

# FURTHER QUANTITATIVE DATA ON THE ROLE OF THE RUMINANT PROVENTRICULI IN THE DIGESTION AND ABSORPTION OF NITROGEN-FREE ORGANIC MATTER

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In an earlier paper PALOHEIMO *et al.* (5, p. 70) have described a method for obtaining quantitative data on the role of the proventriculi (reticulo-rumen and omasum) in the digestion of nitrogen-free organic matter. In their experiments on 14 cows and 5 young bulls it appeared that of the total amount of the N-free non-lignin organic matter digested in the whole digestive tract 76—99 % disappeared in the proventriculi. When the results for two of the cows were discarded the limits in the cows were 85 and 91 %. In those experiments the animals were fed with hay only.

In the said paper earlier investigations on the subject are reviewed. Of later investigations those of BALCH (1, p. 213) and HOGAN (2, p. 25P) deserve to be mentioned. In the experiments of Balch made with fistulated cows which were fed on a variety of rations, small samples of the digesta lying in the region of the reticulo-omasal orifice were taken at frequent intervals over several days and combined to form a sample regarded as representative of the material passing to the omasum. The lignin-ratio technique was applied to values for the constituents of this sample in combination with values for the weight of the corresponding constituents in the food and of lignin in the faeces. It appeared that of the total dry matter disappearing from the alimentary tract from 43 to 83 % disappeared in the reticulum and rumen. The values for animals receiving a high proportion of concentrates in the ration are at the upper end of the range. In the experiments of Hogan with sheep the flow of digesta in the duodenum was exteriorized so that the digesta flowing from the stomach could be measured and sampled, and then returned to the duodenum. It appeared that almost 70 % of the digestible dry matter of the ration consisting of hay and a concentrate mixture was lost between the mouth and the duodenum.

### *Experimental*

As in the earlier investigation of the writers, the digestibility in the proventriculi was determined using the lignin-ratio technique. Analyses were made of the food and of the contents in the abomasum. The cows used in these experiments were the same which had been the experimental animals in the experiments for determining the rate of passage of food in the digestive tract (6, p. 1; 4, p. 39). In those experiments it was necessary to kill the animals at the end of the experimental feeding. Before this the digestibility in the whole digestive tract had been determined applying the lignin-ratio technique. In determining the digestibility in the proventriculi the contents of the abomasum were considered as excrement of the proventriculi. As the endogenous nitrogen containing substances impede the determination of the true digestibility of nitrogenous substance of the food the digestibility percentages were calculated only for N-free organic matter and N-free non-lignin organic matter.

As in the earlier investigation, the experimental cows were of Ayrshire breed. Four of them received hay as their only food. 17 were fed with hay and concentrates (chiefly maize) in a ratio of 1: 0.5, and 4 with hay and concentrates in a ratio of 1:1. Five of the cows received hay and beet pulp in the dry matter ratio of 1:0.5, and 8 hay and swedes in the dry matter ratio of 1:0.5. The hay used was timothy harvested at the beginning of blooming. Further notes concerning the feeding of the cows are given in the above mentioned papers of Paloheimo and Mäkelä.

### *Results and discussion*

The results of the experiments are given in Table 1. The consumption of food is given in kg dry matter per 100 kg reduced net weight. This is obtained by subtracting the amount of contents in the alimentary canal from the live weight and reducing the obtained net weight to a normal state with regard to its degree of fatness (3, p. 66). In the Table the animals in each group are enumerated according to the relative consumption of dry matter, beginning from those whose consumption per 100 kg reduced net weight was the smallest.

It is evident that the individual results obtained with this method are sometimes misleading. Especially the smallness of the samples obtained from the abomasum can lead to errors. The table shows, however, that the share of the proventriculi in the digestion of the N-free non-lignin organic matter must be rather large irrespective of the composition of the ration. As for the results obtained with different feedings one sees that in the first group the digestibility in the whole digestive canal has been greater than in our earlier experiments, whereas the digestibility in the proventriculi has been of the same order as earlier. Thus the ratio a:b, i.e. the relative share of the proventriculi, is smaller. Probably the result in the case of cow 27 is erroneous. Similarly it is probable that in the 2nd group the cows 29, 32, and 41 have given erroneous results. Apart from these the ratio a:b varies in 14 cows of group 2 between 0.58 and 0.85. Omitting also the two highest

Table 1. The digestibility of nitrogen-free non-lignin organic matter in the proventriculi and in the whole digestive tract of cows.

| Cow No.                                     | Food dry-matter kg per 100 kg reduced net weight | Digestibility of N-free non-lignin organic matter |                                   |      | a:b  | Cow No. | Food dry-matter kg per 100 kg reduced net weight | Digestibility of N-free non-lignin organic matter |                                   |  | a:b |
|---|--|---|-----------------------------------|------|--|---------|--|---|-----------------------------------|--|-----|
|   |  | a) in pro-ventriculi %                            | b) in the whole digestive tract % |      |  |         |  | a) in pro-ventriculi %                            | b) in the whole digestive tract % |  |     |
| 1) Animals fed on hay only                  |  |   |                                   |      | 3) Hay and concentrates in a ratio 1:1                 |         |  |   |                                   |  |     |
| 25  | 0.61   | 62  | 74                                | 0.84 | 46   | 1.81    | 53   | 75  | 0.71                              |  |     |
| 26  | 0.63   | 58  | 73                                | 0.79 | 47   | 1.83    | 39   | 75  | 0.52                              |  |     |
| 27  | 1.95   | 41  | 70                                | 0.59 | 48   | 1.88    | 2  | 77  | 0.03                              |  |     |
| 28  | 2.09   | 55  | 73                                | 0.75 | 49   | 2.08    | 55   | 70  | 0.79                              |  |     |
| 2) Hay and concentrates in a ratio of 1:0.5 |  |   |                                   |      | 4) Dry matter of hay and beet pulp in a ratio of 1:0.5 |         |  |   |                                   |  |     |
| 29  | 0.96   | 33  | 78                                | 0.42 | 50   | 1.38    | 59   | 74  | 0.80                              |  |     |
| 30  | 1.00   | 52  | 76                                | 0.68 | 51   | 1.38    | 62   | 72  | 0.86                              |  |     |
| 31  | 1.01   | 56  | 77                                | 0.73 | 52   | 1.84    | 68   | 71  | 0.96                              |  |     |
| 32  | 1.24   | 20  | 72                                | 0.28 | 53   | 1.88    | 50   | 72  | 0.69                              |  |     |
| 33  | 1.29   | 55  | 74                                | 0.74 | 54   | 1.90    | 67   | 75  | 0.89                              |  |     |
| 34  | 1.30   | 44  | 73                                | 0.60 | 5) Dry matter of hay and swedes in a ratio of 1:0.5    |         |  |   |                                   |  |     |
| 35  | 1.31   | 43  | 71                                | 0.61 | 55   | 1.85    | 64   | 77  | 0.83                              |  |     |
| 36  | 1.82   | 42  | 71                                | 0.59 | 56   | 1.88    | 64   | 72  | 0.89                              |  |     |
| 37  | 1.84   | 40  | 69                                | 0.58 | 57   | 1.92    | 76   | 80  | 0.95                              |  |     |
| 38  | 1.85   | 49  | 71                                | 0.69 | 58   | 1.99    | 74   | 81  | 0.91                              |  |     |
| 39  | 1.88   | 57  | 71                                | 0.80 | 59   | 2.26    | 59   | 66  | 0.89                              |  |     |
| 40  | 2.10   | 54  | 73                                | 0.74 | 60   | 2.35    | 60   | 71  | 0.85                              |  |     |
| 41  | 2.42   | 20  | 65                                | 0.31 | 61   | 2.50    | 64   | 71  | 0.90                              |  |     |
| 42  | 2.46   | 43  | 72                                | 0.60 | 62   | 2.57    | 57   | 75  | 0.76                              |  |     |
| 43  | 2.53   | 42  | 69                                | 0.61 |  |         |  |   |                                   |  |     |
| 44  | 2.53   | 48  | 69                                | 0.70 |  |         |  |   |                                   |  |     |
| 45  | 2.57   | 62  | 73                                | 0.85 |  |         |  |   |                                   |  |     |

values the limits for 12 cows are 0.58 and 0.74. In the 3rd group the case of cow 48 is obviously erroneous. In the others the ratio a:b varies 0.52—0.79. Especially if the results of the earlier experiments are taken into account it seems that the share of the proventriculi in the digestion of N-free non-lignin organic matter is larger when hay is the only food than in the cases where the ration consists of hay and concentrates.

In the cases in which the cows received hay and beet pulp (group 4) the ratio a:b is very high varying in four cases (excepting the cow 53) 0.80—0.96. The highest figures for the ratio a:b, 0.76—0.95, were obtained when the cows were fed with hay and swedes. Omitting cow 62 the limits for 7 cows are 0.83—0.91.

In none of the groups does the amount of dry matter consumed seem to have any influence upon the results.

## Summary

Using a method previously described the share of the proventriculi in the digestion of nitrogen-free non-lignin organic matter in cows was determined. The cows used in the experiments can be divided into 5 groups according to their food combination: 1) hay as the only food, 2) hay and concentrates in a ratio of 1:0.5, 3) hay and concentrates in a ratio of 1:1, 4) hay and beet pulp in the dry matter ratio of 1:0.5, and 5) hay and swedes in the dry matter ratio of 1:0.5. Omitting some obviously erroneous results the share of the proventriculi seems to vary between 58 and 96 %. This share is largest in group 5 and smallest in groups where the cows were fed with hay and concentrates. In none of the groups did the amount of dry matter consumed seem to have any influence upon the results.

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## SELOSTUS

### LISÄÄ KVANTITATIIVISIA TIETOJA MÄREHTIJÖIDEN ESIMAHOJEN OSUUDESTA TYPETTÖMÄN ORGAANISEN AINEEN SULATUKSESSA JA IMEYTYMISESSÄ

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Noudattamalla tässä aikakauskirjassa aikaisemmin (27, 1955, s. 70) selostettua menetelmää tutkittiin lehmän esimahojen osuutta typettömän ligniiniivapaan orgaanisen aineen sulatuksessa. Kokeissa käytetyt lehmät muodostivat saamansa rehuyhdistelmän mukaan 5 ryhmää: 1) heinä ainoana rehuna, 2) heinää ja väkirehua (pääasiassa maissijauhoa) suhteessa 1:0.5, 3) heinää ja väkirehua suhteessa 1:1, 4) heinää ja sokerijuurikasleikettä kuiva-ainesuhteessa 1:0.5 ja 5) heinää ja lanttuja kuiva-ainesuhteessa 1:0.5. Jättämällä pois muutamia ilmeisesti virheellisiä tuloksia esimahojen osuus näyttää vaihtelevan prosenttimäärien 58 ja 96 välillä. Suurin on tämä osuus ryhmässä 5 ja pienin ryhmässä, joissa lehmät saivat heinän ohella väkirehua. Missään ryhmässä syödyn kuiva-aineen määrällä ei näyttänyt olevan vaikutusta tuloksiin.