THE EFFECT OF FEEDING FRESH FORAGE AND 3 ROUGHAGE-MIXED RATIONS ON DAIRY COW PERFORMANCES IN EARLY LACTATION DURING RAINY SEASON.

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Abstract

An experiment was conducted during the rainy season to compare 1 fresh forage and 3 Roughage-Mixed Rations using 32 Holstein Friesian Cross Dairy Cows in early of their first or second lactation (8 cows in each treatment). All cows were fed 7 kg concentrate twice daily after each milking. Fresh forage or roughage-mixed which were carefully formulated to be equal in energy and crude protein contents were also fed twice daily according to treatments. Measurements were made of milk yield and milk composition. Feed intake and liveweight were also recorded. Cows receiving fresh forage produced significantly higher 4% fat corrected milk and fat yield ($p<0.05$). For other performances, there were no statistically significant differences between treatments. The cows on fresh forage rations also gave higher marginal returns than other cows. It is concluded that when fresh forages are in short supply the roughage-mixed can be used as good as fresh forage.

Keywords: roughage-mixed, bagasse, metabolisable energy, rumen degradable protein.

Introduction

Feeding dairy cattle in Thailand relies heavily on expensive meal concentrate when pastures are in short supply. In addition, the cost of former roughage used during the dry season such as rice straw has drastically increased in recent year. However, agricultural by-products such as bagasse has enough potential to use as animal feed (Preston and Leng, 1987). Although bagasse and other agricultural by-products are low in protein and digestibility and thus their nutritive values, the use of such by-products together with other sources of protein and energy in the form of roughage-mixed should provide considerable quality roughage for dairy cattle during the dry season.

Supplementation of bagasse-based diet with small amount of rice polishing has been reported to increase liveweight gain of beef cattle up to 600 g/day (Preston, 1987). Calves lost weight on a diet of bagasse supplemented with only urea and minerals. Significant improvements in growth were brought about when fish meal and/or maize grain were added to the diet (Naidoo *et al.*, 1977).

A few researches have been conducted on dairy cows fed bagasse-based diet. The previous experiment (Suksombat, 1997) determined the effect of 4 different roughage mixtures on dairy cow performances in late lactation. The result showed that cows on all

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roughage-mixed rations gave reasonable milk production (i.e. 8.3 to 9.3 kg/cow daily) and one roughage-mixed ration, containing 25% bagasse and 15% rice straw, produced slightly higher milk yield than other roughage-mixed rations containing varied ratios of bagasse and rice straw. However, the previous 4 different roughage-mixed rations did not compare with the conventional roughage used in dairy farms during rainy season i.e. the fresh forage such as grasses and other forage crops. The conclusion, therefore, could not be clearly made.

The present study aimed to determine the influence of fresh forage and 3 different roughage-mixed rations on dairy cow performances in early lactation during rainy season. The marginal financial returns were also evaluated.

Materials and Methods

Thirty-two Holstein-Friesian (75.0-87.5%) crossbred dairy cows averaging 14.2±0.4 kg milk yield, 394±6 kg body weight, 39±2 months old and 43±4 days in milk were allowed to adjust to the treatment for 2 weeks prior to the 8-week experiment. All cows were raised with the main herd during the pre-experimental period and were fed concentrate at a rate of 1 kg per 2 kg of milk yield together with fresh forage *ad libitum*. Milk yields were recorded on 4 consecutive days to select the balanced groups of experimental cows. Samples of milk were taken on 2 consecutive days for initial composition analyses. The cows were then assigned to 8 blocks based on milk production, days in milk, age and body weight. Within each block the cows were assigned at random to one of four dietary treatments. Treatments comprised one fresh forage (FF) and three roughage mixtures (RMs). The RMs were mixed from the same raw materials but they varied in the ratios of bagasse and rice straw (Table 1). Cows within each treatment were housed and fed as a group. Diets were fed at 0700 and 1600 each day for 8 weeks of the experimental period. The same commercial concentrate containing 16% crude protein was fed to all cows (7 kg/cow daily). The fresh forage or RMs were fed *ad libitum* after the meal concentrate was eaten. Dry matter intake was measured on 2 consecutive days per week throughout the entire experimental period. When measurement was made on dry matter intake, feed offered and left uneaten were sampled twice weekly and then pooled and

Table 1 : Composition of Roughage-Mixed. (kg as fed)

	RM1	RM2	RM3
Rice straw	25	15	5
Bagasse	35	45	55
Others[1/]	40	40	40
Calculated Composition[2/]			
% ADF	35.0	39.1	40.5
% NDF	62.6	64.0	61.9
Cost (Baht)	2.10	2.06	2.02
Estimated *dg* of N	0.67	0.66	0.65

[1/] composed of 16% cassava chip, 9% cotton seed meal, 6% ground leucaena leave, 8% molasses and 1% urea.

[2/] roughage mixtures were balanced for energy and protein contents (10.0% CP, 57.0% TDN or 9.0 MJME) subsampled for chemical analyses [DM, Ash, N (K jeldahl); CF, ADF, NDF (Fibretec; Goering and Van Soest, 1970); *in vitro* DMD, OMD, DOMD (Tilley and Terry, 1963)]. The N degradability of concentrate, fresh forage and RMs were determined by *in sacco* method (Orskov and Mehrez, 1977; Lindberg, 1985). Cows were milked at 0530 and 1500. Milk sample was taken from individual cow on 2 consecutive days weekly throughout the entire experimental period and analysed for fat, protein, lactose and total solid. Unfasted liveweight was individually recorded on 2 consecutive days at the beginning of the 2 week adjustment period, and at the start and end of the experimental period.

Milk yield and composition data were analysed using multivariate analysis of covariance (initial data were used as a covariate), with repeated time measurements (Gill and Hafs, 1971; Morrison, 1976; Bryant and Gillings, 1985). Body weight data were analysed with analysis of covariance. Body weight change and nutrient data were analysed with analysis of variance (Steel and Torrie, 1986) .

Table 2 : Chemical analyses of concentrate and Roughage-Mixed.

	% (DM Basis)										MJ/kgDM
	DM	**CP**	**CF**	**ADF**	**NDF**	**ASH**	**FAT**	**DMD**	**OMD**	**DOMD**	**ME**[1/]
Concentrate	90.7	17.7	15.8	18.4	44.9	8.4	4.52	77.3	80.1	72.5	11.6
Fresh forage	27.0	8.4	32.7	33.2	65.1	7.4	1.35	60.2	62.2	56.3	9.0
RM1	86.3	9.8	32.4	33.6	60.7	7.5	0.27	60.8	62.3	56.9	9.1
RM2	86.2	7.3	35.7	35.0	61.8	6.0	0.31	60.8	62.3	56.9	9.1
RM3	86.3	7.8	36.9	38.4	66.9	7.4	0.30	61.5	63.5	57.5	9.2

[1/] ME (MJ/kgDM = 0.16DOMD (ARC., 1984)

Results and Discussion

As shown in Table 2, the chemical analyses showed that crude protein contents of roughage mixtures were slightly lower than calculated values particularly in RM2 and RM3 rations. The lower analysed CP can be attributed to the probable improper mixing technique. When mixing was made, the distribution of urea-molasses liquid may not be thoroughly blended into the roughage mixed. When samples were taken and then analysed, they were therefore low in CP concentration. Fresh forage contained higher fat content than RMs.

Table 3 showed intakes of dry matter (DM), crude protein (CP) and metabolisable energy (ME) by cows. The consumptions of roughage and total DM and ME were similar ($p>0.05$) in all treatments. Cows on RM1 ration had highest roughage and total CP consumption, followed by cows on FF and RM3 rations being similar and cows on RM2 ration had least roughage and total CP intake. However, the cows on RM2 ration consumed slightly lower roughage and total DM than the other cows.

The slightly lower DM intake of RM2 cows can be attributed to the lower intake of CP and thus RDP (Rumen Degradable Protein). (See Table 3 and Table 5.) A reduction in the supply of RDP in the rations has been reported to reduce fibre digestion particularly in the very low RDP supply from the basal diet and hence DM intake (Hannah *et al.,* 1991). Another reason for reduced DM intake in the RM2 cows was probably that the RM2 cows consumed less UDP (Undegradable Protein) than the others (Table 5). An increase in the UDP supply could improve amino acid supply, or amino acid balance in the animal, which had the effects on the intake control mechanisms as found for sheep (Egan and Moir, 1965).

As presented in Table 4, cows on FF ration produced significantly higher 4%FCM and fat yield than cows on the other rations. This reflected the slightly higher milk fat content of the FF cows. For other parameters measured,

Table 3 : Mean values for matter (DM), crude protein (CP), fat and metabolisable energy (ME) eaten by cows.

	FF	RM1	RM2	RM3	SEM	Sig.
DM intake (kg/day)						
Concentrate	6.4	6.5	6.5	6.5	0.07	NS
Roughage	7.5	7.7	7.1	7.6	0.35	NS
Total	13.9	14.2	13.6	14.1	0.34	NS
CP intake (g/day)						
Concentrate	1133	1155	1151	1151	-	-
Roughage	630[b]	755[a]	518[c]	593[b]	67	***
Total	1763[b]	1906[a]	1669[c]	1744[b]	69	***
Fat intake (g/day)						
Concentrate	289	294	294	294	-	-
Roughage	101[a]	21[b]	22[b]	23[b]	12	*
Total	390[a]	315[b]	316[b]	317[b]	14	*
ME intake (MJ/day)						
Concentrate	74	75	75	75	-	-
Roughage	68	70	65	70	6.5	NS
Total	142	145	140	145	6.6	NS
MJME/kgDM ration	10.2	10.2	10.3	10.3	0.1	NS

there were no significant differences between group of cows. Final liveweight and liveweight gain for all groups were similar.

The slightly higher milk fat content of the FF cows can be attributable to the higher fat intake (390 vs 316 g fat/day; Table 3). Since the fresh forage contained higher fat content than RMs (1.35 vs 0.3%; Table 2), the FF cows certainly consumed higher fat . The precursors for milk fat synthesis were derived directly from the dietary fat and from body fat reserves in the adipose tissue (Holmes and Wilson, 1984). In this case all cows gained weight therefore the major precursors for fat synthesis would probably have been singly derived from dietary fat.

Using the respective protein degradability of concentrate of 0.70, fresh forgae 0.65 and of RMs as shown in Table 1 (determined by nylon bag technique), the estimated supplies of rumen degradable protein (RDP) and undegradable protein (UDP) to the cows were calculated (Table 5). The resulting RDP/ME ratios in the rations consumed are also presented in this Table. The cows on RM1 ration ate more RDP and UDP ($p<0.001$) than those cows on FF, RM2 and RM3 rations. This clearly explained the effect of RDP and UDP supply on the tendency of higher DM intake of the RM1 cows. The supply of RDP relative to ME (RDP/MJME) for the RM1 cows was also higher than the other cows ($p<0.001$) and all groups had higher RDP/MJME than that suggested by ARC (1980) being 8.1 gRDP/MJME.

By combining the data for milk yield and liveweight gain (as MJ net energy), it was possible to compare the influence of different roughages on the apparent utilisation of ME intake (Table 6). All cows consumed similar ME and the partitioning of energy between milk production and liveweight gain was also similar. The "apparent" efficiencies of energy retention (milk plus liveweight gain) relative to ME available above maintenance were similar in all rations.

All groups of cows had considerable supply of ME, but the milk yields were much lower than would have been predicted from ME

Table 4 : Mean performance values of experimental cows

	FF	RM1	RM2	RM3	SE_{lsm}	Sig.
Milk yield (kg/day)	13.2	12.2	12.5	11.5	0.45	NS
4% Fat Corrected Milk (kg/day)	14.4[a]	12.6[b]	12.4[b]	11.9[b]	0.52	*
Fat yield (g/day)	595[a]	511[b]	507[b]	495[b]	24	*
Protein yield (g/day)	366	345	356	342	14	NS
Lactose yield (g/day)	552	500	512	510	33	NS
SNF yield (g/day)	995	968	981	935	47	NS
Total solid yield (g/day)	1603	1489	1475	1423	60	NS
% Fat	4.44	4.27	4.12	4.29	0.16	NS
% protein	2.80	2.86	2.85	2.89	0.04	NS
% Lactose	4.06	4.23	4.13	4.33	0.16	NS
% SNF	7.57	7.94	7.80	8.03	0.17	NS
% Total Solid	12.15	12.31	11.81	12.20	0.22	NS
Final Liveweight (kg)	396	395	400	408	4.0	NS
Liveweight Gain (g/day)	53	30	133	260	113	NS

Data shown were LS Means

Table 5 : The estimated supply of rumen degradable protein (RDP, g/cow daily), undegradable protein (UDP, g/cow daily and the ratio of RDP/total metabolisable energy intake (g/MJ) in the total ration consumed.

Details	FF	RM1	RM2	RM3	SEM	Sig.
RDP supply[1/]						
Concentrate	793	806	806	806	18.4	NS
Roughage	391[b]	506[a]	342[b]	385[bc]	43.8	***
Total	1203[b]	1312[a]	1148[b]	1191[b]	45.5	***
UDP supply[1/]						
Concentrate	340	345	345	345	-	-
Roughage	220[b]	249[b]	176[c]	208[b]	23.0	***
Total	560[b]	594[a]	521[c]	553[b]	23.5	***
Total ME intake (MJ/day)	142	145	140	145	6.6	NS
RDP/ME (g/MJ)	8.7[b]	9.4[b]	8.6[b]	8.6[b]	0.24	***

[1/] protein degradability of concentrate was 0.70, of RMs as shwon in Table 1 and of fresh forage was 0.65

intakes. The respective intakes of 142, 145, 140 and 145 MJME daily by the FF, RM1, RM2, and RM3 cows, in theory, should have been able to produce approximately 17.4, 18.0, 17.0 and 16.6 kg milk [ME intake - (ME for maintenance + ME for liveweight gain)].

The low calculated 'apparent' efficiency of ME utilisation above maintenance (Table 6) reflected the overestimate of ME intake. It should be realised that an error in estimated ME intake

Table 6 : Estimates of the partitioning of ME intake (MJ/day)

	FF	RM1	RM2	RM3	SEM	Sig.
Total ME intake	142	145	140	145	3.1	NS
ME_m [1/]	53	53	52	54	2.7	NS
NE_l [2/]	44	39	40	37	5.0	NS
NE_g [3/]	1	1	2	5	2.6	NS
NE Retention [4/]	45	40	42	42	2.9	NS
MEI-ME_m	89	92	88	91	2.9	NS
Efficency [5/]	0.51	0.44	0.48	0.46	0.04	NS

[1/] $ME_m = 0.60LW^{0.75}$ (ARC,1980)
[2/] Tyrrell and Reid (1965)
[3/] 19 MJ/kg Gain and 16 MJ/kg Loss (AFRC, 1992)
[4/] = [2/]+[3/]
[5/] = NE Retention/(MEI-ME_m)

Table 7 : The estimated supply of RDP (g/cow daily) and UDP (g/cow daily) to the tissues of the dairy cows (Calculation based on ARC, 1980 and 1984)

Details	FF	RM1	RM2	RM3
RDP requirement [1/]	1108	1131	1092	1131
RDP supply	1203	1312	1148	1191
Deficit/surplus	+95	+181	+56	+60
Tissue protein supply by microbial protein [2/]	469	479	462	479
Total tissue protein requirement [3/]	583	550	573	582
Tissue protein required from dietary UDP [4/]	114	71	111	103
Eqiuvalent to dietary UDP (TP/0.7) [5/]	163	101	159	147
UDP supply	560	594	521	553
Deficit/surplus	+379	+493	+362	+406

[1/] RDP requirement = 7.8 ME (ARC, 1980; 1984).
[2/] TP supply by microbial protein = 3.3 ME (ARC, 1980 ; 1984).
[3/] ARC (1980,1984)
[4/] = [3/]-[2/]
[5/] Assuming 70% of the digested dietary UDP can be utilised for synthesising tissue protein.

would result in a difference in calculated apparent efficiency of ME utilisation. For example, if the digestible organic matter had decreased by 3% units, the ME available above maintenance would have been reduced by 4 MJ.

From Table 6, the 'apparent' efficiency of utilisation of ME above maintenance for cows on all rations was lower than 0.60 as suggested by ARC (1980). The calculated partition of ME (Table 6) are approximations rather than exact measures of M/D value of feeds, of maintenance requirements and are probably subject to errors arising from the difficulty of weighing animals precisely and possible changes in the content of digestivetract. One of these or their combination probably contributed to the underestimated

Table 8 : Marginal returns from different roughage-mixed.

	FF	RM1	RM2	RM3
4% FCM yield (kg/cow daily)	14.4	12.6	12.4	11.9
Milk return[1/] (Baht)	136.22	119.20	117.30	112.57
Cost of concentrate[2/] (Baht)	35.00	35.00	35.00	35.00
Cost of roughage[3/] (Baht)	13.88	16.17	14.63	15.35
Marginal return (Baht)	87.34	68.03	67.67	62.22

1/ = 9.46 Baht/kg 4% FCM.
2/ = 5.00 Baht/kg as fed.
3/ = as in Table 1 and 1.85 Baht/kg DM forage.
$US 1 = 45.0 Baht

apparent efficiency of ME utilisation.

The inclusion in RMs rations of tapioca chip which contains readily fermentatble carbohydrate can result in a reduction in the digestibility of fibre in the feeds (Milne *et al.*, 1981). Mould *et al.*, (1983) found that a major cause of reduced digestibility was a rapid fermentation of carbohydrate resulting in a reduction in rumen pH which consequently inhibited bacterial cellulolytic activity. They also found that when a hay was fed with rolled barley, the hay DM digestibility could be reduced by as much as 0.2 units (from 0.51 to 0.31) and the digestibility of the whole diet reduced by about 0.09. The prediction of M/D value of feeds in this study used the values from *in vitro* determination and did not take into account a possible reduction in the diet digestibility due to adding tapioca chip. Consequently, the M/D values of the feeds in the present study were presumably overestimated.

Using the measured values for animal performance, for rumen degradability of feed protein, the intake and requirement of RDP and UDP as given by the Agricultural Research Council (1980, 1984) have been calculated (Table 5 and Table 7). The supplies of UDP as well as RDP were adequate to sustain the recorded milk yields in all treatments. The sufficient in RDP supply relative to demand would have encouraged microbial protein synthesis and thus a high quantity of microbial protein would have reached the small intestine (Oldham, 1984).

When an economic assessment was made of the marginal financial returns from the milk produced per treatment less the cost of feeds (Table 8), it showed that the marginal return was highest when feeding FF ration (87.34 Baht) or the FF ration gave 19.31, 19.67 and 25.12 Baht more than the RM1, RM2 and RM3 rations respectively.

Conclusion

Although this experiment is conducted during the rainy season when a large quantity of good quality fresh forage is in supply, the finding of this experiment is extremely important for the dairy farmer if he is in need of urgent feed for stock particularly during the dry season. There is no doubt that this trial clearly demonstrates that the RMs can be used as good as fresh forage in terms of animal production response although they give a less marginal return. Further researches should be conducted to determine the response to RMs during mid lactation.

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