is its low voluntary consumption by sheep and cattle. Less of it is eaten than either the fresh herbage (Harris and Raymond, 1963) or hay made from it (Gordon *et al.*, 1961; Murdoch and Rook, 1963).

The characteristics of silage that are responsible for its low consumption are not known. Their development appears to be associated with the moisture content of herbage since wilting prior to ensilage improves dry matter (DM) consumption (see Murdoch, 1964). Factors which have been suggested include the presence of toxic or physiologically active compounds (Neumark *et al.*, 1964), a reduced rate of disappearance from the reticulo-rumen (Campling and Murdoch, 1966), low nitrogen retention (Fatianoff *et al.*, 1966), osmolality (Ternouth, 1967) and acid content (Harris *et al.*, 1966). Unequivocal evidence in favour of any one of these being the causative agent is lacking. What is clear, however, is that the development of the characteristics responsible is associated with the fermentation of the ensiled herbage. Thus it was considered worth while to examine the relationship between changes in chemical composition and intake of herbage ensiled for different periods of time.

The present paper reports some results of this approach, one made possible by the extensive facilities at Ruakura for storing herbage in the frozen state.

## EXPERIMENTAL

### FEEDS

Herbage was flail harvested on December 4, 1967, and November 8 and 11, 1968. On each occasion, three of the nine tons harvested were immediately frozen. Equal portions of the remainder were similarly frozen after 4 and 170-190 days' ensilage in a vacuum pack. The temperature of the plate freezer used for rapid initial freezing was  $-32^{\circ}\text{C}$  and that of the room used for storage, approximately  $-20^{\circ}\text{C}$ .

In 1967, a ryegrass-clover pasture at the stage of ear emergence was used. 'Grasslands Tama' ryegrass immediately prior to ear emergence was used in the first harvest of 1968 and a ryegrass-clover pasture commencing to flower in the second. The feeds were used in three feeding experiments, described here as Experiments 1, 2 and 3 corresponding to the first, second and third harvests, respectively.

### ANIMALS

In each experiment, 9 wether sheep, 1 to 2 years of age, were used for assessing intake and digestibility and three, fitted with rumen cannulae, for rumen sampling. They were housed and fed indoors in individual crates. Faeces were collected with the aid of bags and harnesses.

### DESIGN

In each experiment, the three treatments ("Grass", "4-Day silage" and "180-Day silage") were fed as a sole ration according to a replicated  $3 \times 3$  Latin Square design. Treatment periods were of 21 days where intake and digestibility were assessed and 15 to 18 days in the case of the fistulated sheep.

### FEEDING AND SAMPLING

Feeds were removed from storage as required and allowed to thaw overnight at room temperature. Approximately 120% of the expected intake was offered at 8-9 a.m. Residues were removed and weighed 23 hr or, in the case of the fistulated sheep, 8 hr later. Intake and digestibility of

the feeds were calculated from the analysis of samples of feed, residues and faeces obtained by aggregating daily samples over the last 10 days of each period.

The rumen contents of the fistulated sheep were sampled on two days of each treatment period after a prior fast of 20 hr. On the first sampling day (Day 1), 3 to 4 days prior to the end of each period, feed was offered *ad lib.* over 4 hr and samples of rumen fluid obtained immediately before feed was offered (0 hr) and 1, 2, 4, 6 and 8 hr later. On the second (Day 2), which was the last day of each period, 250 g DM (Exp. 1) or 300 g DM (Exps. 2 and 3) were offered in four equal portions at 30 min intervals. Rumen contents were sampled at 0, 1, 2, 3, 4 and 6 hr.

#### CHEMICAL ANALYSIS

Frozen samples obtained as "sawdust" from the repeated cross-sectioning of frozen, aggregated samples with a tungsten-tipped power saw were used for the analysis of feeds and residues. DM content of the 4- and 180-Day silages was assessed by toluene distillation; osmolality of centrifuged rumen liquor and of juice expressed from the feeds with the aid of a Fiske G-66 osmometer.

#### RESULTS

##### COMPOSITION OF FEEDS (Table 1)

In each experiment, the 4-Day silage was of low pH and contained appreciable amounts of ammonia and acids. In these respects, it was similar to the 180-Day silages of Exps. 2 and 3 although the longer time of ensilage resulted in 60 to 80% more total acids. The 180-Day silage of Exp. 1 was noticeably different from the other silages; it was of high pH, contained high levels of ammonia and butyric acids and low levels of lactic acid. Ensilage resulted in no obvious change in DM or nitrogen content and small, consistent increases in ash, fibre and lignin content. The Tama ryegrass used in Exp. 2 contained very low levels of crude protein and high levels of soluble sugars.

##### INTAKE AND DIGESTIBILITY (Table 2)

There were no significant differences in the intake of Grass and 4-Day silage in any of the experiments. In contrast, the intake of 180-Day silage was 15 to 30% lower. Treatment differences in digestibility were generally small and not consistent over the three experiments.

TABLE 1: COMPOSITION OF THE FEEDS  
(% DM unless otherwise stated)

	<i>Experiment 1</i>			<i>Experiment 2</i>			<i>Experiment 3</i>		
	<i>G*</i>	<i>4</i>	<i>180</i>	<i>G</i>	<i>4</i>	<i>180</i>	<i>G</i>	<i>4</i>	<i>180</i>
DM %	17.0	18.3	17.8	18.4	18.8	18.9	17.1	17.1	18.8
Ash	11.1	10.9	13.5	8.5	9.6	12.0	13.6	13.6	14.0
Crude protein	18.6	18.2	20.1	9.9	10.4	10.0	14.3	14.8	15.1
Acid detergent fibre				26.1	28.5	34.7	29.5	32.1	35.4
Lignin				3.0	3.1	3.6	3.9	4.1	4.6
Water-soluble sugar	9.7			27.5			11.9		
Ammonia (% total N)		6.0	22.4		4.0	4.8		9.0	10.8
Total acids		10.3	17.6		8.0	12.9		8.4	12.8
Lactic		6.5	0.7		5.9	8.6		6.6	8.5
Acetic		3.8	7.8		2.1	4.3		1.9	4.3
Propionic		0	1.6		0	0		0	0
Butyric		0	7.5		0	0		0	0
pH	5.2	4.1	5.4	5.4	3.8	3.7	5.3	4.0	3.7
Osmolality (MOSM/kg H <sub>2</sub> O)	410	708	944	531	757	1108	542	699	914

\*G, Grass; 4, 4-Day silage; 180, 180-Day silage.

TABLE 2: INTAKE AND DIGESTIBILITY OF RATIONS

Experiment	Treatment			S.E.
	Grass	4-Day Silage	180-Day Silage	
<i>OM Intake (kg/day)</i>				
1	1.07	1.05	0.70	0.05**
2	1.14	1.20	0.92	0.04**
3	1.01	0.98	0.82	0.06*
<i>OM Digestibility (%)</i>				
1	71.1	72.9	70.6	0.23**
2	65.7	69.1	71.7	0.91**
3	66.9	71.3	68.1	0.49**

\* $P < 0.05$ , \*\* $P < 0.01$ .

#### EFFECT OF CHANGE OF RATIONS ON FOOD INTAKE

When the rations were changed in Exp. 1 from one that was readily eaten (Grass, 4-Day silage) to the less readily eaten 180-Day silage, a decrease of intake was apparent on the first day that the 180-Day silage was offered (Fig. 1). Intake continued to decrease during the subsequent 3 to 4 days.

An opposite effect was apparent when the order of feeding was reversed. Less consistent trends were found in Exps. 2 and 3 where the number of observations were fewer than in Exp. 1.

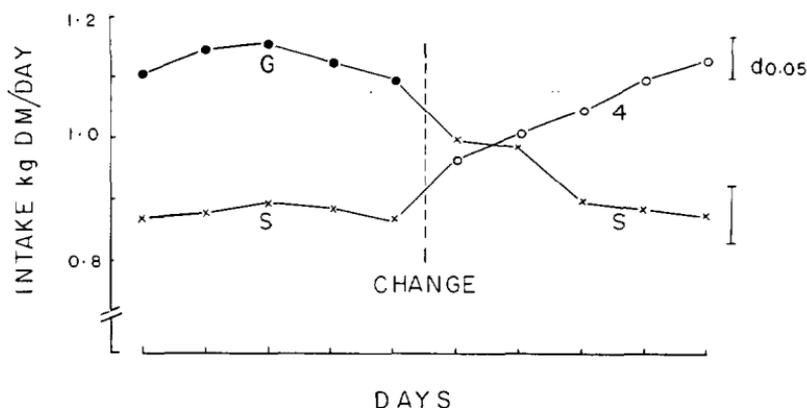


FIG. 1: The effect of change in rations on food intake. Mean of 9 sheep. G = Grass ration; 4 = 4-Day silage; S = 180-Day silage.

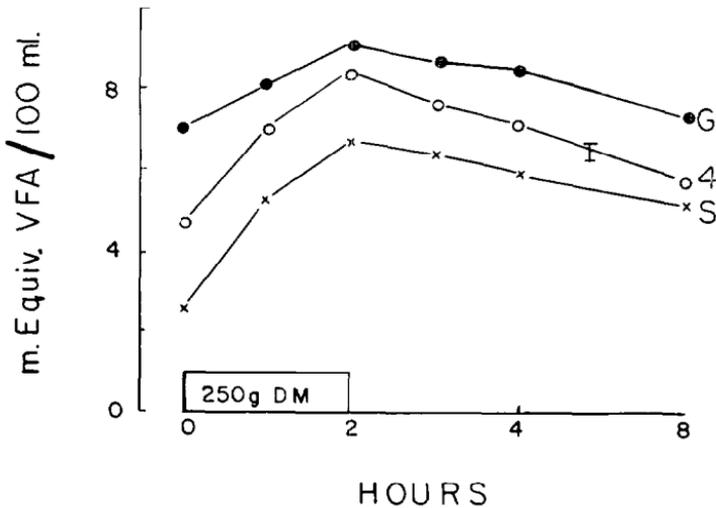


FIG. 2: Concentration of VFA in rumen liquor on Day 2, Experiment 1.

#### FISTULATED SHEEP

The fistulated sheep also ate less 180-Day silage than either Grass or 4-Day silage. This applied to the days preceding the first sampling day and to the first sampling day itself, when the sheep were fed *ad lib.* for 4 hr (Table 3). The differences may have been more accentuated than those shown by the non-fistulated sheep.

TABLE 3: FOOD INTAKE OF FISTULATED SHEEP

Experiment	Treatment			S.E.
	Grass	4-Day Silage	180-Day Silage	
<i>Mean daily intake (kg/DM)</i>				
1	0.94	0.90	0.49	0.10
2	0.94	0.80	0.45	0.15
3	1.49	1.34	0.66	0.10*
<i>Intake 0-4 hr Day 1 (g DM)</i>				
1	684	479	183	10**
2	624	529	293	69
3	884	896	260	26**

\* $P < 0.05$ , \*\* $P < 0.01$ .

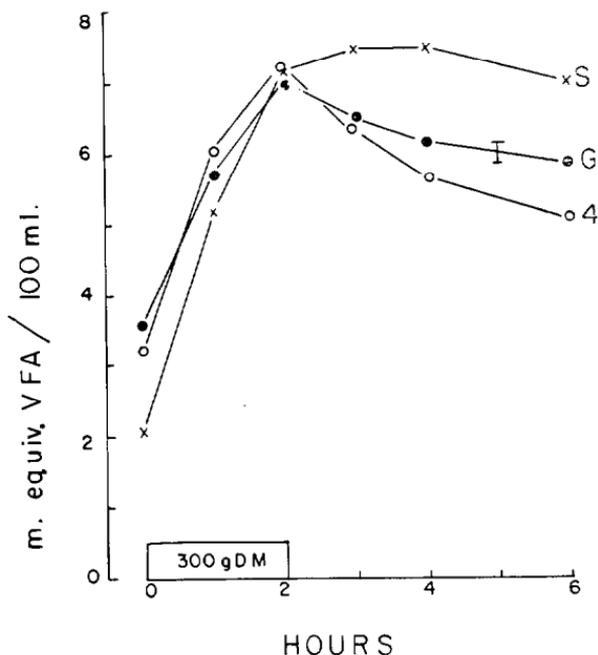


FIG. 3: Concentration of VFA in rumen liquor on Day 2, Experiment 3.

The considerable amounts of acids contained in the silages were not reflected as increased concentrations of VFA in the rumen in Exp. 1 (Fig. 2). In Exps. 2 and 3, however, the 180-Day silage resulted in higher concentrations during the last 2 to 3 hr of sampling. This is shown in Fig. 3 where, as in subsequent figures, the data of Exp. 3 are used to illustrate the effects. A marked effect on the proportions of the individual VFA was apparent in Exp. 1 when 180-Day silage was fed; the proportion of acetic acid decreased and that of butyric increased in the 2 hr following the start of feeding more than they did with either Grass or 4-Day silage (Fig. 4). In contrast, the changes that occurred in Exps. 2 and 3 were similar for each treatment.

#### OSMOLALITY

The treatments did not differ in their effect on rumen fluid osmolality on Day 1 of Exps. 2 and 3 (Fig. 5).

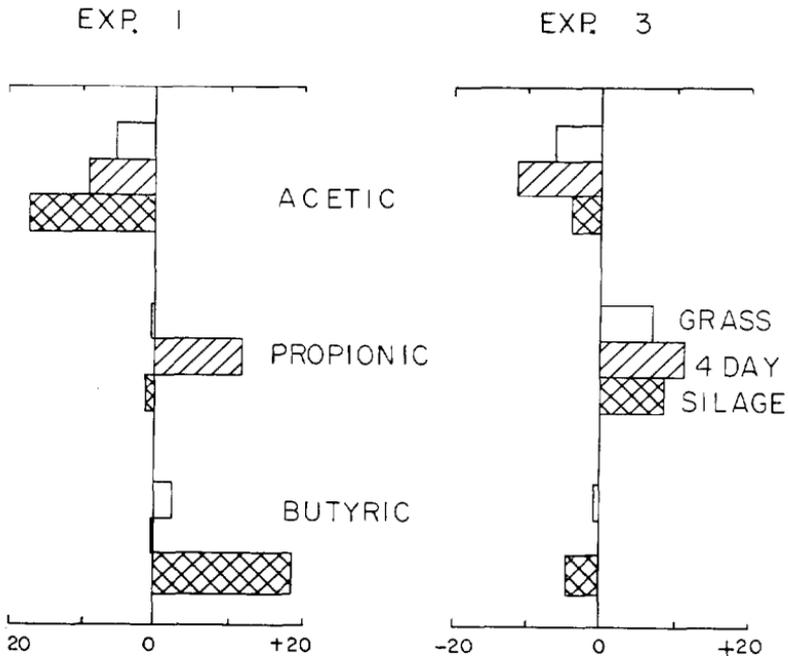
When 300 g DM of each feed were eaten on Day 2, however, the 180-Day silage resulted in a markedly greater

rise in osmolality than did either of the other rations (Fig. 6). Similar changes were not apparent in Exp. 1. On both sampling days, the osmolality resulting from the consumption of 180-Day silage was exceeded by one or other of the remaining treatments (Figs. 7 and 8).

#### DISCUSSION

The outstanding feature emerging from this work is that herbage that had been ensiled for four days was as readily eaten as the parent material. This was so even though in many respects the chemical composition of the 4-Day silage was similar to that of material ensiled for a longer time.

The commonly accepted criteria for evaluating silage in terms of chemical composition are that "good" silage should have a pH of less than about 4.2, contain no butyric acid, little ammonia and substantial amounts of lactic and acetic acids. In each of the three experiments, the 4-Day



% At 2 hr. Less % At 0 hr.

FIG. 4: The change in proportions of individual VFA during 0-2 hr on Day 2, Experiments 1 and 3.

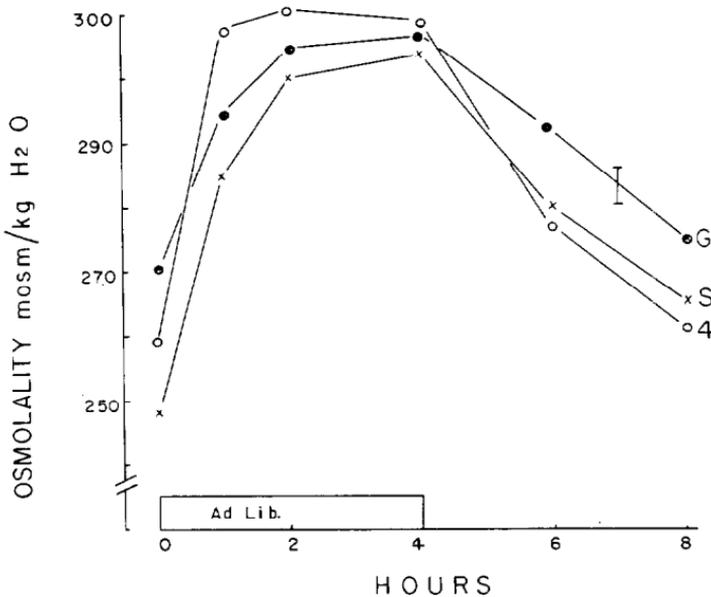


FIG. 5: Effect of rations on osmolality of rumen liquor, Day 1, Experiment 3.

silage complied with these criteria. So, too, did the 180-Day silages with the noticeable exception of that in Exp. 1. Yet the amount of them eaten was considerably less than that of the 4-Day silage. Certainly, the intake of the 180-Day silage compared with 4-Day silage was relatively lower in Exp. 1 than in either of the other experiments. This may have been associated with the high pH, ammonia and butyric acid content which classifies it as a "poor" silage in terms of chemical composition. However, as the three experiments were undertaken at different times using different sheep, comparisons of this nature are unlikely to be valid. These observations emphasize that assessments based on chemical composition have limited value for predicting the intake of silage by sheep. In support of this, Harris *et al.* (1966) using sheep and Lancaster (1967) using cattle found that "poor" silage was eaten in greater quantities than was "good" silage. In both instances the level of intake was considerably below that generally associated with fresh herbage.

It is clear that any hypothesis that attempts to explain the low intake of the 180-Day silages would have to account for the high intake of 4-Day silage. Clearly the reduced intake was not explicable in terms of digestibility, pH or

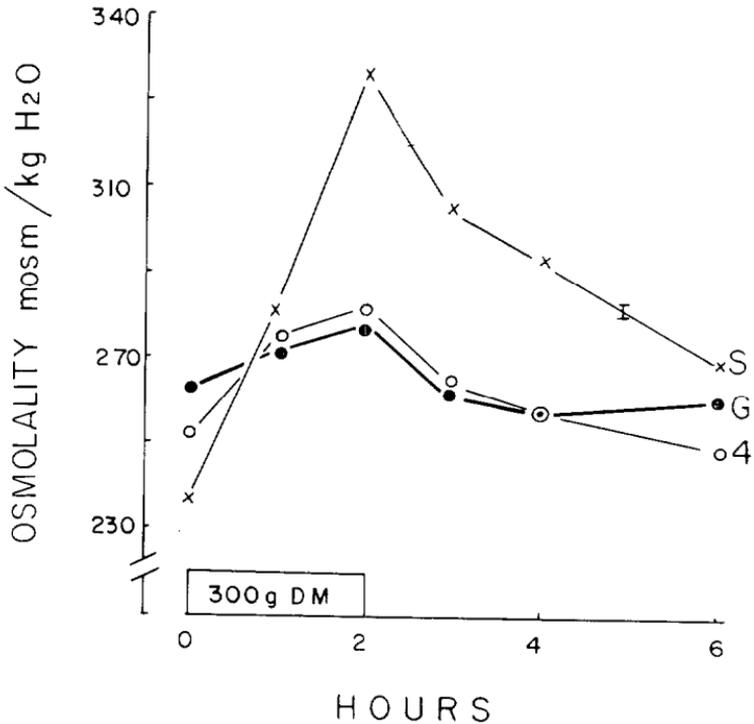


FIG. 6: *Effect of rations on osmolality of rumen liquor, Day 2, Experiment 3.*

DM content of the silage. Baile and Pfander (1966) reported that an increase in the concentration of acetic acid in the rumen was associated with a decrease of food intake by sheep. They suggested that a "chemosensitive feed intake regulatory mechanism", dependent on changes of acetic acid concentration in the rumen, was involved. It is unlikely that such a mechanism was important in the present experiments since the consumption of 180-Day silage did not always result in higher concentrations of total VFA or proportions of acetic acid in the rumen liquor than those observed when Grass or 4-Day silage was fed.

Even so, VFA are a major end product of rumen fermentation and intraruminal infusions of them may result in reduced food intake (see Ulyatt, 1965; Weston, 1966). It is possible, therefore, that they induce a complex of stimuli involved in the cessation of eating. A reduction of intake in this way is unlikely to have occurred in the

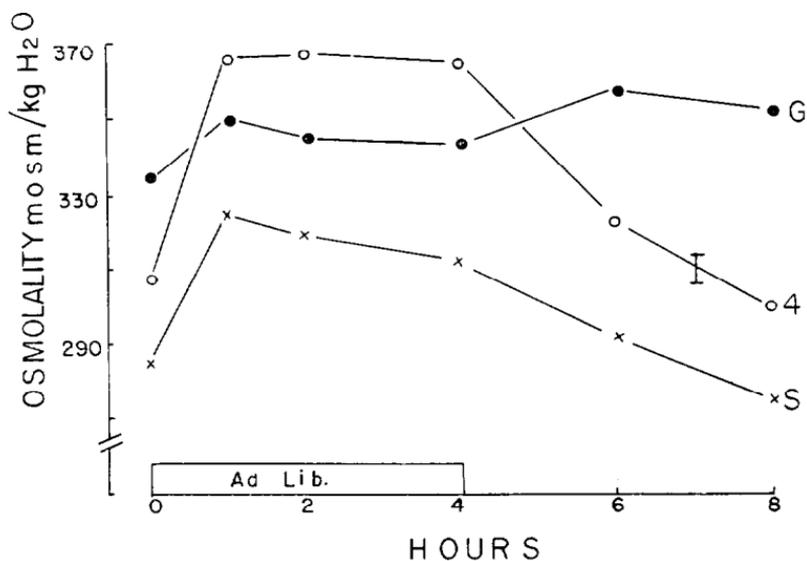


FIG. 7: Effect of rations on osmolality of rumen liquor, Day 1, Experiment 1.

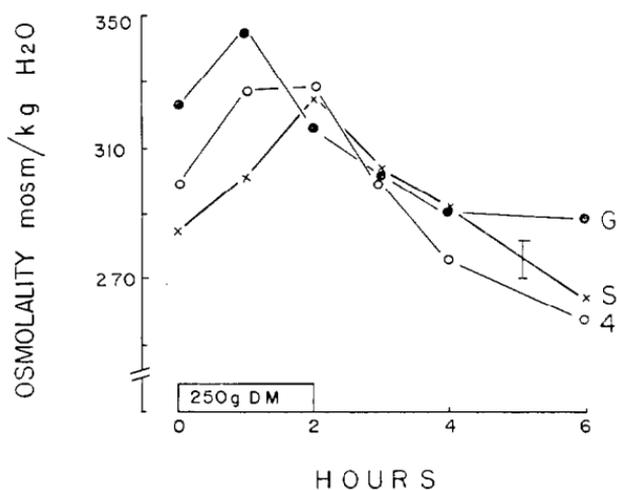


FIG. 8: Effect of rations on osmolality of rumen liquor, Day 2, Experiment 1.

present experiments since the acids contained in the 4-Day silage were without effect. This view is supported by the work of Thomas *et al.* (1961) and McLeod *et al.* (1968) who found no obvious effect on intake when VFA were added to the diet or directly into the rumens of animals fed silage.

Ternouth (1967) found that the intake of sheep was reduced by the intraruminal infusion of hypertonic liquids. About 60% of the reduction was explicable in terms of changes in the osmolality of rumen fluid. He suggested that the low intake of silage may be caused in part by a large increase in rumen osmolality immediately the silage is eaten. Certainly the juice extracted from the 180-Day silage was of high osmolality, and in Exps. 2 and 3 was associated with the greatest increase of rumen fluid osmolality (Fig. 6). The latter was not evident in Exp. 1 (Figs. 7 and 8) suggesting that osmolality changes of rumen fluid were not important in that instance.

The immediate change of intake apparent in Exp. 1 when rations were changed suggests that the 180-Day silage was less acceptable to the sheep's senses of smell, sight, touch or taste than either Grass or 4-Day silage. Further, when sheep fed 180-Day silage ceased an episode of eating, they avidly ate Grass immediately it was offered. This again suggests that palatability factors were operative. If this were so, the low palatability of 180-Day silage appeared to account for only part of its low intake since 3 to 4 days were required after a change of rations to achieve constant intake.

The work reported here does little towards explaining the low intake of pasture silage. It demonstrates, however, that the characteristics responsible develop some time after the initial vigorous fermentation has occurred. The concurrent evaluation in terms of chemical composition and animal response of herbage ensiled for different periods of time may be a useful technique leading to their identification.

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