

## RUMEN FERMENTATIONS WITH NaOH-STRAW RATIONS<sup>(1)</sup>

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In this paper, the influence of the incorporation of NaOH-treated straw in the rations on rumen fermentation patterns was followed. pH, volatile fatty acids (V.F.A.) and ammonia were measured. Microbial growth yield was determined *in vitro* on a limited scale.

It should be emphasized that these results refer to observations made after application of fattening rations to ordinary farm animals.

### Material and Methods

**Rations:** the four basal diets contained NaOH-treated barley straw pellets of Danish origin (10, 20, 30 or 40 %), dried beet pulp (70, 60, 50 or 40 %) and rolled barley (20 %). Soya oilcake was given to reach a dietary crude protein concentration of about 12.5 to 13.5 %. Intake was calculated individually as 100 g feed/kg (L.W.)<sup>0.75</sup> fed in two equal parts at 08.00 and 16.00h.

**Animals:** twelve young White Blue Belgian bulls were housed in digestion stalls with free access to water. They were given the experi-

mental diets over the weight range of 275 to 500 kg. The animals were put at random into four groups of three, and were fitted with rumen cannulas.

**Sampling frequency:** four sampling series (days) were chosen at reasonably equal intervals over the entire growth-fattening period.

Each day the rumen content of all twelve animals was sampled at 0 h (i.e. before morning feeding), 2 h, 4 h and 7 h after feeding.

**Sampling technique:** a representative sample of the whole rumen content was taken by means of a vacuum device and a flexible tube. Fermentations were stopped by adding Thiomersal. Samples were immediately centrifuged (3000 rpm/20 min.), the content partitioned into liquid and solid fractions, and the samples cooled.

**Analytical methods:** pH was measured immediately by potentiometry. Volatile fatty acids were estimated by gas chromatography. Ammonia was determined by an autoanalyzer methodology adapted in our laboratory after the Berthelot reaction.

Microbial growth rate was estimated by measurement of <sup>32</sup>P incorporation *in vitro* as described by Van Nevel and Demeyer (1977) on 3 separate sampling series.

**Statistical analysis:** the data were subjected to analysis of variance and to a multiple com-

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parison test based on the least significant difference.

## Results and discussion

The main experimental variable to be considered was the percentage of NaOH treated straw in the rations, i.e. 10 %, 20 %, 30 % and 40 %.

Each result is a mean of 4 (series)  $\times$  3 (animals) = 12 determinations.

*pH*: mean daily pH rose slightly with increasing NaOH-straw content in the rations, e.g. 5.9, 6.1 and 6.2. Initial pH values were around 6.5. Minima were observed 2 h after feeding. Diurnal variation was generally less than 1 pH unit. Differences between treatments were very highly significant ( $P < 0.001$ ) except between the 20 and 30 % levels (N.S.). As quoted by Kristensen *et al.* (1978) with diets based on 50 % treated straw and 50 % of either barley or molassed dried beet pulp, the straw component apparently had a moderating effect so that a drastic drop in pH did not occur.

*Volatile fatty acids*: (fig. 1). Total volatile fatty acids concentration (sum of individual acids) decreased as the NaOH-straw level rose. Differences were highly significant ( $P < 0.001$ ). The 10 % straw ration seemed to be distinctly different and higher than the remaining three levels. The rations containing 20 % and 30 % were fairly similar (no statistically significant differences) while the 40 % straw level appeared to yield the lowest VFA concentrations. Shapes of the evolution pattern were also different with the 10 % and 20 % rations, showing a maximal concentration 4 h after feeding. With the 30 % and 40 % levels VFA concentrations levelled off to a constant value 2 h after feeding.

Acetic acid concentration was lowest with the 40 % straw ration (daily mean: 79 mmoles/l) while the other 3 levels had quite similar results (81 - 82 mmoles/l). Maximum concentration was also lower with the highest NaOH-straw levels although differences were not statistically significant. Propionic acid decreased in a similar way. Daily mean concentration was distinctly higher with the 10 % straw treatment i.e. 32 mmoles/l vs. about 25 mmoles/l for the others ( $P < 0.001$ ). For Butyric acid, mean daily concentration was about

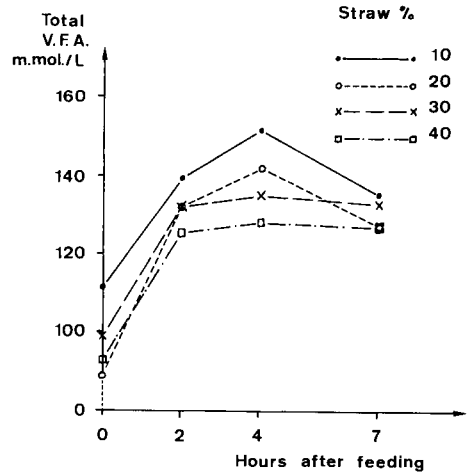


Fig. 1. — Diurnal variation of Total Volatile Fatty Acids with the four NaOH-straw levels.

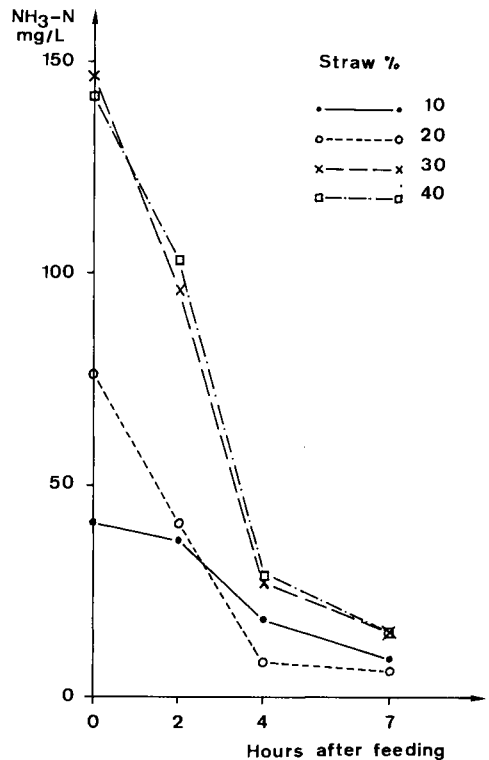


Fig. 2. — Diurnal variation of Ammonia-N with the four NaOH-straw levels.

15 mmoles/l and variations between treatments were small.

Molar proportions of acetic acid were lowest with the 10 % straw ration (62.7 %) and differed from the other three rations ( $P < 0.001$ ) which yielded quite comparable and higher results (about 66 %). Propionic acid proportions varied in an opposite way, i.e. from 23.6 to 20.5 % ( $P < 0.001$ ). Consequently the acetic/propionic ratio increased. Butyric acid molar proportions remained quite constant (11.5 to 12 %).

*Ammonia* : (fig. 2). A distinct difference was observed between the 10 and 20 % straw rations (mean daily concentrations, 26 and 33 mgN/l), respectively, and on the other hand, between the 30 and 40 % rations (mean concentrations 71 and 72 mgN/l). Differences were very highly significant ( $P < 0.001$ ). The higher straw levels showed much higher concentrations. This could, however, be due to higher soya levels needed to obtain iso-N rations. Maximal ammonia concentration always occurred before the morning feeding. It decreased regularly after feeding although with the 30 and 40 % levels ammonia concentration remained fairly high even several hours after feeding.

*In vitro determination of microbial growth yield* : at the end of the growth fattening period microbial growth yield was estimated on four animals and repeated three times.

Total microbial growth yields, expressed as g N incorporated per kg organic matter fermented, were 93.9, 80.8, 79.5 and 58.9 respectively for the 10, 20, 30 and 40 % NaOH-straw levels. We are aware of the fact that these values especially for the 10 % level, are high compared with values determined *in vivo* and are even of the same magnitude as the maximal values calculated on a theoretical base (Van Nevel and Demeyer, 1977 ; Stouthamer, 1977). However, our results are total growth values which can be considerably higher

than net growth. Furthermore, it should be borne in mind that in determining microbial growth yield by isotopes or calculation of theoretical yields, the assumption made may not always be correct (Van Nevel and Demeyer, 1977). Nevertheless, although interpretation should be done with care, we think that mutual comparison between animals are still permissible. The higher microbial growth efficiency with the 10 % straw level is in line with the lower ammonia concentrations in the rumen. In our opinion, the lower microbial growth efficiency with higher straw levels is due to shifts in the microbial population towards a slower fermenting and growing flora, while it is known that lower microbial growth rates result in decreased growth efficiencies.

### Conclusion

It seems likely that incorporating higher levels of NaOH-straw in the ration results in slower fermentation rates. Rumen fermentation patterns reveal higher accumulation of intermediate products such as glucose, lower levels of end products (VFA) and a slow rate of reaching maximum concentration values. The decrease in total microbial growth with higher NaOH-straw levels follows the same trend. However, it should be emphasized that, despite this possible slower rumen fermentation activity, apart from a slight decrease in growth and O.M. digestibility with the highest NaOH-straw level, zootechnical results do not reveal that the higher NaOH-straw level have any particular deleterious effect. Treatments with 20 and 30 % NaOH-straw yield quite comparable results, whereas treatments with 10 and 40 % are somewhat lower. The former is probably due to a certain lack of fibre structure in the rumen, while the latter might be an indication of a possible upper limit of NaOH-straw incorporation with these rations. However, even with the highest NaOH-straw levels animal performances are quite satisfactory.

### References

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