Effect of Replacing Cereal Grain in Concentrate With Wheat Bran on the Performance of Lactating *Bos indicus*×*Bos taurus* Cows Fed Green Fodder *ad libitum* in the Northern Plains of India

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ABSTRACT : Thirty-one multiparous *Bos indicus*×*Bos taurus* cows were offered concentrate supplements based on (1) 2 kg wheat bran; (2) 4 kg wheat bran; and (3) concentrate (30 maize: 67 wheat bran) at 0.5 kg per 1.0 kg milk produced, in a one year study in India. All supplements also contained 2 parts of a mineral mixture and 1 part salt. Cows were allocated to treatments at calving on parity (2nd and 3rd calf) with 13, 8 and 10 cows respectively in treatments 1, 2 and 3. They were individually fed for whole lactation, the basal diet being *ad libitum* berseem clover plus 2 kg wheat straw in the cool season/winter (period 1) and chopped maize in summer (period 2). Diets with berseem offered TDN and CP contents of 67.6, 18.2; 65.5, 16.8; and 67.5, 16.8 percent; and with maize fodder 62.6, 12.0; 62.6, 12.5; and 63.3, 12.5 percent for treatments 1, 2 and 3, respectively. Total dry matter (DM) intakes (1) 9.9 kg, (2) 10.9 kg and (3) 11.1 kg DM/day and intake of nutrients (TDN, CP) increased with level of supplementation ($p<0.01$), but effects of treatment on animal performance were not significant. Cow milk yields averaged (1) 7.9 kg, (2) 8.1 kg and (3) 8.8 kg milk/day ($p>0.05$) for lactation lengths of 252, 270 and 220 days ($p>0.05$) and cows gained +7.3; +8.1; and +12.0 kg respectively over their lactation ($p>0.05$). Wheat bran was used effectively as the sole energy component in concentrates for lactating dairy cows. Its use could potentially reduce feed costs and demands for cereal grain. Reduced concentrate levels may be considered if green forages of high nutrient content are fed *ad libitum*. Associated economic advantages or disadvantages require further evaluation. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 12 : 1699-1707*)

Key Words : Concentrate Level, Grain Replacement, Lactation, Performance, Cows

INTRODUCTION

The potential of dairy cows in India to produce milk has been increased due to extensive crossbreeding of low milk yield native cattle (*Bos indicus*) to high producing exotic breeds (*Bos taurus*). These crossbred cattle are capable of producing 2000 to 3000 kg/lactation, but many Indian farmers lack knowledge of feed required to exploit this potential. To achieve higher milk yields, nutritional levels need to be increased. Concentrates such as cereal grain can provide additional energy, and oil seed cake, additional protein, but are expensive. Replacement of these concentrates with cheaper alternative feeds would increase profitability and reduce demand for cereal grains which might be used for human consumption. A minimum level of 30% cereal grain has been considered for the feeding of milch cows reared on basal green fodder based diet to support about 10 kg milk/day (Pathak and Pandey, 1995). Wheat bran has been successively substituted for grain in several studies (in India) on milk fed calves (Mondal et al., 1996; Rout et al., 1996), growing cattle (Mondal and Pathak, 1997; Das, 1997), and. lactating cows (Pathak et al., 1997). Green forage will provide higher nutrient levels than conserved roughages such as wheat straw; and if sufficient quantities can be grown, requirements for purchased feed can be reduced. In northern plain region of India, berseem clover was grown as fodder in the cool season and a maize crop used in summer. In this study effects of substitution of wheat bran for cereal grain in concentrate rations and level of supplementation of cows offered green fodder *ad libitum* were investigated.

MATERIALS AND METHODS

Location and environment

The experiment was conducted at Institute's Livestock Production Research Center for Cattle and Buffalo, which is situated at an altitude of 564 feet above sea level. It is coming under northern plain region of India at 28.22 °N and 79.24 °E. the average rainfall is about 90-120 cm, most of which is received during July-September. The climatic pattern touches both extreme cold (approx. 5℃ in winter) and hot (approx. 45℃ in summer) with R. H. ranges from 15 to 85%.

Design and treatments

In a randomized block design thirty-one crossbred (*Bos indicus*×*Bos taurus*) cows were allocated to three treatments comprising of 6, 4 and 4 second parity (2P) cows and 7, 4, and 6 third parity (3P) cows, in treatment 1 (T1), 2 (T2) and 3 (T3), respectively. The cows of 2P and 3P were distributed

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on staggered basis as and when available soon after calving on the basis of their milk yield in previous lactation and calving date, which run through a period starting from November to March the next year. Treatment 3 was considered as normal control, where the animals were offered a standard concentrate mixture containing ground maize (30), wheat bran (67), mineral mixture (2) and salt (1) over and above maintenance to meet the energy requirement of milk production as per NRC (1989). The amount of concentrate was fixed (0.5 kg concentrate per 1.0 kg milk produced) after studying the average weekly milk yield of individual cow and thus it varied through lactation depending on increase or decrease in milk yield. In treatment 1 and 2, the animals were offered 2.0 and 4.0 kg (as fed basis) wheat bran fortified with equal amount of mineral mixture+salt (similar level in the mixture of treatment 2 and double the level in T1) in place of concentrate mixture. The level of concentrate was fixed at 2.0 kg (as fed basis) in T1, a level, commonly practiced by most farmers, and double the level of treatment 1 (4.0 kg) in T2. The basal diet was *ad libitum* leguminous (Berseem clover, *Trifolium alexandrinum*) (December-April) or cereal (Maize, *Zea mays*) (May-November) green fodder. While feeding with green berseem wheat (*Triticum aestivum*) straw (2.0 kg, as fed basis) was offered prior to the feeding of green fodder to reduce total dietary protein intake with berseem fodder. The concentrate was fed once in the morning (8.00 A.M.) while the green fodder was fed twice, also in the afternoon (4.00 P.M.).

Forages and management

The forage crop was grown on sandy to sandy-loam soil provided with proper irrigation and fertilization practice. The main source of fertilizer was organic manure. Berseem clover was grown in the first part of October and fed to animals during the months of December-April. Maize fodder was grown in the month of March to harvest in May and fed chopped to animals. Serial sowing was made in as many number of plots at weekly intervals to provide uninterrupted fodder supply to Livestock Farm throughout the year. The fodder was cut daily and fed to animals, berseem, as such and maize, after chaffing (1-4 cm). The forage quality was ensured by maintaining a cropping pattern with a maximum of 20-25 days re-growth intervals between cuts for leguminous fodder.

Measurements

All the animals were fed individually and the data on feed offered and residue left from concentrate, wheat straw (only during berseem feeding period) and green fodder was recorded daily for whole of lactational study. The cows were milched twice daily and the milk yield was recorded for individual cow throughout its lactational study. The lactation performance of individual cow at biweekly intervals was noted from day 1 to an average of 252.3±11.5, 269.7±16.3 and 220.1±14.3 days post lactation in treatment 1, 2 and 3, respectively. Live weight of cows was recorded biweekly prior to feeding and watering in the morning during the whole period. Dry matter of concentrate and wheat straw was estimated at different periods, while that of green fodder offered and residue left was analyzed daily. Samples of dry fodder from initial and final cuts of the number of harvests were pooled over the period for chemical analysis. Concentrate samples from each lot prepared, was also pooled over the period for the analysis of chemical constituents.

Chemical analysis

The pooled dried samples of concentrate, wheat straw and green fodder was analysed for the proximate principles (AOAC, 1980) and fiber fractions (Van Soest et al., 1991). The nutritive value of the total ration was calculated from the digestibility values of nutrients of crossbred cows fed seasonally on similar fodder based ration in an earlier experiment (Sahoo et al., 1999).

Statistical analysis

Differences in milk production, liveweight change and intakes of concentrate, forage and nutrients were

Table 1. Chemical composition and nutritive value of feeds offered during lactation

Attributes	Wheat bran	Concentrate mixture	Wheat straw	Green berseem	Green maize
Chemical composition (%)					
OM	91.3	91.0	92.2	86.8	88.0
EE	2.5	2.1	1.0	2.8	3.2
CP	15.7	15.7	4.1	20.0	9.5
Total carbohydrate	73.1	73.2	87.1	64.0	75.3
ADF	15.1	15.4	48.0	26.6	39.6
NDF	41.6	38.1	77.4	44.8	70.3

Nutritive value of rations (% DM basis)	Ration 1	Ration 2	Ration 3
Period 1 (Dec-April)-Berseem clover + wheat straw			
TDN	67.6	65.5	67.5
CP	18.2	16.8	16.8
Period 2 (May-Nov)-Maize forage			
TDN	62.6	62.6	63.3
CP	12.0	12.5	12.5

Table 2a. Feed intake and performance of crossbred cows fed different type and levels of concentrate based on wheat bran

Attributes	Treatments 1	2	3	Significance
Number of cows				
2P	6	4	4	
3P	7	4	6	
Total	13	8	10	
DM intake (kg/day)				
Concentrate				
CF	1.81 ± 0.00[c]	3.60 ± 0.00[b]	3.39 ± 0.18[a]	**
LF	1.80 ± 0.00[c]	3.60 ± 0.00[b]	4.96 ± 0.21[a]	**
All period	1.81 ± 0.00[c]	3.60 ± 0.00[b]	4.01 ± 0.16[a]	**
Roughage				
CF	7.03 ± 0.06[a]	6.71 ± 0.12[ab]	6.64 ± 0.07[b]	*
LF	9.50 ± 0.15[a]	8.49 ± 0.26[b]	8.12 ± 0.16[b]	**
All period	8.03 ± 0.06[a]	7.46 ± 0.18[ab]	7.20 ± 0.09[b]	*
Total				
CF	8.84 ± 0.06[b]	10.31 ± 0.12[a]	10.03 ± 0.21[a]	**
LF	11.30 ± 0.15[b]	12.09 ± 0.26[a]	13.08 ± 0.20[a]	**
All period	9.84 ± 0.06[b]	11.06 ± 0.18[a]	11.21 ± 0.17[a]	**
2P	9.91 ± 0.07[b]	10.90 ± 0.20[a]	11.07 ± 0.20[a]	**
3P	9.77 ± 0.09[b]	11.22 ± 0.30[a]	11.30 ± 0.25[a]	**
Nutrient intake/d				
TDN (kg)				
2P	6.63 ± 0.15[b]	6.98 ± 0.13[ab]	7.23 ± 0.14[a]	**
3P	6.34 ± 0.07[b]	7.16 ± 0.20[a]	7.34 ± 0.18[a]	**
All cows	6.47 ± 0.09[b]	7.07 ± 0.14[ab]	7.30 ± 0.12[a]	**
CP (g)				
2P	1,530 ± 27	1,588 ± 33	1,610 ± 45	NS
3P	1,471 ± 30	1,607 ± 64	1,603 ± 63	NS
All cows	1,498 ± 21[a]	1,597 ± 33[b]	1,605 ± 40[b]	*
Milk yield (kg/d)				
2P	7.79 ± 0.55	7.92 ± 0.76	7.75 ± 0.62	NS
3P	8.07 ± 0.22[b]	8.27 ± 0.47[ab]	9.50 ± 0.34[a]	**
CF	6.40 ± 0.24	6.63 ± 0.32	7.15 ± 0.44	NS
LF	9.99 ± 0.48	10.14 ± 0.73	11.07 ± 0.58	NS
All cows	7.94 ± 0.27	8.09 ± 0.42	8.80 ± 0.41	NS
Lactation length (days)				
2P	253.7 ± 12.9[ab]	300.7 ± 12.2[a]	234.3 ± 14.3[a]	*
3P	251.1 ± 11.5	238.8 ± 21.1	210.7 ± 22.1	NS
All cows	252.3 ± 11.5	269.7 ± 16.3	220.1 ± 14.3	NS
Live weight (kg)				
Post calving	404.7 ± 10.4	431.0 ± 24.3	423.0 ± 12.3	NS
End of experiment	412.0 ± 11.6	439.1 ± 23.7	435.0 ± 11.8	NS
Change in live weight (kg)				
2P	+3.3	+16.2	+13.8	
3P	+10.7	+0.0	+10.8	
All cows	+7.3	+8.1	+12.0	

Treatment means bearing different superscripts differ significantly, * $p<0.05$; ** $p<0.01$; NS: Non-significant.
2P, Second parity cows, 3P, Third parity cows, CF, Cereal forage feeding period, LF, Legume forage feeding period.

compared by analysis of variance (Snedecor and Cochran, 1989) using treatment and parity as factors by applying non-orthogonal procedure. Average milk yield for each treatment was adjusted by covariate analysis using period of lactational observation as the covariate. The difference in the slopes of lactational curves was also tested by applying analysis of covariance.

RESULTS

As initially planned, the experiment could not complete a full lactation study due to discontinuation of some animals in the middle of experiment, as a part of annual auctioning programme of livestock farm, where the experiment was being conducted. Only three, three and zero animals had completed their full lactation and thus, they averaged 252±11, 270±16 and 220±14 days of observation period in treatment 1, 2 and 3, respectively (table 2a). Due to staggered availability, four, four and two cows of T1, T2 and T3 undergone initial cereal (15-45 days), then legume (berseem) and ended with cereal fodder based ration. All other cows had initial legume to end with cereal fodder based ration and thus T1, T2 and T3 averaged 55.6, 54.8 and 58.4% of time on legume fodder regime and the rest on cereal fodder.

Nutrient composition

The CP content of green berseem was higher at 20.0% compared to 9.5% of maize fodder (table 1) and thus the two fodder based regime provided 65.6-67.6% and 62.6-63.3% of TDN in the total diet, respectively. The NDF content of maize fodder (70.3%) was much higher than berseem clover (44.8%).

Feed and nutrient intake

Average dry matter (DM) intakes from concentrate in T1 and T2 were 1.81 and 3.60 kg respectively, which was fixed throughout the experimental feeding period. But in T3 it varied from 3.40 to 4.93 kg (average, 4.01±0.06 kg) depending on periodic change in milk yield (figure 1). The average DM intake from cereal fodder in T1 (7.03±0.06) was significantly higher ($p<0.05$) than T3 (6.64±0.07) and about 5% higher intake compared to T2 (6.71±0.12). But DM intake of T1 (9.50±0.15) from legume fodder was higher than both T2 (8.49±0.26) and T3 (8.12±0.16). The substitution rates of concentrate for forage were 32% (T2 vs T1), 38% (T3 vs T1) and 63% (T3 vs T2). The total time spent on cereal fodder regime ranged from 41.6 to 45.2% with the control (T3) animals being for a lower period. Wheat straw offered during berseem feeding period was consumed on an average of 1.0 kg by all the treatment groups.

Low level of concentrate/wheat bran in T1 contributed to decreased DM intake (9.84±0.06) compared to T2 (11.06±0.18) and T3 (11.21±0.17). This resulted in lower ($p<0.05$) TDN intake in T1 (6.47±0.09) compared to T3 (7.30±0.12) and the difference between T2 and T3 was non-significant. The intake per kg $W^{0.75}$ was significantly low only in 3P and all cows of T1 compared to T3. The difference in CP intake between the treatments was statistically non-significant in 2P and 3P cows, but significant ($p<0.05$) in all cows. However, the CP intake per unit body weight (W $kg^{0.75}$) did not reveal any significant difference ($p>0.05$) between the treatments.

Animal responses

As stated earlier the lactation length in the three treatments were dissimilar and it averaged at 246 days. Average milk yields of cows in T1, T2 and T3 were 7.9±0.27, 8.1±0.42 and 8.8±0.41 kg/d, respectively and did not differ significantly ($p>0.05$) among the treatments (table 2a). Milk yield (kg/d) peaked during 4th week in T1 (11.7±0.63) and T2 (11.7±1.01) and 6th week in T3 (12.3±0.59) (figure 1). Then it showed a steady decline to reach at 5.0±0.32, 5.3±0.35 and 5.3±0.46 kg/d at the end of 34th week. The prediction equations are as below:

$Y1=11.94-0.42X_1$ ($r1=0.966$) - Group 1
$Y2=11.83-0.38X_2$ ($r2=0.958$) - Group 2
$Y3=12.57-0.44X_3$ ($r3=0.941$) - Group 3

From the prediction equations, no significant ($p>0.05$) difference was observed in peak milk yield and its declining trend among the treatments. Milk yield of 3P cows in treatment 3 was greater than for cows in T1 ($p<0.05$), but difference for 2P and all cows were non-significant.

In all the three treatments live weight post calving (394.6±10.4, 425.0±24.3 and 408.0±12.3 in T1, T2 and T3, respectively) was declined steadily and started regaining after 16 (T1), 16 (T2) and 14 weeks (T3) of lactation for an average of +7.3, +8.1 and +12.0 kg gain, respectively (table 2a, figure 1). They averaged 398.3±10.7, 429.14±23.9 and 414.0±11.7 kg during the lactation period of 252, 270 and 220 days, respectively in T1, T2 and T3.

The nutrients (DM, TDN and CP) intake per kg milk yield were comparable in the three treatments (table 2b). When the relative intake of nutrients for 1.0 kg milk production was worked out it seemed to be higher (numerically) in T2 and particularly in third parity cows (about 13% more TDN intake) compared to T1 and T3. The plane of nutrition of animals showed a positive balance of nutrients (CP; TDN) in all the three treatments (0.49; 0.40 kg in T1, 0.83; 0.47 in T2 and 0.93; 0.42 in T3) (table 2c). The

Table 2b. Relative nutrient intake of crossbred cows in different treatments

Attributes	Treatments 1	Treatments 2	Treatments 3	Significance
Nutrient intake (g)/kg $W^{0.75}$				
TDN 2P	73.87 ± 2.35	76.72 ± 2.82	78.14 ± 1.96	NS
3P	70.67 ± 2.05[a]	74.98 ± 4.84[ab]	80.82 ± 2.02[b]	*
All cows	72.15 ± 1.55[a]	75.85 ± 2.61[ab]	79.75 ± 1.44[b]	*
CP 2P	17.49 ± 0.62	17.45 ± 0.62	17.39 ± 0.49	NS
3P	16.40 ± 0.48	16.80 ± 1.04	17.65 ± 0.69	NS
All cows	16.90 ± 0.40	17.12 ± 0.57	17.54 ± 0.44	NS
Relative nutrient intake compared to NRC (1989)				
TDN 2P	107.2 ± 3.0	113.0 ± 5.9	117.0 ± 3.1	NS
3P	107.3 ± 2.3	116.0 ± 6.0	114.1 ± 2.1	NS
All cows	107.3 ± 1.8[a]	114.5 ± 3.9[ab]	115.3 ± 1.7[a]	*
CP 2P	141.3 ± 4.6	144.0 ± 9.3	146.2 ± 4.0	NS
3P	134.5 ± 2.3	142.3 ± 8.8	129.9 ± 4.3	NS
All cows	137.6 ± 2.6	143.2 ± 5.9	136.4 ± 3.9	NS
Nutrient intake/kg milk yield				
DM (kg) 2P	1.301 ± 0.082	1.409 ± 0.113	1.449 ± 0.084	NS
3P	1.215 ± 0.032	1.372 ± 0.095	1.193 ± 0.020	NS
All cows	1.255 ± 0.041	1.390 ± 0.069	1.295 ± 0.053	NS
TDN (kg) 2P	0.847 ± 0.051	0.902 ± 0.073	0.946 ± 0.053	NS
3P	0.788 ± 0.019	0.875 ± 0.062	0.775 ± 0.014	*
All cows	0.815 ± 0.026	0.888 ± 0.044	0.843 ± 0.035	NS
CP (g) 2P	200 ± 10	205 ± 16	210 ± 10	NS
3P	183 ± 3	196 ± 15	169 ± 6	NS
All cows	191 ± 6	201 ± 11	186 ± 8	NS
Relative nutrient intake				
DM 2P	89.8	97.2	100.0	NS
3P	101.8	115.0	100.0	*
All cows	96.9	107.3	100.0	NS
TDN 2P	89.5	97.2	100.0	NS
3P	101.7	112.9	100.0	NS
All cows	96.7	105.3	100.0	NS
CP 2P	95.2	97.6	100.0	NS
3P	108.3	116.0	100.0	NS
All cows	102.7	108.1	100.0	NS

Treatment means bearing different superscripts differ significantly.
* $p<0.05$; NS: Non-significant.
2P, Second parity cows.
3P, Third parity cows.

expected milk yield from the excesses of nutrients consumed by cows of T1, T2 and T3 was calculated out to be 1.4, 2.4 and 2.7 kg, respectively.

DISCUSSION

The results of this study indicated that cows consumed less DM at lower levels of concentrate supplementation. In otherwords, cows fed extra concentrate (T2 and T3) ate less forage dry matter. Although animals in T1 consumed higher ($p<0.05$) forage DM compared to T2 and T3, they failed to compensate the deficit of decreased concentrate level as that offered in T2 and T3. The substitution of DM intake from concentrate was higher in berseem feeding period (56.1 and 43.7 for T1 vs T2 and T3, respectively) compared to that in cereal fodder regime showing corresponding values of 17.9 and 24.7. This was related to total bulk of digesta in the rumen, as concentrate provided lesser volume than roughage (green or dry) and thus, rumen fill governs the total substitution of concentrate with roughage in ruminants due to difference in their rate of digestion (Forbes, 1988). Mertens (1994) have proposed NDF-Energy Intake system to formulate dairy

Table 2c. Plane of nutrition of crossbred cows in different treatments

Average body weight(kg)				
2P	391.7 ± 16.9	413.1 ± 29.4	419.4 ± 13.2	NS
3P	403.9 ± 14.6	445.0 ± 40.3	410.4 ± 18.3	NS
All cows	398.3 ± 10.7	429.1 ± 23.9	414.0 ± 11.7	NS
Nutrient requirement as per NRC(1989)				
For maintenance				
TDN (kg) 2P[#]	3.39 ± 0.11	3.53 ± 0.19	3.57 ± 0.11	NS
3P	3.15 ± 0.09	3.39 ± 0.23	3.19 ± 0.11	NS
All cows	3.26 ± 0.07	3.46 ± 0.14	3.34 ± 0.09	NS
CP (g) 2P[#]	344 ± 11	358 ± 19	362 ± 9	NS
3P	320 ± 9	344 ± 23	324 ± 11	NS
All cows	331 ± 7	351 ± 14	339 ± 9	NS
For milk production				
TDN (kg) 2P	2.67 ± 0.19	2.72 ± 0.26	2.66 ± 0.21	NS
3P	2.77 ± 0.08^{a}	2.84 ± 0.16^{ab}	3.26 ± 0.11^{b}	*
All cows	2.72 ± 0.09	2.78 ± 0.14	3.02 ± 0.14	NS
CP (g) 2P	748 ± 52	760 ± 72	744 ± 60	NS
3P	775 ± 22^{a}	794 ± 45^{a}	912 ± 32^{b}	*
All cows	762 ± 26	777 ± 40	845 ± 40	NS
Balance of nutrients				
TDN (kg) 2P	0.41 ± 0.17^{a}	0.73 ± 0.32^{ab}	1.00 ± 0.15^{b}	*
3P	0.41 ± 0.13	0.93 ± 0.32	0.89 ± 0.12	NS
Over all	0.41 ± 0.10^{a}	0.83 ± 0.21^{b}	0.93 ± 0.09^{b}	*
CP (g) 2P	438 ± 28	469 ± 73	504 ± 19	NS
3P	376 ± 22	470 ± 80	367 ± 50	NS
Over all	405 ± 19	470 ± 50	423 ± 37	NS
Expected additional milk yield (4.5% fat)				
From TDN balance(kg)				
Kg/animal/day	1.2	2.4	2.7	
Extra CP required (g)	Nil	Nil	Nil	
From CP balances (g)				
kg/animal/day	4.2	4.9	4.4	
Extra TDN required(kg)	0.95	0.85	0.58	
TDN required for milk production as in T1				
	0.95	0.61	0.51	

Treatment means bearing different superscripts differ significantly.

* $p<0.05$; NS: Non-significant.

[#] 10.0% extra allowance of nutrients for growth in second parity cows (NRC, 1989).

2P, Second parity cows.

3P, Third parity cows.

rations, where NDF is used to represent the filling of the diet. In the present experiment cereal fodder contributed higher NDF content in the diet (table 1) and thus substituted at lower level compared to legume fodder for the difference in concentrate/wheat bran intake between the treatments. However, the NDF level of diets in all the treatments were higher than the recommended level of 25-35% (Sudweeks et al., 1981; Mike Allen, 1995).

The difference in nutrient consumption (CP and TDN) between the treatments were in line with the difference in feed DM intake. The CP content of berseem clover was higher than that of total diet and therefore, cows in **T1** received extra CP during berseem feeding resulting in non-significant difference between the groups in 2P and 3P cows, but an over all higher CP intake from concentrate influenced the CP intake in all cows. However, the CP intake per kg $W^{0.75}$ was similar in all the treatments. The difference in TDN consumption between T1 and T3 was about 16% higher in 3P compared to 9% in 2P cows. Increased TDN intake by 2P cows did not influence the milk yeild, but similar increased level of intake in 3P cows resulted in significantly higher milk yield in 3P cows of treatment 3. This may refer to a probable conclusion that the cows under second parity probably utilize the extra nutrients to meet the higher maintenance requirement for continued growth and milk production (NRC, 1989) and also, may very well sustain on cereal grain replaced diets. The findings were thus supported by the earlier results on growing male crossbred calves (Mondal and Pathak, 1997; Das and Pathak, 1998), where replacement of cereal grain with wheat bran from the concentrate mixture did not influence the growth potential of crossbred (*Bos indicus*×*Bos taurus*) calves. The non-significant difference between T2 and T3 was indicative of similar nutritional status which supported comparable milk yield in both 2P and 3P cows. The numerical difference between T3 and T2 (T3 had about 15% higher milk yield in 3P cows and 8% in all cows) was attributed to shorter observation period (220 vs. 270 days) since the milk yield declined in the latter part of lactation (figure 1). Analysis of covariance also showed non-significant difference in between the slopes. The milk yield was similar to that reported by Nawaz et al. (1993) for Jersey cows reared in the similar tropical environment.

Relative nutrient intake by cows were 7 to 15% higher for TDN and 36-44% higher for CP than the NRC (1989) recommendation and was thus reflected in positive live weight gain in all the treatments. Nutrient intake per kg milk yield compared against T3, the productive control, revealed better utilization of nutrients by 2P cows in T1 compared to T2 and T3, which was in line with the earlier discussion that supplementation of concentrate devoid of cereal grain supported well for continued growth and milk production. But in 3P cows, the TDN requirement was higher or utilized less efficiently for unit production of milk. An altered rumen fermentation with increased propionate from cereal grain based concentrate might have influenced the milk yield in T3 compared to T2 (Annison, 1983). Another factor which might have contributed to increased relative consumption of nutrients in T2 was its higher live weight, since T2 and T3, both consumed about 15% higher TDN per kg $W^{0.75}$ compared to NRC (1989).

The plane of nutrition in Groups 1, 2 and 3 was worked out from the balance of nutrients after subtracting the nutrient allowances for maintenance, live weight gain and milk yield (table 2c) as per the recommendations of NRC (1989). These calculations suggest extra nutrient intake by animals in T2 and T3, which may be expected to support an additional milk yield of about 2.5 kg, which was not seen in the present experiment. An additional 1.0 kg milk yield may also be expected in animals of T1, which also showed positive balance of nutrients. There was further scope of reducing the CP intake in animals of all the three groups as assessed from CP balance during berseem feeding period. Jackson and Gupta (1971) also observed an excess of protein intake in lactating crossbred cows on sole feeding of berseem. On the other hand, an additional 4-5 kg milk may be expected from increased CP consumption, but it requires extra energy (TDN) intake in all the treatment groups. The requirement of TDN was observed to be more for T1 cows compared to T2 and T3. Above all, a lower sustenance of milk production and comparatively the fall in live weight post calving may provide an indication of low energy state in T1 cows, which will probably need extra level of energy to show similar production as in T2 and T3. However, animals in all the three treatments showed positive live weight gain which may be considered as a good indicator of nutrient supply and thus, the balances of nutrients

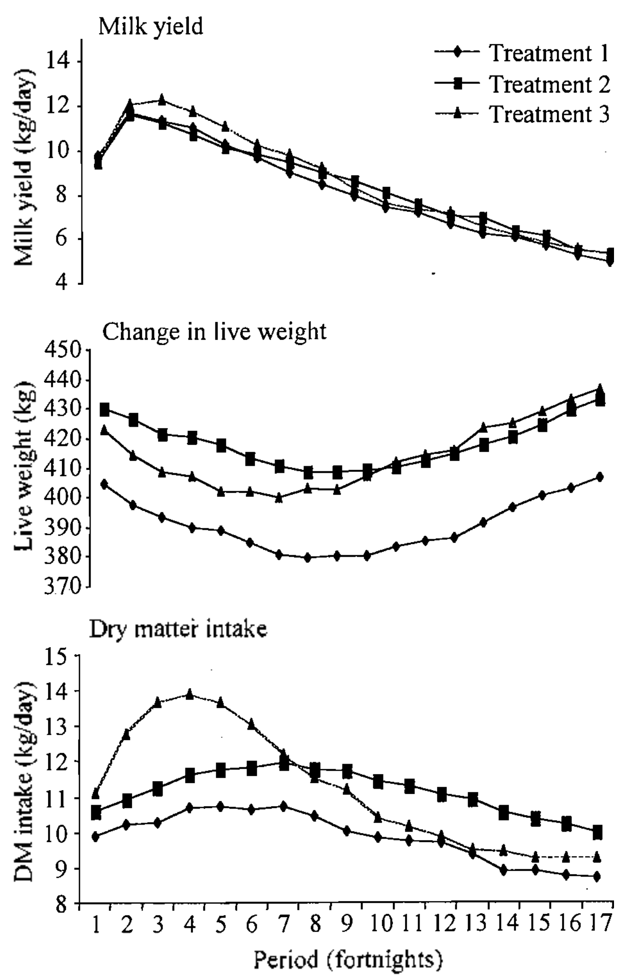

Figure 1. Milk yield, live weight and feed intake pattern of different treatments during lactation

would have expected to sustain even higher milk production than that observed in the present experiment. Pathak and Pandey (1995) observed similar balance of nutrients for live weight gain in crossbred cows fed on different levels of cereal grain with *ad libitum* berseem fodder. On the basis of nutrient balance the average milk yield in cows under T1 may thus be comparable to that under T2 and T3. A reduction in intake of cereal fodder resulting in declined milk production trend in all treatments was also attributed to physiological decline in milk yield with the advancement of lactation. Pathak et al. (1990, 1991) also reported higher milk production with feeding of green berseem compared to green maize forage to lactating cows. However, an increase in milk yield in cows may be expected with little enhancement in DM intake through the provision of increased level of concentrate during cereal fodder feeding. According to Veerkamp and Thompson (1999) feed intake during early lactation was negatively correlated with milk yield but feed intake during the later weeks was positively correlated with milk yield. In tropical countries like India, a decrease in voluntary feed intake might also be due to seasonal effect as berseem fodder was made available during comfortable months from December to April where as maize fodder was available from May to November of which a greater part was harsh hot climate.

The results of the experiment indicate that wheat bran can be used as the sole energy component of concentrate mixtures for lactating dairy cows and thus will spare cereal grain for human consumption. A lactation yield of beyond 2,500 kg milk may be expected at reduced levels of concentrate (2.0 kg/day) without adverse effect on live weight and/or health of the animals. However, its overall contribution to economic benefits or losses may need further investigation.

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