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UTILIZATION OF GRAIN SUPPLEMENTS BY ROUGHAGE-FED CATTLE

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Summary

Sixty-four steers in groups of eight were fed various combinations of sorghum grain and either hammermilled good quality oaten hay or hammermilled wheaten straw plus minerals and urea. In each case at least one dietary component was offered ad lib. Growth rates and feed intakes were measured and the conversion efficiency of grain to liveweight was estimated.

The substitution of grain for roughage ranged from 14.9% to 89.5% depending on roughage quality and grain intake, and grain utilization compared favourably with published lot-feeding results.

I. INTRODUCTION

In grazing systems the output of the individual animal and the output of animal product per hectare are the most important parameters of productivity. Since these parameters interact, they should always be considered concurrently in attempting to estimate physical and economic efficiency of a system.

Grain supplements affect both the performance of the grazing animal and its pasture consumption. The magnitude of these effects is likely to be influenced by the quantity of grain fed (Tayler and Wilkinson 1972) and the pasture quality. Changes in pasture intake, which are reflected in changes in carrying capacity, are very difficult to measure, but this information is essential to realistic estimates of the value of supplementary concentrates.

The experiment reported here was conducted to provide information on the effects of roughage quality and of supplemental grain intake on roughage intake and on utilization of the grain by steers.

II. MATERIALS AND METHODS

(a) Animals

The test animals were Hereford steers approximately 15 months of age and mean (±SD) initial live weight (LW) 160.4 ± 16.8 kg. All animals were treated with a broad spectrum anthelmintic ‡; dosed with a cobalt bullet, and given 0.5×10^6 I.U. vitamin A parenterally. They were confined in dirt yards, each 112 m^2 in area and having 6 m of trough space available for roughage feeding, and 6 m for grain feeding.

(b) Design and Treatments

Eight groups each of 8 steers were randomly selected after stratification on the basis of live weight and assigned to the following treatments.

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1. oaten hay ad lib.
2. oaten hay ad lib. + grain restricted (½ intake treatment 3)
3. oaten hay ad lib. + grain ad lib.
4. oaten hay restricted (½ intake treatment 3) + grain ad lib.
5. wheaten straw ad lib.
6. wheaten straw ad lib. + grain restricted (½ intake treatment 7)
7. wheaten straw ad lib. + grain ad lib.
8. wheaten straw restricted (½ intake treatment 7) + grain ad lib.

The roughages and the grain were hammer-milled and were fed separately. The very poor quality of the wheaten straw necessitated the addition at feeding of 4% urea, 0.7% $CaCl_2$, and 1% Biofos* in solution. The grain contained 1% added limestone and 1% NaCl. Steers were introduced to their diets during a preliminary period of 2 weeks, and experimental data were collected during the following 7 weeks.

(c) Measurements

Full LW were recorded weekly for individual animals.

Dry matter intakes (DMI) of roughage and grain were measured weekly. Roughage samples were taken daily for DM determination, and bulked fortnightly for nitrogen analyses. Grain samples were taken weekly and bulked for DM determination and nitrogen analyses.

Chemical analyses were done essentially by the methods of the A.O.A.C. (1965).

(d) Statistical Analysis

For the analyses of growth rates (GR) the linear component (b) was determined for each animal from the regression of weekly full weights, and these were analysed as a 2 x 4 x 8 factorial design by a standard analysis of variance. The relationship between mean grain DMI per unit of roughage DMI and mean LW gain per unit of roughage DMI was used to calculate the efficiency of utilization of supplemental grain. The reciprocal of the slope of the regression line is the conversion ratio (CR) of grain DM to LW gain.

Feed intake data could not be examined statistically since the steers were fed in groups without replication.

III. RESULTS

The mean ± SD crude protein content (DM basis) of the oaten hay was 14.9 ± 0.8% and of the wheaten straw was 3.5 ± 1.3%. The Ca and P contents of the wheaten straw were 0.14% and 0.06% respectively. The crude protein content of the bulked grain sample was 14.6%.

Mean GR, feed intakes, substitution effects and grain CR are presented in table 1.

Mean GR (± SE 0.041 kg/d) was significantly affected ($P < 0.01$) by roughage type (oaten hay 0.99 kg/d, wheaten straw 0.64 kg/d) and by grain intake. In neither roughage type was the growth rate difference between the highest two levels of grain intake significant ($P < 0.05$).

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TABLE 1

Effect of grain DMI and roughage quality on roughage DMI, GR, and grain CR in steers.

Treatment		Mean roughage DMI (kg/head/d)	Mean grain DMI (kg/head/d)	Mean GR (*b* value kg/d)	Mean grain CR (kg DM/kg LW)	% substitution
	1	6.45		0.78		
oaten	2	5.27	1.62	0.88		72.8
hay	3	4.22	2.82	1.06	4.9	79.1
	4	2.08	4.88	1.23		89.5
	5	2.49		-0.01		
wheaten	6	2.14	2.35	0.55		14.9
straw	7	0.57	5.42	1.00	5.6	35.4
	8	0.30	5.66	1.01		38.7

The grain substitution effect ranged from 14.9% to 89.5%, depending on roughage quality (and hence roughage intake) and grain intake. Roughage intakes were restricted in treatments 4 and 8 so the substitution values for these treatments are not strictly comparable with those for treatments 2,3, 6, and 7. However, the values have been included in table 1 as they are analogous to the situation which can arise when pastures are heavily stocked.

The regression equations derived for the calculation of grain CR were

(a) oaten hay $y = .203x + .114$

(b) wheaten straw $y = .177x + .039$

where x = kg grain DMI/kg roughage DMI, y = kg LW gain/kg roughage DMI

Correlation coefficient and goodness of fit were significant ($P < .01$) in both cases.

IV. DISCUSSION

This experiment shows that the substitution effect, which is defined as the decrease in roughage DMI per unit of grain consumed, is of appreciable magnitude for both a good quality and a poor quality roughage. It was largest when roughage quality was good and tended to increase with increasing grain intake. This tendency is also evident in the data of Mott *et al*. (1968), although not in the data of Tayler and Wilkinson (1972), and implies that the incremental substitution effect is also increasing. This suggests that the relationship between grain intake and roughage intake is curvilinear rather than rectilinear as suggested by Tayler and Wilkinson (1972). However, when roughage quality is high (and substitution effects are large) the radius of curvature of the relationship will be large.

Although statistical evaluation is not possible from this experiment, it is apparent that roughage quality has a large influence on the magnitude of the substitution effect. This probably results from the effect of roughage quality on roughage DMI. Cattle consuming very high quality roughages approach their maximum capacity to ingest DM; consequently substitution effects will be large. Conversely, when DMI is restricted by the inadequacy of roughage quality smaller substitution effects could be expected. Without information on the magnitude of changes in roughage DMI it is impossible to realistically evaluate supplementary grain in a grazing system. The "put and take" method (Mott *et al*. 1968) obtains this information by equalizing the severity of herbage removal (i.e. grazing pressure) between systems being compared. Changes in intake per animal are therefore counterbalanced by changes in animal numbers, and quantitative responses to supplements are measured on an area basis.

The method used in this paper to calculate grain CR is analogous to the "put and take" analysis in that CR is measured on the basis of equal total consumption of roughage in all treatments. The ratios presented therefore measure the efficiency of utilization of grain within the particular roughage/grain systems not within the individual animals. They assume that roughage "substituted for" is consumed later or by additional animals. On biological grounds a curvilinear relationship between grain DMI per kg roughage DMI and LW gain per kg roughage DMI would be expected but with the limited data available the linear models presented had better predictive capacity. This suggests that the efficiency of utilization of grain is not very sensitive to the level of grain intake. Further support for this suggestion is found in the results of Mott et al. (1968).

Growth rate was used as the sole index of animal performance, but the proportion ofliveweight gain which is attributable to carcase gain increases as the proportion of grain in the diet increases (Tayler and Wilkinson 1972). It is therefore probable that in terms of animal product the calculated ratios slightly underestimate the value of the supplemental grain. However, the ratios obtained were comparable with those commonly reported for lot-fed cattle (Preston and Willis 1970, p 315). It is noteworthy that the influence of roughage quality on grain conversion ratio did not appear to be as great as its effect on substitution.

Failure to take account of substitution effects may result in a misleading assessment of the potential value of supplementary grain to roughage-fed cattle particularly when roughage quality is good (Hodgson and Tayler 1972). In this experiment grain CR calculated only on the basis of animal growth responses and grain intake data were 16.2, 10.1, 10.8, 4.2, 5.4 and 5.5. for treatments 2,3,4,6,7, and 8 respectively. These compare with mean values of 4.9 and 5.6 for oaten hay and wheaten straw respectively when substitution effects were included in the calculation. In situations where roughage is effectively unlimited substitution effects may be of academic interest only, since saved roughage probably will not be utilized. However, in more intensive grazing systems, where roughage quality is generally better (and substitution effects are larger) the increased carrying capacity possible when using supplementary grain is likely to be exploited.

The relative insensitivity of grain CR to changes in roughage quality and intake suggests that the data will be indicative of the grazing situation. It seems probable therefore that grain supplements can be a valuable aid to pasture management by regulating grazing pressure, to animal production by efficient grain utilization, and to controlling animal performance.

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