# Voluntary intake of hay and silage: The role of intake related rumen characteristics

P.H. Henning and J.P. Pienaar

Animal and Dairy Science Research Institute, Private Bag X2, Irene, 1675, Republic of South Africa

Experiments were conducted to examine the difference in intake between hay and silage made from lucerne *(Medicago sativa)* and whether these differences could be accounted for in terms of physical rumen characteristics. Voluntary intake was lowest on lucerne hay ensiled with molasses (16% on a DM basis) and highest on lucerne hay and lucerne ensiled with molasses and formic acid. There was a tendency for the OM content in the rumen (Z) to increase with increasing OM intake (I). Differences in the rate constant for fermentation and outflow of fermentable OM ($\gamma_1 + \gamma_0$) and rate constant for outflow of unfermentable OM ($\gamma_2$) were small except for the lucerne hay diet.

Eksperimente is uitgevoer om die verskil in inname tussen hooi en kuilvoer wat van lusern (*Medicago sativa*) gemaak is te ondersoek en om te bepaal of hierdie verskille verklaar kan word in terme van fisiese eienskappe van die grootpens. Vrywillige inname was die laagste vir lusernhooi wat ingekuil is met melasse (16% op 'n DM basis) en die hoogste vir lusernhooi en lusern wat ingekuil is met melasse en mieresuur. Daar

was 'n neiging vir die OM inhoud in die grootpens (Z) om toe te neem met 'n toename in OM inname (I). Verskille in die tempokonstantes vir fermentasie en uitvloei van fermenteerbare OM ($\gamma_1 + \gamma_0$) en die tempokonstante vir uitvloei van niefermenteerbare OM ($\gamma_2$) was klein, behalwe vir die lusernhooi dieet.

**Keywords:** Voluntary intake, lucerne, rumen fermentation, rumen outflow

## Introduction

Many experiments have shown the voluntary intake of silage to be lower than that of hay made from the same crop. This lower intake has been variously associated with the products of silage fermentation such as pH, lactic acid, volatile fatty acids, ammonia and various nitrogenous constituents. Investigations based on suggestions that these fermentation products cause lower intake, either by affecting palatability or by interfering with metabolism, gave disparate results. Furthermore, digestibility of hay and silage from the same crop remains quite similar and the relatively high moisture content of silage does not appear to be directly responsible for lower intakes. This leads one to suspect that there are other reasons for the above-mentioned intake differences.

Pienaar, Roux, Morgan & Grattarola (1980) describe a model which relates voluntary intake of a roughage type diet on the one hand to mass of organic matter in the rumen, the insoluble fermentable fraction of the diet, the rate of fermentation, the rate of outflow of fermentable organic matter and the rate of outflow of unfermentable organic matter from the rumen on the other hand. The aim of this study was to examine the extent of the difference in intake between hay and silage and to determine whether the difference in intake between hay and silage can be accounted for in terms of the physical rumen characteristics mentioned above.

## Materials and Methods

### Experimental diets

Lucerne *(Medicago sativa),* harvested during early bloom stage at a theoretical chop length of 3,5 cm was either;

- dried to 92% DM in a coal heated crop dried at 1000°C for approximately two minutes (diet LH) or
- ensiled in concrete tower silos after the addition of molasses (16% on a DM basis) (diet LS1) or
- ensiled in concrete tower silos after the addition of molasses (16% on a DM basis) and 85% (w/v) formic acid (5 l/t fresh lucerne) (diet LSF).

A second cut of lucerne was harvested from the same field 28 days later at the same growth stage as the first cut, treated in the same way as LS1 and designated diet LS2. Two seemingly similar silages, LS1 and LS2, were prepared to obtain an indication of the variation in silage quality between one ensiling and another. LSF was prepared to obtain a silage of markedly different quality to the other two silages.

The resulting silages were removed after approximately 70 days and packed in vacuum bags until used. Molasses was mixed with diet LH (at 16% of DM) just prior to feeding.

### Experimental procedure

A change-over design was used in which eight rumen cannulated mature South African Mutton Merinos were randomly allotted to four groups of two each, every group receiving one of the experimental diets during each period at a level of *ad lib* plus 10% in four equal portions at six-hourly intervals. Twenty one days were allowed for adaptation to the diet, followed by a 12-day period during which daily feed OM intake and faeces OM production were measured and samples from all diets were collected for chemical analysis.

During the 12-day measurement period the rumen of every sheep was emptied at 03h00, 07h00, 11h00, 15h00, 19h00 and 23h00 to obtain representative values for rumen OM content and representative samples of rumen contents. The rumen of each sheep was emptied only once a day every second day to minimize any disturbing effect on the sheep. $^{51}$Cr EDTA, used to determine the retention time of water, was mixed with the removed rumen digesta prior to its return to the rumen. Samples of rumen contents were thereafter taken at approximately 8h00, 12h00 and 16h00 hours for determination of $^{51}$Cr.

## Results

### Chemical composition

The results in Table 1 show that treatment of the material with formic acid before ensiling inhibits fermentation during ensiling. This is evident from the comparatively low levels of $NH_3 - N$ and volatile fatty acids (end products of fermentation) in LSF. Silage LS2 underwent more extensive fermentation than LS1. This fermentation took place at a higher pH, making it more likely to be of a clostridial nature. This was confirmed by the higher butyric acid content of LS2.

**Table 1** The chemical composition of experimental diets (values are % in DM unless otherwise stated)

| | LS1 | LS2 | LSF | LH |
|---|---|---|---|---|
| pH | 4,4 | 4,7 | 4,2 | 5,9 |
| Acetic acid | 3,35[a] | 4,67[b] | 2,32[c] | – |
| Propionic acid | 0,11[a] | 0,37[b] | 0,07[a] | – |
| Butyric acid | 0,35[a] | 0,52[a] | 0,06[b] | – |
| $NH_3 - N$ (% of total N) | 21,7 [a] | 28,6 [b] | 15,6 [c] | – |

[a,b,c:] means with different superscripts differ significantly. ($P<0,01$).

### Voluntary intake and rumen characteristics

The voluntary OM intake (I), *in vivo* OM digestibility (D), diet solubility (S), rumen OM content (Z), combined rate constant for fermentation and outflow of fermentable OM ($\gamma_1 + \gamma_0$) and rate constant for outflow of unfermentable OM ($\gamma_2$) for sheep receiving the four experimental diets are shown in Table 2.

From Table 2 it is evident that voluntary intake was lowest for diet LS2 and was 11, 25 and 28% higher for diets LS1, LH and LSF, respectively, although only the difference for LSF was significant ($P<0,05$). There were no significant

**Table 2** Voluntary intake and rumen characteristics* of sheep receiving the four experimental diets.

| Component of model | Experimental diet | | | |
|---|---|---|---|---|
| | LS2 | LS1 | LH | LSF |
| I (g/day) | 1021[a] | 1134[ab] | 1278[ab] | 1308[b] |
| Z (g) | 450 | 480 | 517 | 526 |
| $\gamma_1 + \gamma_0$ (day $^{-1}$) | 2,83 | 2,78 | 2,67 | 2,81 |
| $\gamma_2$ (day $^{-1}$) | 0,94 | 0,97 | 1,08 | 0,99 |
| D (%) | 71,6 | 72,8 | 72,6 | 74,7 |
| S (%) | 34,4 | 34,5 | 32,8 | 35,4 |

[a, b]: means with different superscripts differ significantly ($P<0,05$)

* calculated according to Pienaar *et al.*, 1980.

differences between the rumen characteristics of the respective diets. There was, however, a considerable tendency for OM content in the rumen to increase with increasing OM intake. Differences in $\gamma_1 + \gamma_0$ and $\gamma_2$ between diets were relatively small (except for diet LH). The relatively lower value for $\gamma_1 + \gamma_0$ in the case of diet LH may be a result of the high drying temperature used. The relatively higher value for $\gamma_2$ may be due to the fact that, whereas particle size remained unaltered for all the silage diets, it was markedly reduced by drying and subsequent handling of the hay.

## Conclusions

Only 1,4 and 13,0% of the difference in intake between LS2 (lowest) and LSF (highest) could be accounted for in terms of the differences in rate constants, $\gamma_1 + \gamma_0$ and $\gamma_2$, respectively. However, 60,0% of this difference in intake could be accounted for by the difference in Z. If the lower intake of diet LS2 was caused by the effect of some physical characteristic of silage on Z then it would be expected that Z would be affected in the same way for diet LSF. This was not the case. Thus, it seems more likely that low Z is the consequence of low intake, rather than the cause.

Comparing voluntary intakes with the values in Table 1 it is evident that intake declines with increased fermentation in the silo. It therefore seems that the difference in intake between hay and silage is the consequence of the type and extent of fermentation during ensiling. It is, however, still not clear whether the end products of silage fermentation influence palatability or some physiological equilibrium of the animal or both. Results supporting each of these views are cited in the literature but there seem to be some contradictions.

## References

PIENAAR, J.P., ROUX, C.Z., MORGAN, P.J.K. & GRATTAROLA, L., 1980. Predicting voluntary intake on medium quality roughages. *S. Afr. J. Anim. Sci.* 10, 215.