

A note on the effects of feeding total mixed ration on performance of dairy goats in late lactation

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ABSTRACT

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Feeding dairy goats (Israeli Saanen) in late lactation (last trimester) a total mixed ration (TMR), or a combination of TMR and separate concentrates and hay, or a separate feeding of concentrates and a high-quality hay was compared. Diet selectivity was appreciable with goats fed concentrates and hay separately, whereas there was no selectivity with TMR. Daily milk yield, milk fat, protein production and feed conversion ratio (kg feed kg^{-1} milk) in goats fed TMR was equal to or better than those recorded in the control and the combined regime. It was concluded that, in terms of diet utilization, the TMR feeding system was superior to feeding the different components separately.

INTRODUCTION

The common practice for feeding goats in Israel is to give fixed amounts of concentrates and free access to high-quality hay (usually alfalfa). This results in approximately a 60% concentrates–40% forage ration. As the quality of the ration is high, it is considered adequate compared with nutritional standards (Haenlein, 1978). However, compared with common dairy cattle rations, it is more expensive in spite of containing a similar ratio of concentrates to forage. Dairy cattle feeding in Israel is based almost exclusively on feeding the animal with a total mixed ration (TMR). In addition to the nutritional advantages of feeding TMR (Holter et al., 1977; Phipps et al., 1984; Nocek et al., 1986), it is flexible and allows the use of agricultural by-products (e.g. cotton seeds and citrus pulp) with silage and hay. Goats are frequently very

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choosy about the parts of the feedstuffs they eat and particularly about forages (Huston, 1978; Morand-Fehr, 1981). Therefore goat breeders are reluctant to use a TMR.

The purpose of this study was to examine the feeding to dairy goats of a TMR, and to compare it with the common feeding practice and with a further version of 60% TMR–40% hay and concentrates.

MATERIALS AND METHODS

Twelve Saanen goats were used in this study. Two goats in their first and two in their second lactation, 6 months post partum, were allocated to each of three groups (T, PT and C) on the additional basis of milk yield.

For 1 month before the experiment, the goats were group fed a fixed amount of concentrates and separately high-quality hay *ad libitum* (Table 1). The goats were machine-milked twice a day at 09:00–10:00 h and 17:00–18:00 h. Goats were weighed once a week. Daily ration allotment and chemical composition are given in Table 1.

Diets were introduced over a 2 week period followed by 4 week data collection; groups T and C received half of the ration after each milking, and group PT received TMR after the morning milking and hay plus concentrates in the

TABLE 1

Daily ration components (% of DM offered) and chemical composition (% of DM)

Allotment	Group T 100% TMR	Group PT		Group C No TMR
		60% TMR	40% TMR	
Wet silage ¹	27	13	–	–
Concentrates ²	38	24	22	61
Midbloom vetch hay ³	12	9	17	39
Whole cotton seeds ⁴	23	15	–	–
Composition (%)				
DM (%)	78.89	81.65	–	88.82
CP	16.39	16.31	–	16.18
Crude fiber	19.47	18.15	–	15.60
Crude fat	8.87	6.90	–	3.66
Crude ash	6.28	7.08	–	8.19
Calcium	0.88	0.86	–	1.16
Phosphorus	0.42	0.43	–	0.45
Concentrates:roughage ratio	61:39	61:39	–	61:39

¹CP 10.7%, crude fiber 24.5%, ash 6.0%.

²CP 17.4%, crude fiber 6.55%, ash 6.3%, fat 5.2%, NaCl and vitamin + trace element concentrate 1%.

³CP 14.3%, crude fiber 30.1%, ash 11.1%.

⁴CP 22.3%, crude fiber 28.5%, ash 3.8%.

afternoon. During the experiment, each component was offered at about 20% above the reference *ad libitum* consumption.

The TMR was freshly prepared each day. The hay was chopped into pieces of approximately 2 cm length, before being mixed with the other components for 20 min in a horizontal mixer (Davis Sons Meg. Co.). Samples of feeds offered and refused were taken daily and frozen for further analysis. Feed samples were composited, sampled, dried and ground to 1 mm size for cell wall (CW) analysis (Goering and Van Soest, 1970). Ration components were analyzed for dry matter (DM), ash, crude protein (CP), crude fat, crude fiber, phosphorus and calcium (Association of Official Analytical Chemists, 1975) and the results are presented in Table 1.

Individual milk yield of each milking was measured daily. Milk samples of morning and afternoon milkings were taken once a week for analysis of fat, protein and total solids. The samples were kept at 4°C for no longer than 24 h before analysis. Fat content was measured according to the Gerber method, protein by Kjeldahl analysis, and total solids were determined by drying milk samples at 100°C for 4 h.

The results are presented as mean values $\pm$ SD. The paired *t*-test was applied to compare between pre-experimental and experimental variables. Differences between treatments were assessed by analysis of co-variance on production variables using pre-experimental yields as the co-variant.

RESULTS

There was no difference in DM consumption between the three groups (Table 2). However, ration selectivity was indicated by higher CW content in refusals of groups PT and C compared with group T (Table 2).

In group C, daily milk yield in all four goats decreased during the experiment compared with that of the pre-experimental period (data not shown),

TABLE 2

Group DM intake and cell wall contents in rations and refusals of goats fed different diets

Group ¹	T	PT	C
DM offered (kg)	10.9	10.3	10.4
Refusals ² (kg)	2.7 $\pm$ 0.4	2.3 $\pm$ 0.6	1.6 $\pm$ 0.4
Intake ² (kg)	8.2 $\pm$ 0.3	8.0 $\pm$ 0.4	8.8 $\pm$ 0.3
Cell wall (% of DM offered)	41.5	38.4	33.7
Cell wall (% of DM refused)	40.1	58.4	54.4

¹Group T, 100% TMR; PT, 60% TMR; C, 0% TMR.

²Average and SD of 7 days measurement in each group.

TABLE 3

Mean production (kg) of milk, fat, protein and milk total solids, of goats before the experiment and when fed different diets ($\bar{x} \pm \text{SD}$)

Group ¹		Pre-experiment	Experimental
T	Milk yield	2.610 $\pm$ 0.480	2.570 ^a $\pm$ 0.130
	Milk fat	0.073 $\pm$ 0.008	0.077 ^a $\pm$ 0.008
	Milk protein	0.082 $\pm$ 0.009	0.080 $\pm$ 0.005
	Milk solids	0.290 $\pm$ 0.009	0.288 ^a $\pm$ 0.017
PT	Milk yield	2.540 $\pm$ 0.610	2.260 ^b $\pm$ 0.250
	Milk fat	0.069 $\pm$ 0.009	0.068 ^b $\pm$ 0.008
	Milk protein	0.085 $\pm$ 0.008	0.078 $\pm$ 0.009
	Milk solids	0.287* $\pm$ 0.070	0.256 ^b $\pm$ 0.070
C	Milk yield	2.680* $\pm$ 0.370	2.32 ^b $\pm$ 0.260
	Milk fat	0.070 $\pm$ 0.009	0.069 ^b $\pm$ 0.009
	Milk protein	0.084 $\pm$ 0.008	0.077 $\pm$ 0.007
	Milk solids	0.297* $\pm$ 0.040	0.255 ^b $\pm$ 0.050

¹Group T, 100% TMR; PT, 60% TMR; C, 0% TMR.

*Significant differences within rows ($P < 0.05$).

^{a,b}Significant differences within columns ($P < 0.05$).

TABLE 4

FCM (4%)¹ production before and during the experiment and feed conversion factor² ratio of goats fed different diets

Group ³	FCM before the experiment	FCM during the experiment	Feed conversion during the experiment
T	2.15 $\pm$ 0.31	2.19 ^a $\pm$ 0.17	0.94
PT	2.36 $\pm$ 0.48	1.93 ^b $\pm$ 0.22	1.12
C	2.13 $\pm$ 0.23	1.96* $\pm$ 0.27	1.04

¹FCM (4%) = $0.4M + 15F$, where M is daily milk yield (kg) and F is daily fat yield (kg), calculated from data in Table 3.

²Feed conversion on a group basis, i.e. mean group DM intake per mean group milk yield.

³T, 100% TMR; PT, 60% TMR; C, 0% TMR.

*Significant difference ($P < 0.05$) within rows.

^{a,b}Significant difference ($P < 0.05$) within columns.

resulting in a significant reduction (from 2.68 to 2.32 kg day⁻¹, $P < 0.05$) in total group yield (Table 3). In group PT, milk yield dropped from 2.54 to 2.26 kg day⁻¹ (NS), whereas in group C no such drop was recorded. Daily milk fat and protein production in all three groups was maintained during the experimental period (Table 3).

During the experiment, total daily milk yield, fat and solids production were significantly higher ($P < 0.05$) in goats of group T than in groups PT and C

(Table 3). The changes described between groups for milk yield were also reflected in 4% fat correct milk (FCM) yield (Table 4). Feed conversion efficiency during the experimental period was similar in groups C and T, and in both was better than in group PT (Table 4). The general trend in body weight changes in all groups was a slight increase (10 out of 12 goats) during the experimental period.

DISCUSSION

High selectivity, as evidenced by the differences in CW between feed offered and refused, was demonstrated by goats fed a ration of unmixed diet components (groups PT and C, Table 2), but not by goats fed TMR (group T). The latter also consumed the same amounts of DM as the other two groups, which can be explained by the fact that goats are capable of maintaining high intakes even when consuming large amounts of forage (Morand-Fehr, 1981). We observed that refusals of goats in group PT contained a high proportion of the TMR portion, apparently because the goats expected their preferred feed (concentrates and hay) in the afternoon. Therefore we may conclude that the approach of feeding a combination (group PT) of the traditional (group C) and TMR (group T) systems is inferior to both separately.

Milk production was expected to decline, as was indeed found in groups PT and C (Table 3). Feeding TMR not only did not adversely affect milk production, protein and fat secretion compared with controls, but even slightly improved it (Table 3). Group PT, and to a lesser extent, group C, which selectively preferred the more concentrated components of the diet, and whose consumption was therefore more energetically dense, did not perform better than group T. In fact, the best feed conversion ratio was calculated for group T. It seems that diet utilization was not hampered by the TMR, which is in accordance with the view that goats are efficient in digesting fiber (Morand-Fehr, 1981). Increases in the proportion of roughage in the diet will increase the proportion of acetic acid in the rumen, and hence the higher fat content and total solids yield in group T. Generally, the feed conversions in this work are similar to those cited in other studies (Bhattacharya, 1980; Morand-Fehr and Sauvant, 1980; Maltz et al., 1982).

Results obtained in dairy cattle (Holter et al., 1977; Phipps et al., 1984; Nocek et al., 1986) showed that feeding TMR is superior to feeding different components separately in terms of diet utilization. From our results it seems that this system may be regarded as an alternative to the common practice for feeding dairy goats as well.

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