

SOME ASPECTS OF THE DIGESTION OF *ATRIPLEX NUMULLARIA* (SALTBUSH) BY SHEEP

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Summary

The values of various parameters relating to digestion, e.g. nutrient digestibilities, the flow of digesta and their constituents through the rumen and abomasum and the concentrations of end products of digestion, were measured in sheep fed *A triplex nummularia* (saltbush) .

The chemical composition and digestibility of the saltbush were within the ranges reported in the literature for saltbush grown in semi-arid environments. The values of most parameters measured were within, or close to, the ranges observed with pasture grasses and legume. However, with saltbush, the stomach played a less important role in the digestion of organic matter and fibre; further, it appeared that the ruminal absorption of volatile fatty acids was impaired.

The protein of the saltbush was extensively degraded to ammonia in the rumen and accordingly the protein value of the diet was much lower than indicated by its digestible crude protein content.

I. INTRODUCTION

Various species of the genus *Atriplex* (saltbushes) are present in large areas of arid and semi-arid Australia and are generally considered to be extremely valuable as a fodder reserve during drought. The nutritive value of the leaves of these plants has been studied by conventional digestibility and body growth studies (Wilson 1966). These investigations have shown that although the level of digestible crude protein is high and energy digestibility is moderately high, these diets will furnish barely more than sufficient nutrients for the maintenance of energy and nitrogen equilibrium.

There appear to be no data for sheep fed any of the *Atriplex* species on either the distribution of nutrient digestion and absorption between the stomach and intestines, or the rate of flow of digesta through these sections of the alimentary tract. It is of some interest to know if these patterns of digestion are the same for the *Atriplex* species as for the more common pasture plants. Differences between these two different types of herbage might be expected as high intakes of mineral constituents and drinking water accompany the consumption of saltbush by sheep. Further, in view of the importance of absorbed amino acids in promoting wool growth, it is pertinent to have information on the extent of wastage of dietary protein in the rumen due to deaminative degradation. The studies reported here provide some data relevant to these various aspects of digestion for a diet consisting entirely of the leaves of *Atriplex nummularia* (saltbush).

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II. EXPERIMENTAL

(a) *Saltbush*

The saltbush was grown at Prospect, approximately 30 km west of Sydney, and at the time of defoliation the shrubs were about six years of age and had not been grazed or pruned in the preceding year. The leaves, obtained by stripping the branches manually, were dried with a minimum of heat (Weston and Hogan 1968a) before being offered to the sheep.

(b) *Feeding and Management of Sheep*

Four mature Merino wethers fitted with rumen and abomasal cannulae were maintained indoors in metabolism cages and offered 720 g of saltbush daily, in equal meals at intervals of 3 hr for 21 days.

(c) *Experimental Procedures*

Faeces were collected during the last eight days of saltbush feeding to permit overall nutrient digestibility to be measured. The distribution of nutrient digestion between the stomach and intestines was determined from the flow of digesta through the pylorus, as measured by reference to two marker substances introduced intraruminally. The markers, the ^{51}Cr complex of ethylenediaminetetraacetic acid (^{51}Cr -EDTA) (Downes and McDonald 1964 and ^{103}Ru -labelled Tris (1,10-phenanthroline) ruthenium (II) chloride (^{103}Ru -P) (Tan, Weston and Hogan, unpublished data), were infused continuously as a mixture throughout the faeces collection period. During the last three days of the period, water intakes were measured and a total of nine samples of both rumen and abomasal digesta were obtained according to the schedules used earlier (Weston and Hogan 1968a).

(d) *Chemical Analysis*

Sodium, potassium and osmotic pressure were measured as described by Warner and Stacy (1965). ^{51}Cr -EDTA and ^{103}Ru -P were assayed by a method developed at this laboratory (Tan, unpublished data). The other methods of analysis were outlined previously (Weston and Hogan 1967).

(e) *Calculations*

Rumen volumes, marker residence times and the rates of flow from the rumen and abomasum of water soluble substances were calculated by reference to the concentrations of ^{51}Cr -EDTA in rumen and abomasal liquors as described by Weston and Hogan (1967). The rates of flow through the pylorus of organic matter (OM) and its components were calculated by reference to the concentrations of ^{51}Cr -EDTA and ^{103}Ru -P; the equations presented by Hogan and Weston (1967) were used with ^{103}Ru -P replacing lignin.

All errors given in the text are standard errors of the mean.

III. RESULTS

(a) *Chemical Composition of the Saltbush*

The saltbush as offered to the sheep contained 8 per cent of water. The levels of cell wall constituents (CWC), crude protein, ash, sodium and potassium on a dry matter basis were respectively 41.1, 19.8, 22.7, 4.0 and 3.4 per cent.

(b) *Digestion of OM and CWC*

The daily OM intake was 510 g of which 407 ± 9 g left the stomach via the pylorus and 200 ± 5 g was excreted in the faeces. Thus a total of 310 ± 5 g or

60.8 per cent of the dietary OM was digested, 103 ± 9 g being apparently digested in the stomach and 207 ± 12 g in the intestines; apparent digestion in the stomach hence accounted for only 33 ± 3 per cent of the total digestion in the alimentary tract. The digestion of CWC followed much the same pattern. The intake of this fraction was 272 g per day and its digestibility was 60.4 ± 1.7 per cent; 43 ± 10 per cent of this digestion occurred in the stomach.

(c) Digestion of Nitrogen

There was a net loss of nitrogen (N) during the passage of digesta through the stomach. Thus 18.1 ± 1.2 g N left the stomach daily whereas the corresponding N intake was 20.1 g. The quantity of N leaving the stomach in digesta in the form of ammonia was 3.6 ± 0.5 g N daily, thus the quantity of N passing the pylorus in forms other than ammonia (non-ammonia N or NAN) was 14.5 ± 0.8 g, the equivalent of 72 per cent of dietary N intake. The loss of dietary N during the passage of digesta through the stomach, presumably due to the microbial deamination of dietary nitrogenous substances, was reflected by the presence of significant quantities of ammonia in the rumen. The total amount of ammonia in rumen liquor was 1.45 ± 0.2 g N, the concentration being 27 ± 3 mg N per 100 ml; the quantity leaving the rumen in digesta was 3.21 ± 0.37 g N per day.

The quantity of N excreted in the faeces was 5.1 ± 0.2 g per day; hence the overall digestibility of dietary N was 75.8 ± 1.1 per cent. As the quantity of NAN entering the intestines was 14.5 g per day, the amount of NAN apparently digested in the intestines was 9.4 ± 0.6 g per day, the equivalent of 1.85 ± 0.12 g N or 11.5 ± 0.7 g crude protein per 100 g OM intake.

(d) The Flow Of Digesta through the Alimentary Tract

The amount of water passing from the rumen to the omasum in digesta was 11.8 ± 1.4 l. per day or about 6.2 l. above the mean intake of water from the diet and drinking water. The mean residence time of ^{51}Cr -EDTA molecules in the rumen was 9.8 ± 0.8 h. The mean volume of water in the rumen was 5.4 ± 1.0 l. The flow of water through the pylorus was greatly enhanced over that from the rumen, the mean quantity being 23.8 ± 3.0 l. per day; most of this water was absorbed distal to the pylorus, only 0.78 ± 0.15 l. being excreted daily in the faeces. As the OM intake was comparatively small and the rates of flow of digesta through the stomach moderately high, the OM contents of the digesta were low, the values being 3.8 ± 0.4 per cent and 1.8 ± 0.2 per cent for digesta leaving the rumen and abomasum respectively.

The levels of volatile fatty acids (VFA) in rumen and abomasal liquors were 85 ± 5 mmole/l. and 22 ± 2 mmole/l. respectively, thus the quantities of VFA passing in digesta from the corresponding organs were 1030 ± 170 mmole/day (70 g/day) and 550 ± 110 mmole/day (37 g/day); accordingly the absorption of VFA from the omasum and abomasum was 33 g/day.

The daily intake of sodium from the diet was 1.2 moles and its level in rumen liquor was 121 ± 10 mmole/l. On the average, however, the quantity of sodium leaving the rumen in digesta (1.5 ± 0.3 moles) was a little greater than intake and further, the quantity leaving the abomasum was higher again at 1.6 ± 0.4 moles/day. The levels of potassium, in rumen and abomasal liquors, were lower than those of sodium the respective values being 41 ± 4 and 29 ± 2 mmole/l. The quantity of potassium leaving the rumen was 0.47 ± 0.01 moles/day, somewhat lower than

the dietary intake of 0.55 moles; as with the sodium, the quantity leaving the abomasum (0.68 ± 0.03 moles) exceeded that leaving the rumen.

The pH of rumen liquor varied between sheep from 6.9 to 7.1 and the corresponding range in abomasal liquor was 2.9 to 3.1. The osmotic pressure of rumen liquor was comparatively high at 33.1 ± 11 m-osmole/kg; in abomasal liquor the value was 265 ± 6 m-osmole/kg.

IV. DISCUSSION

In recent years, digestion studies similar to those reported here have been conducted at this Laboratory with 23 chopped herbage diets differing widely in chemical composition and digestibility (see Weston and Hogan 1968b). The values of most parameters measured with saltbush were within the range of those obtained with the other herbage, or were close to one end of the range. However, saltbush deviated markedly from the others in two aspects of digestion, the extent of digestion of OM including CWC in the stomach and the rate of absorption of VFA in the rumen. The proportion of the total OM digestion that occurred in the stomach was 33 per cent with saltbush, considerably lower than the range of 55 to 67 per cent found with the other herbage diets. Similarly, with saltbush only 43 per cent of the total digestion of CWC took place in the stomach compared to 75-100 per cent with the other diets. The explanation of these differences is not apparent. Possible explanations would include (i) a shorter residence time of feed particles in the rumen, and (ii) an impairment of the metabolism of the rumen microbes that digest fibre. The latter possibility is more likely as the residence time of ^{51}Cr -EDTA was within the normal range. The quantity of VFA absorbed from the rumen may be calculated as the difference between the production rate and the rate of transfer to the omasum in digesta. The rate of production of these acids was not measured but it is unlikely to exceed by a significant amount the equivalent of 95 g per 100 g OM apparently digested in the stomach, the mean value obtained at this Laboratory with 20 roughage diets. On this basis, about 98 g of VFA should have been produced daily, of which 70 g was calculated to pass out with digesta; the remaining 28 g or 29 per cent of that produced, was absorbed from the rumen. This situation is in marked contrast to that prevailing with the other diets where the amounts absorbed from the rumen have ranged from 70 per cent to 80 per cent of the ruminal production. Again, the explanation for the impaired absorption is not apparent. There was ample time for absorption of the acids as indicated by ^{51}Cr -EDTA residence time. Ruminal pH was 0.3-0.9 pH units higher with the saltbush and, although this would tend to reduce the absorption rate, this alone appears unlikely to account for more than a small portion of the discrepancy.

Attention has been drawn to the high digestible crude protein content of the leaves of the saltbushes and their protein values have been assessed accordingly. The present data suggest however that the protein value of these diets may be appreciably lower than the digestible crude protein contents indicate. Thus, with the saltbush studied there was considerable degradation of dietary crude protein to ammonia in the rumen. The quantity of crude protein in forms other than ammonia digested in the intestines, presumably the principal source of amino acids for the sheep's tissues, was equivalent to only 60 per cent of the total digestible crude protein.

V. REFERENCES

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