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# The Eating and Rumination Behaviour in Sheep Fed only Forage Diet in Dried Form†

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## 乾草給与時におけるメンヨウの採食・反芻行動について

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## INTRODUCTION

In ruminant animals, it is well recognized that the chemical property of feed eaten considerably affects eating and rumination behaviour.[1,2,3] In particular, it appears that the dietary crude fibre is one of the effective constituents of roughage feed for rumination behaviour.[4,5,6] It has been shown in sheep or cattle that the daily time spent ruminating was clearly decreased with a decrease of dietary fibre content in the feeding of hay diet.[5,6] It is also suggested that the rumination behaviour in sheep fed a similar amount of hay is fairly influenced by differenced in hay species and its fibre content.[7,8,9] In feeding of the fibrous residue silage, however, daily rumination time in sheep was fairly smaller than in hay feeding, although the dietary fibre content was almost similar in both rations.[8,9] Therefore, it is fair to assume that the quality of dietary fibre in roughage feed should affect rumination behaviour as well as quantity of dietary fibre.

Recently, the author reported that the daily time spent chewing (eating plus ruminating) in sheep might be closely related to the amount of dietary crude fibre when they were fed only fresh forage harvested at different times from a same pasture.[6] In the present experiment, the eating and rumination behaviour was investigated in sheep fed only dried forage harvested from a same pasture.

## EXPERIMENTAL PROCEDURE

The diets of dried forage was prepared with the forages harvested at different times from a same pasture (Italian ryegrass/red clover). The harvested fresh forage was instantly dried by a ventilating drier at about 50°C for 24 hours, and stored at room temperature. The dried forage was cut to about 5 cm long before feeding. The chemical composition (as % day matter) of forages, determined by the method of AOAC,[10] are shown in Table 1. Diets I and II were composed of the first- and second-cut forages, respectively, and these forages were originally similar to those used as fresh form in the previous work.[6] Diet III was the same as that of hay used in the previous experiment.[7]

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Three Japanese Corriedale male sheep (nos k433, k468 and k790) and three wethers (nos 501, 503 and 523), weighing 22−32kg, were used. These sheep were allocated for three feeding treatments as follows ; diet I, 501, 503 and 523 ; diet II, k433, k468 and k790 ; diet III, 501 and 503, respectively.

Table 1. Chemical composition of diet

| Forage diet | Organic matter | Crude protein | Crude fat | Crude fibre | NFE* |
|---|---|---|---|---|---|
| I | 91.0** | 10.3 | 3.4 | 30.6 | 46.7 |
| II | 89.6 | 13.4 | 2.3 | 28.8 | 45.1 |
| III | 87.8 | 16.5 | 3.4 | 24.2 | 43.7 |

* Nitrogen free extract.
** % of dry matter.

The sheep were kept in the metabolism cages throughout the experimental period. Five-day sampling periods were preceded by 7-day preliminary periods. Each sheep was fed 2.25−2.38% as dry matter of diet per kg body weight. Water was freely available, and each sheep had access to a mineralized salt lick at all time. One-half of the daily ration was given at 09.00 hr and the other half at 17.00 hr. During the 5-day sampling period the time spent chewing during eating and ruminating was measured daily by the method described by Harumoto and Kato.[11] The terms used for indicating rumination behaviour is the same as in a previous report[7] of the author based on the work of Gordon.[12] The procedure of digestion trial was the same as described previously.[4]

## RESULTS and DISCUSSION

As shown in Table 1, crude protein content of diet II was slightly lower than that of fresh form, and crude fibre content was fairly higher in diet II than that of fresh form reported previouly.[6] This might be due to a slight difference of maturity in original herbage as described previously.[6] In diet I, the nutrient contents were very similar to those reported previously in fresh form.[6]

Table 2 shows the eating and rumination behaviour of sheep fed only forage diet in dried form. Time spent eating diet III was fairly shorter than those for diets I and II, and the value was slightly longer than those of previous result in which the sheep were fed only cocksfoot hay.[8] The time spentg eatin diets I and II were fairly shorter than that of timothy hay reported previously.[9] It has been reported that, in sheep given the same amount of dry matter in different forms of grass, when the rate of eating was slow, the energy cost was higher per unit dry matter and vice versa.[21] It can be inferred, therefore, that the energy cost of eating diet III was lower than that for diets I and II in the present experiment.
An ealier report suggested that the difference of time spent eating hay could be due to a difference in hay species and quality.[9] The author also reported that the difference in quality, especially crude fibre content, of fresh herbage might cause a difference in a ease of making boli for swallowing, and this could result in difference of eating time in fresh forage feeding.[6] In the present experiment, the fact that the time spent eating diet III was much less than diets I and II would be caused by a difference in fibre content of diets as shown in Table 1. The rate of eating was almost similar in feedings of diets II and III, though there were some variations among the experimental animals. This might be due to a small difference in the dry matter intake, i. e., average dry matter intake per kg body weight was 2.35 and 2.25% in the feedings of diets II and III, respectively.

Daily time spent ruminating was shorter in feeding of diet III than in feeding of diets I

Table 2. Eating and rumination behaviour in sheep fed only forage diet in dried form

| | Diet I (3)# | Diet II (3) | Diet III (2) |
|---|---|---|---|
| Time spent eating (min) | 170.5±20.2* | 167.4± 8.0 | 128.7±25.3 |
| Rate of eating (g D.M./min) | 3.4± 0.4 | 4.1± 0.2 | 4.0± 0.5 |
| Daily time spent ruminating (min) | 581.5±22.5 | 612.8±35.0 | 528.1±35.5 |
| Daily no. of boli regurgitated | 569.7±61.1 | 610.0±42.3 | 512.5± 6.3 |
| Daily no. of rumination periods | 32.2± 2.5 | 32.3± 1.5 | 26.6± 0.4 |
| Cyclic rate** (sec) | 62.6± 6.7 | 59.4± 2.7 | 62.1± 5.1 |
| Time spent per rumination period (min) | 18.3± 1.9 | 19.1± 1.8 | 20.0± 1.2 |
| No. of boli per rumination period | 17.7± 1.5 | 19.0± 1.8 | 19.5± 0.4 |
| Rumination index*** | 108.1±17.6 | 89.5± 3.4 | 107.4±14.7 |
| No. of chews per bolus | 82.9± 2.9 | 69.8± 9.2 | — |
| Bolus time (sec) | 52.4± 2.3 | 48.1± 3.5 | — |
| Rumination chewing rate/min | 95.0± 1.4 | 86.4± 4.9 | — |

# Number of sheep used.
* Mean±S. E. of 2–3 sheep.
** Total rumination time/no. of boli regurgitated.
*** Time spent ruminating per 100 g D. M. eaten.

and II. The daily number of boli regurgitated with diet III was also smaller than those with diets I and II. The value with diet III was similar to that reported previously,[7] in which sheep were given only hay diet. According to Hancock,[4] in cattle fed two kinds of grass, the grass of high fibre content required much longer rumination time per pound of dry matter than the grass of low fibre content. Recently, Harumoto and Kato[5] also reported that the time spent ruminating and the number of chews were clearly high with the hay of high-fibre content when sheep were given hays varying crude fibre content. In the present experiment, the fact that the time spent ruminating with diet III was shorter than those with diets I and II, also may be due to a decrease of crude fibre in the forage diet eaten. This result also confirmed that the time spent ruminating of sheep fed only dried forage harvested from a same pasture closely related to the crude fibre content of forage as well as forage species as reported previously.[6,9]

The daily number of rumination periods after feeding of diet III was fairly smaller than those after feeding of diets I and II, and the value was very in agreement with that of previous report using cocksfoot hay.[8] It has been noted that the number of rumination periods per day was not affected by the changes of amounts and type of roughage feed in cows.[13] Harumoto and kato[5] reported with sheep that the daily number of rumination periods was significantly smaller with hay of high fibre content than with a hay of low fibre content. Recently, Okamoto[14] also reported with sheep that the daily number of rumination periods tended to decrease with an increase of the ratio of small particle in ground or chopped hay diet. From these findings mentioned above, further investigation should be neccessary to clear a relationships between the roughage quality and/or quantity and the daily number of rumination periods as a parameter indicating the changes of rumination behaviour in-sheep or cattle.

Cyclic rate was defined by Gordon[15] as the average number of seconds from the beginning of one bolus to the beginning of the next, i. e. total rumination time (in seconds)/number of

boli regurgitated. It is seen from Table 2 that this value was similar in feedings of three diets used, and cyclic rate was similar to that in earlier report.[7] This result indicates that the fibre content of diet did not affect on cyclic rate in sheep, and this finding did not always agree with those described by other workers.[5,16]

Time spent chewing and number of boli regurgitated within each rumination period were similar in feedings of three diets. The values were greater than those in the feeding of fibrous residue silage, and was fairly smaller than those in fresh grass feeding.[6] The rumination index[7] (time spent ruminating per 100 g D. M. eaten) indicating the work done by sheep in comminuting a diet was almost similar in feedings of diets I and III, and the values were slightly higher than that of diet II and closely in agreement with those reported previously using cocksfoot or timithy hays,[8,9] whereas the fibre content of diet was not always the same in these experiments. This result did not agree with that of earlier report, in which the grass of high fibre content required a longer rumination time per unit of dry matter than the grass of low fibre content when cows were given two kinds of grass.[4] The discrepancy between the result in this study and that in other work might be due to a difference of quality of dietary fibre, such as fibre digestibility in roughage feed, since it is evident that some treatments of roughage feed (such as ensiling) should increase a digestibility of dietary crude fibre,[17,18] though the rumination time per unit dry matter eaten could be decreased by these treatments.[8,9] In the present experiment, the fibre digestibility of diet III (low fibre content) was fairly lower than those of diets I and II (high fibre content).[19] This was in agreement with that reported previously, in which sheep were given the fresh grass varying crude fibre content.[6] From these findings described above, it is fair to suggest that the time spent chewing per unit dry matter eaten would be clearly influenced by the qualitative difference rather than the quantitative difference of dietary crude fibre.

The number of chews per bolus, bolus time (average time in seconds spent chewing each bolus) and chewing rate were measured after feeding of diets I and II in order to estimate the efficiency of rumination. Number of chews per bolus in feeding of diet I was slightly more than that in feeding of diet II. Bolus time was almost similar in both feedings of diets I and II. Therefore, the chewing rate was fairly faster with diet I than with diet II. These results shows the rumination of sheep was more intensive and efficient in diet I feeding than in diet II feeding, and this would induce a greater utilization of nutrients of feed eaten. In the present experiment, the digestibility of crude fibre in diet I feeding was higher than that in diet II feeding. The utilization efficiency of dietary nitrogen was also higher in feeding of diet I than in feeding of diet II.[19] These findings exactly give support to the opinion described by the author.[7,20] The number of chews per bolus and rumination chewing rate in diet I feeding were fairly greater than that in previous experiment using hay similar to the diet III in the present study. From these results, it may be concluded that the rumination by sheep was more intensive and efficient in the feeding of high fibre diet than in the feeding of low fibre diet. Similar result has also been obtained in sheep fed only a forage diet in fresh form.[6]

From the results obtained in the present study, it is evident that the time spent ruminating in sheep fed only a dried forage was fairly influenced by a quality as well as quantity of dietary fibre, and also suggested that the rumination efficiency was clearly affected by the changes of dietary fibre content.

## SUMMARY

The eating and rumination behaviour was investigated in sheep fed only a dried forage diet varying crude fibre content, and the following results were obtained.

1) The time spent eating the dried forage diet was clearly decreased with a decrease of dietary fibre content, and tnerefore, the rate of eating tended to increase with a decrease of dietary fibre content.
2) Daily time spent ruminating and the number of boli regurgitated were smaller in feeding of diet of low fibre content than in feeding of diet of high fibre content. The daily number of rumination periods was decreased with a decrease of dietary fibre content.
3) The number of chews per bolus and rumination chewing rate were fairly greater in feeding of high fibre diet than in feeding of low fibre diet. This result clearly shows that the rumination by sheep was more intensive and efficient when they were given the diet of high fibre content.



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## 摘　　要

乾草給与時におけるメンヨウの採食・反芻行動について検討するため，イタリアンライグラスと赤クローバの混播草地から刈取って人工乾燥した粗繊維含量の異なる三種類の乾草を，各々乾物で1日1頭当り体重の2.25〜2.38%の量をメンヨウに給与して，7日間の予備期の後連続5日間の採食・反芻行動について調査した．

1日当りの採食時間は給与乾草の粗繊維含量が低い場合には短かくなり，従って採食速度（乾物g/分）は速くなる傾向が認められた．1日当りの反芻時間は給与乾草の粗繊維含量が低い場合には短かくなり，また1日当りの吐出回数が少なくなる傾向があった．

1日当りの反芻期数は給与乾草の粗繊維含量が低い場合に少なくなったが，吐出周期は給与乾草の粗繊維含量の違いによって影響されないようであった．

1吐出当りの再咀しゃく時間は給与乾草の粗繊維含量の差によってほとんど影響をうけないようであったが，1吐出当りの再咀しゃく回数は給与乾草の粗繊維含量の高い場合には多くなる傾向があり，再咀しゃく速度もかなり速くなった．この事から，給与乾草の粗繊維含量が高い場合には，反芻時間が長いばかりでなく，かなり集中して効率良い反芻がなされていることがわかった．（メンヨウにおける粗飼料の利用性に関する研究　3）