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MEASUREMENTS OF ENERGY METABOLISM IN SHEEP FED KURRAJONG *(Brachychiton populneum),* MULGA *(Acacia aneura)* AND NATIVE PASTURE *(Stipa spp.).*

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Summary

Leaves of kurrajong *(Brachychiton populneum)* and mulga *(Acacia aneura)* and cut native pasture *(Stipa spp.)* were offered to penned sheep. Digestible energy, CO_2 entry rate and volatile fatty acid (VFA) concentrations in ruminal fluid were determined in animals given their ration in equal portions over 24 h. Using these data, heat production and VFA production rates were estimated. Sheep given mulga were in negative energy balance, and all sheep lost the same amount of weight during the feeding period. All diets were well digested in the rumen, over 50 per cent of the digestible energy appearing as VFA. The heat production of animals given mulga leaves was higher than animals given the other two diets.

1. INTRODUCTION

When herbage is consumed by sheep, a large proportion of the digestible energy is transformed by ruminal fermentation into volatile fatty acids, methane, heat and energy stored in microbial cells. The quantitative relations of these end products suggests that one or more measures of them may be useful as a nutritive index of the herbage for sheep. Considerable data on VFA production by sheep given a variety of conventional feeds, has been obtained (Bergman *et al.* 1965; Leng and Brett 1966; Gray *et al.* 1967; Weston and Hogan 1968; Hogan, Weston and Lindsay 1969; Weston and Hogan 1971).

The relationship between production rate and the concentration of VFA in ruminal fluid is linear over a wide range of forages examined (Leng and Brett 1966; Weston and Hogan 1968), and there is also a good relationship between VFA production and digestible organic matter intake (Weston and Hogan 1968). Thus estimates of VFA concentrations or production may provide data for prediction of digestible organic matter intake both in penned and grazing sheep (Leng,

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Corbett and Brett 1968; Weller, Pilgrim and Gray 1969), and at the same time provide information relating to the utilization of the digestible energy of a feed and thus its nutritive value.

In order to make valid predictions of nutritive value of a particular feed for grazing animals, it is necessary to establish the relationship of VFA production and digestible energy for a wide variety of feeds. Therefore we have decided to obtain data for a range of herbage plants available to grazing sheep in Australia.

In present studies, some measures of digestion and energy metabolism have been made on sheep given kurrajong (*Brachychiton populneum*), mulga (*Acacia aneura*) and mixed *Stipa spp.* pasture, and these are compared with estimates of VFA production in the rumen.

II. MATERIALS AND METHODS

(a) Animals and diets

Three groups of Merino wethers all with rumen cannulae were housed in a woolshed near Cobar, N.S.W. Two groups were given rations of 1400 g of fresh kurrajong and 1400 g of fresh mulga respectively; the total amount being consumed each 24 h in both instances. The third group was offered 1000 g of fresh native pasture; animals in this group consumed approximately half the dry matter in their ration. All sheep were given their daily ration in 12 equal portions throughout the day.

The group fed pasture was divided into two subgroups, Pasture 1 and Pasture 2. One subgroup (Pasture 1), was used for estimating rate of entry of CO_2 into the blood; Pasture 2 subgroup was used to determine VFA concentration.

All measurements were carried out during a digestibility trial, results of which appear together with further details of animals, experimental design, routine, and diets in the companion paper by Norton ***et al.*** (1972). VFA concentrations were monitored at hourly intervals over 8 h on one day; and on a second day towards the end of the digestibility trial, the rate of entry of CO_2 into the blood was measured using a continuous infusion of ^{14}C sodium bicarbonate ($0.4 \mu Ci/ml$, 20 ml/h).

Kurrajong and mulga were harvested every two days by hand lopping large branches and storing these in mesh cages in the woolshed. Leaves and succulent stems were plucked by hand from these branches, the daily rations weighed into plastic bags and a sample taken for dry matter determination.

Fresh native pasture was obtained by cutting a selected area close to the ground with a rotary lawn mower, and raking the material into a hessian bag.

Feed refusals from sheep fed pasture were also recorded each day, samples taken and oven dried. These samples were then bulked, mixed and subsampled for each sheep. The dried batch samples for each feed were treated similarly.

Table 1 shows the mean values for dry matter and crude protein content of the three forages, and of all refusals.

(b) Techniques

Ruminal fluid samples were analyzed for total concentration and preparation of

TABLE 1

Dry matter and crude protein content of the diets and pasture refused by sheep

Diet	Dry matter (%)	Crude protein (%Nx6.25)
Kurrajong	44.8	14.6
Mulga	46.6	14.9
Pasture	75.0	7.9
Pasture refused*	88.6	1.4

*Mean value for feed refused by all sheep.

VFA (Leng and Leonard 1965), and the rates of effective production were calculated from the linear relationships for individual acids described by Leng (1970).

The heat production of the animals was estimated from the regression equations of carbon dioxide entry rate and heat production (Corbett ***et al.*** 197 1).

Digestible and gross energy values were obtained from the energetic values for feed and faeces obtained by bomb calorimetry.

III. RESULTS

The total VFA concentrations and relative proportions of each acid in the ruminal fluid are given in Table 2, together with the estimated effective production rates of acetic, propionic and butyric acids. Of the rations, the pasture gave the lowest total VFA concentration and therefore production. Although the predicted total effective production rate of VFA (kJ) was the same for mulga and kurrajong, the total VFA concentration for mulga was higher than that for kurrajong. The

TABLE 2

Concentration of VFA and proportions of individual acids in the ruminal fluid and the predicted rates of production of these acids in sheep fed diets of kurrajong mulga or mixed Stipa spp. ***pasture***

Feed	Total VFA concentration (m-mole/l)	Molar proportions of individual VFA in rumen fluid (%)				Estimated effective production rates of VFA			
		Acetate	Propionate	Butyrate	Others	Acetate M/day	Propionate M/day	Butyrate M/day	Total M/day
Kurrajong	74.6	69	16	10	5	2.37	0.78	0.33	4.02
Mulga	86.6	69	20	7	4	2 85	1.05	0.27	4.68
Pasture	48.5	76	15	5	4	1.53	0.55	0.13	2.57

*Predicted from regression equations published by Leng (1970).

mulga diet had a higher proportion of propionate in the total acids than either kurrajong or pasture.

Table 3 shows the heat production, energy intake and contribution of VFA production to the digestible energy intake for the three diets.

TABLE 3

Heat production, energy intake and contribution of VFA to digestible energy intake (D.E.) of sheep fed kurrajong mulga and mixed* Stipa spp. *pasture

Feed	CO_2 entry rate (moles/ day)	Predicted heat production (MJ/day)	Gross energy intake (MJ/day)	Digestible energy intake (MJ/day)	Predicted production of VFA (MJ/day)	Predicted production of VFA (% D.E.)
Kurrajong	19.2	6.56	12.93	7.44	3.99	54
Mulga	23.8	7.52	12.81	6.26	4.70	75
Pasture 1	11.6	4.89	8.62	6.60	—	—
Pasture 2	—	—	5.23	4.00	2.47	62

Note: 1 MJ = 239.23 kcal.

The sheep maintained weight during the ***ad** lib* feeding period. However the liveweights of all sheep decreased over the two weeks of the experiment in which the animals were given 90 per cent of their voluntary intake. The average liveweight loss during this period was 2.03, 2.48 and 1.98 kg respectively for the groups given kurrajong, mulga and pasture respectively.

IV. DISCUSSION

The total concentrations and proportions of VFA in' ruminal fluid of the sheep given kurrajong and mulga approximate the values obtained on more conventional diets (e.g. lucerne chaff: Leng 1970). The low concentrations and thus production rates of VFA in the pasture-fed sheep is due in part to the low intake of dry matter by these sheep.

Estimates of VFA production indicated that all diets were effectively fermented in the rumen since greater than 50 per cent of the apparently digestible energy intakes arose as VFA. From the relationship of the various end products of ruminal fermentation this suggests that in excess of 100 per cent of the digestible energy intake was accounted for by VFA, methane production, the heat of fermentation and the microbial cells produced (Baldwin, Lucas and Cabrera 1970). Thus from these studies mulga and kurrajong and the pasture selected by the sheep appeared to support ruminal fermentation to the same extent or better than lucerne chaff at the same. dry matter intake; however absolute edibility limited the quality of the ration since sheep of equivalent size appear to eat more lucerne than either kurrajong or mulga. However under grazing, the relative intakes are unknown.

The carbon dioxide entry rate technique was used to examine the heat production of these animals as a field technique since no calorimeters were available. For sheep on all diets the mean values of heat production and digestible energy intake show that the animals given mulga were in negative energy balance, and those given pasture and kurrajong were in positive energy balance. The increased heat production of the animals on mulga suggests that there was an increased energy expenditure due to either the physical properties of the feed or to a metabolic disturbance. The mean weight loss of the pasture fed animals was less than those given the other two feeds.

Sheep selected approximately 50 per cent of their ration of cut pasture which indicates that provided the animals selected similarly under grazing conditions they could obtain a highly nutritious diet. In previous trials (Rohan-Jones unpublished data), when penned sheep were offered kurrajong or mulga ***ad lib,*** the animals maintained weight. Of the three diets, mulga has the lowest digestible energy content, although the sheep consumed more gross energy than those given kurrajong or pasture. However, the kurrajong and mulga examined were apparently utilized mainly in the rumen, and may be regarded as feeds that could maintain animals during periods of feed scarcity. It is evident that VFA concentrations and production rates, will be useful as part of a nutritive index for a wider range of feeds than was originally examined. As more than 50 per cent of the digestible energy intake is converted to VFA in the rumen, these measurements provide data from which the end products of ruminal fermentation can be calculated, and digestible organic matter intake may be predicted. Providing forages are realistically calibrated in pens the regression obtained can be applied effectively in the field to obtain feed intake data. It would appear that only VFA concentrations and intake data are required to do this.

The technique could be applied on a routine basis to determine nutritive value and intake of pasture during the feed year under many different grazing situations.

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