CHANGES IN THE QUALITY OF INGESTED HERBAGE, AND IN THE RESULTING MILK PRODUCTION, OF ROTATIONALLY GRAZED DAIRY CATTLE

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Summary

Dairy cattle were rotationally grazed at stocking rates of 2.8 and 4.2 cows/ha on irrigated pasture composed mainly of Lolium perenne and Trifolium repens.

All components of milk production declined with days of grazing a particular paddock in the rotation. The decline in milk production was associated with a decline in protein content of the selected herbage; there was no similar decline in digestibility with days of grazing. Although cows at both stocking rates selected herbage of similar protein content and digestibility, there were some unexplained differences between the components of milk production at the two stocking rates. It appeared from the results, that when cows graze rotationally on irrigated pasture they select from the top layers of the pasture first, regardless of the stocking rate and amount of pasture present.

I. INTRODUCTION

Sheep and cattle grazing annual pastures tend to select pasture of higher digestibility than is present in clipped herbage samples of the same pasture (Arnold et al. 1966; Brendon, Torell and Marshall 1967). The extent to which pasture selection operates is influenced by such factors as amount of pasture present, stocking rate and the physiological state of the animal (Bryant et al. 1965; Arnold and Dudzinski 1967).

This paper reports a short term grazing experiment conducted with lactating dairy cows at Werribee, Victoria in which the effects of stocking rate and amount of pasture present were correlated with the measured quality of pasture selected and with milk production.

II. MATERIALS AND METHODS

Eight pairs of monozygotic twin cattle, which calved in September 1970, were split at random between two treatments of high (HS) and low (LS) stocking rates of 4.2 and 2.8 cows/ha respectively. Oesophageal fistulae were established in two pairs of twins using the procedure described by van Dyne and Torell (1964).

Sixteen paddocks of irrigated pasture, each of 0.36 ha in area, were randomly allocated between the two treatments. Four extra cows were grazed with the HS treatment to give the required stocking rate. Pastures were predominant in Lolium perenne and Trifolium repens, with small amounts of Dactylis glomerata, Bromus unioloides, Paspalum dilatatum and Trifolium fragiferum.

Both groups of cows were moved to the next paddock in the rotation when the HS paddock was appraised to have been grazed to a height of 4 to 7 cm. The cows were rotationally grazed for a period of 3 months on the experimental area before measurements began in January 1971. All measurements were recorded in the same paddock of the 8 paddock rotation for the respective treatments. Each of the four grazings in the "test" paddock lasted for a period of 5 days; the intervals between grazings of the "test" paddock were 25 to 30 days. The amount of pasture present was estimated with an electronic pasture meter (Campbell, Phillips and O'Reilly 1962) prior to the first and second grazing and daily during the third and fourth grazings of the "test" paddock.

Records of milk yield and samples of milk for quality tests were taken twice daily for a period which commenced two days prior to the cows entering the "test" paddock and continued until two days after the cows left the paddock. The components of milk production; fat corrected milk (FCM), butterfat (BF), solids not fat (SNF) and total solids (MTS) were determined using the methods described by

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The Australian Society of Dairy Technology (1966). Milk protein (MP) was determined using the amido black dye-binding technique (Foss 1967).

The samples of pasture eaten by the two cows with fistulae from each treatment were collected twice daily in collection bags similar to those described by Cook, Blake and Call (1963) and were bulked daily for analysis. Crude protein content (CP%DM) of the extrusa (EP) was determined using the Kjeldahl method with copper sulphate catalyst as described by AOAC (1960). The digestibility of the extrusa (ED) expressed as DOM%DM was determined by the in vitro technique of Tilley and Terry (1963).

Three analyses were conducted in which the treatment means were examined using a stepwise regression programme operating at a 5% level of significance utilizing the following model for each:

\[ Y = a + bX + cZ + dXZ + eX^2 + fZ^2 \]

In analysis (1), the dependent variables were the components of milk production (kg), and the independent variables were:

- D, days of grazing, coded 1 = day 1 ... 5 = day 5
- SR, stocking rate, coded 1 = LS, 2 = HS.

In analysis (2), the dependent variables were the components of milk production (kg), and the independent variables were:

- EP, extrusa protein (CP%DM)
- ED, extrusa digestibility (DOM%DM).

In analysis (3), the dependent variables were:

- EP, CP%DM
- ED, DOM%DM,

and the independent variables were:

- D, coded 1 = day 1 ... 5 = day 5
- SR, coded 1 = LS, 2 = HS.

In each analysis, the data used was the daily mean for each treatment. The data for the components of milk production was the daily mean of all cows in each treatment and the data for EP and ED was the daily mean of the two fistulated cows in each treatment. The effect of stage of lactation between each period was removed by controlled variables and a common regression was calculated for all periods. The equations presented are based on a lag period of 1.5 days between collection of extrusa and the related milk production as more of the variation in the results was accounted for with this period than any other time lag.

III. RESULTS

(a) Effect of stocking rate and days of grazing

The LS cows had access to about 40% more feed (73 to 62 kg DM/cow/day) than the HS cows (43 to 39 kg DM/cow/day). From the daily estimates of pasture present during the final two grazings it was found that there was little difference in the apparent consumption of pasture between the two treatments with 10 and 11 kg DM/cow/day of pasture being consumed by the LS and HS cows respectively. There was no significant difference (P > 0.05) in either ED or EP of the extrusa from the two groups of cows during any experimental period.

There were random but insignificant changes (P > 0.05) in ED with D, but there was a significant decline (P < 0.05) in the average ED for each grazing from 53.6 and 52.6 in January to 49.6 and 45.2% in April for the LS and HS cows respectively. There was no significant change in EP between January and April 1971 with an average of 14.6 and 14.8 CP%DM for the LS and HS cows respectively. A significant relationship (P < 0.05) was established between EP and D.

\[ EP = 17.97 - 1.08 (±0.16) D \quad (n = 40, r^2 = 0.60) \]

All components of milk production declined significantly (P < 0.05) with D. Stocking rate affected FCM and BF production with the HS cows producing 0.75 kg FCM/day less than their twin sisters. There was a significant interaction between
D and SR in BF production. BF declined faster with D for the HS treatment than for the LS treatment. MP, SNF and MTS were not significantly effected by stocking rate but declined with D. SNF and MTS declined at a greater rate than MP (Table 1(a)).

TABLE 1

Regression equations relating fat corrected milk (FCM), butterfat (BF), milk protein (MP), solids not fat (SNF) and total solids (MTS) to:
(a) stocking rate (SR) and days of grazing (D),
(b) extrusa protein (EP) and extrusa digestibility (ED).

<table>
<thead>
<tr>
<th>Trait (kg)</th>
<th>Constant</th>
<th>Regression coefficients for D</th>
<th>D X SR</th>
<th>% variation accounted for by equation *</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCM</td>
<td>13.56</td>
<td>-0.06 (0.010)**</td>
<td>-0.75 (0.282)</td>
<td>ns.†</td>
</tr>
<tr>
<td>BF</td>
<td>0.51</td>
<td>ns.</td>
<td>ns.</td>
<td>0.013 (0.002)</td>
</tr>
<tr>
<td>MP</td>
<td>0.43</td>
<td>-0.02 (0.004)</td>
<td>ns.</td>
<td>ns.</td>
</tr>
<tr>
<td>SNF</td>
<td>1.04</td>
<td>-0.06 (0.010)</td>
<td>ns.</td>
<td>ns.</td>
</tr>
<tr>
<td>MTS</td>
<td>1.55</td>
<td>-0.07 (0.020)</td>
<td>ns.</td>
<td>ns.</td>
</tr>
</tbody>
</table>

(b) EP            | ED     | EP X ED   |
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>FCM</td>
<td>4.36</td>
<td>0.03 (0.075)</td>
</tr>
<tr>
<td>BF</td>
<td>0.23</td>
<td>0.01 (0.004)</td>
</tr>
<tr>
<td>MP</td>
<td>0.18</td>
<td>ns.</td>
</tr>
<tr>
<td>SNF</td>
<td>1.37</td>
<td>ns.</td>
</tr>
<tr>
<td>MTS</td>
<td>0.69</td>
<td>ns.</td>
</tr>
</tbody>
</table>

* % variation accounted for by equation = 100 x², n = 40.
** Figure in brackets are ± standard error.
† ns. = not statistically significant, P > 0.05.

(b) Effect of herbage quality on milk production

All components of milk production for both LS and HS treatments were affected by either EP only or by the interaction of EP with ED. FCM and BF declined significantly (P < 0.05) with EP while changes in MP, SNF and MTS were the result of the interaction EP X ED (Table 1(b)).

IV. DISCUSSION

The experiment has illustrated a number of main effects and interactions that are associated with the components of milk production of cows grazed rotationally at different stocking rates.

It could have been expected that, at the beginning of each 5 day grazing cycle, there would be sufficient pasture present to allow ad libitum intake of feed for each animal; and that towards the end of each grazing cycle differences in grazing pressure might either limit pasture intake or affect the digestibility or protein content of the ingested herbage differently for the two groups of cows. However, from the results obtained, it is clear that the variation in both EP and ED was not associated with variation in SR, and that EP, but not ED, declined with D. In addition, the limited evidence on pasture consumed does not suggest that there were major differences in pasture intake per se between SR and D. It would seem therefore from the data, that the decline in all components of milk production was associated with a decline in the protein content of the ingested herbage which was controlled by days of grazing. Cordon and Forbes (1970) and Paquay et al. (1973) found that intake of dietary N effected the daily milk yield of stall fed cattle.
when the intake of energy was at an acceptable level. Unfortunately, the intake of dietary energy was not measured but it could be reasonably assumed that this factor was not limiting since the digestibility of the feed did not change over the period of the grazing and there was a considerable amount of pasture still present in the paddock at the end of each grazing.

Although selection for any particular pasture species was not measured, the results for digestibility and protein content of the diets selected by the cows indicate a particular pattern of grazing behaviour for rotationally grazed dairy cattle regardless of stocking rate and amount of pasture present. Direct evidence of the decline in pasture protein from the top to bottom layers of the pasture and virtually no change in in vitro digestibility from the top to bottom layers is available from a plot experiment conducted on the same pasture and at the same time of the year (Clark et al., unpublished data). When this evidence is considered together with the results obtained from this experiment, there is little doubt that the cows grazed in a stratified manner regardless of grazing pressure and the pasture species available. This is in agreement with the observations of Hennessy and Ahern (1967), that cattle grazed rotationally on irrigated pastures tend to select from the top layers of pasture first.

The results of this experiment suggest that the plant breeder, when considering pastures for dairying, should idealistically place more emphasis on distributing the plant protein over the entire plant to prevent the decline in milk production that is apparently associated with a decline in pasture protein from the top to bottom layers of the pasture. In the mean time some consideration should be given to modification of current rotational grazing practices. More efficient use of pastures may be attained if animals of higher protein requirements, such as lactating cows, were allowed to graze the upper portion of the pasture, followed by animals with lower protein requirements, such as dry, fattening or replacement stock to complete the grazing. Much more research is required to define the nutritional factors affecting the components of milk production, particularly for grazing animals, now that subsidies for butter and cheese have been removed and that it is proposed in the near future to pay the farmer on a protein basis as well as butterfat.

V. ACKNOWLEDGMENTS

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VI. REFERENCES