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Effect of Different Feeding Regimes on Nutrient Digestibility and Nutritive Value in Lactating Punganur Cows

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ABSTRACT

Present experiment was conducted to study the effect of different feeding regimes on nutrient digestibility and nutritive value in lactating Punganur cows. Sixteen lactating Punganur cows which were randomly (CRD) allotted to four experimental groups with four animals in each group. Animals of control (T1) group were maintained as per the feeding practice followed by the farmers rearing punganur cows in Chittoor district (Hedge lucerne, paddy straw, concentrate mixture), T2 group fed with super napier grass, paddy straw, concentrate mixture, T3 group fed with paddy straw, concentrate mixture, UMMB and T4 group fed with TMR. Results indicated that average milk yield (kg/d) was found to be significantly ($P<0.05$) higher in T4 or T3 as compared to T2 or T1 and FCM yield (kg/d) was also found to be significantly ($P<0.05$) highest in T4 followed by T3 or T2 and lowest in T1. The milk composition reported that protein and lactose (%) were ($P<0.05$) higher in T4. The digestibility (%) of DM and OM was higher in T3 than T1 and T4 groups, while the digestibility of other nutrients did not indicate any difference among the treatments. The plane of nutrition indicated DMI (kg/d) was in order i.e.T3>T2 >T4 >T1. The nutritive value in terms of DCP (%) was found to be significantly ($P<0.05$) higher in T1 & T4 than T2 &T3, whereas the TDN (%) did not differ among the treatment groups. It was concluded that average milk & FCM yield is highest for TMR group, while cost economics of milk production revealed that the feed cost per kg milk and FCM yield was lower ($P>0.05$) in T3 group.

KEYWORDS: Dry Matter Intake, Nutrient digestibility, Nutritive value, Plane of nutrition, Punganur cows

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INTRODUCTION

Punganur dwarf cattle originated from the Chittoor district of Andhra Pradesh is among the world's smallest humped cattle breed. Animals are white and light grey in colour with a broad forehead and short horns. Its average height is 70–90 cm and its weight is 115–200 kg (Ekambaram et al.,2014).The cow has an average milk yield of 3-5 litres/day and 200-1100 kg per lactation with an average of 550kgs of milkand were known as "Poor man's cow" (Narendranath, 1993).It has a daily feed intake of 5-7 kgs and is highly drought resistant and able to survive exclusively on dry fodder.

Dwarf cattle breeds have special niche in context of sustainability because of their smaller body size, good grazing habits, adaptability to local conditions, resilience to diseases, less feed requirement for maintenance (Kapila et al., 2013)are beneficial to farms with small acreages or neo-marginal, marginal or landless dairy farmers and the milk of these indigenous cows has medicinal properties, whereas the dung and urine are extensively used for organic farming and for preparation of various products with medicinal values and it is considered as sacred cow (Srinivas and Ramesha, 2017).Being indigenous cattle, their potential for fibre utilization is higher than cross breed cattle(Narendranath, 1993). But, gap in knowledge and proper documentation on different feeding regimes followed in field often makes difficult

in highlighting nutritional advantageous of Punganur cows.In view of the above, the present study is aimed to see the effect of different feeding regimeson feed intake, nutrient utilization, milk yield and profitability in lactating Punganur cows.

MATERIALS AND METHODS

Animals and experimental design

The study was conducted on 16 lactating Punganur cows (168.66 ± 5.94 kgs) maintained in Livestock Research Station, Palamaner with the approval of committee for the purpose of control and supervision of experiments on animals (CPCSEA), New Delhi. (Experiment No. 88/SVVU/2021-CPCSEA dated 28/05/2021). The animals are in 2nd and 3rd parity during 3-4th week of lactation were allocated randomly (CRD) into four treatment groups comprising of four animals each. A lactation trial of 90 days duration was carried out. After 60 days of feeding period, a digestion trial of seven days duration was conducted to evaluate nutrient digestibility using all sixteen Punganur cows.

Experimental feeds and rations

Animals of control group (T1) fed with hedge lucerne (8-10kg/animal/day), paddy straw (1.5-2kg/animal/day) and concentrate mixture @ 0.5 kg/animal/day, which is the common feeding practice followed by the farmers in the area under study. Animals of T2 group fed with super napier grass *ad libitum* (18-20kgs), paddy straw (1kg/animal/day) and concentrate mixture @ 1kg/2 litres milk production. Animals of T3 group fed with paddy straw *ad libitum* (5-6 kgs) and concentrate mixture @ 1kg/2 litres milk production and urea molasses mineral block (200-250 g/day) free access. The hedge lucerne and super napier grass fed to the animals were harvested at 50 and 60 days respectively and fed after chaffing.The concentrate mixture used in this experiment contained 20% CP was prepared by using following ingredients such as maize 40%, de-oiled rice bran 23%, soybean meal 34%, mineral mixture 2%, and salt 1%. The urea molasses mineral block (UMMB) was procured from Livestock Research Station (LRS), Palamaner with known ingredient compositionmolasses 30%, urea 10%, maize 5%, de-oiled rice bran 20%, maida10%, sunflower cake10%, mineral mixture 15% which was used as supplement in the T3 group. Animals of T4 group fed with total mixed ration (TMR) @ 2.5% kg B. Wt. The total mixed ration was prepared by using super napier (*Cenchruspurpureus*) grass which was chaffed, dried and ground in a chaffer cum grinder and then used for the preparation of complete rations by mixing in a horizontal mixer. The dried green forage (60 parts) and concentrates (40 parts) were used to prepare TMR.The concentrate ingredients used are maize 20%, de-oiled rice bran 12%, soybean meal 5%, mineral mixture 2%, and salt 1%, So as to contain 12% crude protein.

Housing and feeding Management

The experimental cows were housed in a well-ventilated milking shed maintained hygienically and stallfed throughout the experiment. Fresh chopped hedge lucerne, super napier grass and paddy straw were fed at 10 AM and 5 PM every day to the experimental cows individually according to the treatments in T1, T2 & T3. The T3 group animals were provided additionally with urea molasses mineral blocks (UMMB) to have free access. The TMR was provided to T4 group animals twice daily in the morning and evening. While the daily concentrate mixture allowance was fed twice before milking (3 AM and 3 PM) for T1, T2 & T3 animals. The animals were offered fresh, clean drinking water free of choice.

Lactation Trial

Daily milk yield

The animals were completely hand milked twice daily at 4.00 A.M and 4.00 P.M throughout the lactation trial of 90 days and daily milk yield of individual cow was measured using digital weighing balance and the samples from morning and evening milking were pooled proportionately and were subjected to analyze fat, solid not fat (SNF), protein, lactose and total solids.

Milk composition

Representative samples of milk were collected in sterile milk sample bottles at weekly intervals and were analysed for fat, protein, lactose, solids not fat (SNF) by using milkoscanminor type 78110. The ash content in the milk analysed as per (AOAC, 2019).

Fat corrected milk

From the milk and fat yield of animals, the 4% fat corrected milk (FCM) was calculated by the following equation given by (Rice et al., 1970)

$$4\% \text{ FCM} = 0.4 \times \text{Total milk yield (kg)} + 15 \times \text{total fat in milk (kg)}$$

Total solids

The total solids content of the milk was arrived by the addition of fat and SNF content.

$$\text{Total Solids (\%)} = \text{Fat\%} + \text{SNF\%}$$

Digestion trial

A feeding trial of 90 days duration was carried out. After 60 days of feeding period, a digestion trial of seven days duration was conducted to evaluate nutrient digestibility using all sixteen punganur cows. During the collection period all the animals were kept in a separate shed where facilities are available for individual feeding, watering, and collection of faeces. The faeces were collected manually during 24 hrs period and pooled. During the 7 days of collection period daily feed consumption, feed left over, water intake, milk yield and composition from each individual cow were recorded.

Collection of samples

Feed offered and fodder residues

During collection period, representative samples of feed offered and feed residue if any during experiment was collected, weighed. The DM of green fodders and left over was estimated daily and the dried material were ground to pass through 1mm sieve size and used for further analysis.

Faeces

A 24-hour collection of faeces was recorded everyday morning at 9:00 AM for seven days. Total quantity of faeces voided daily was weighed, mixed thoroughly and representative sample (2%) was taken separately from each animal, pooled for 7 days and stored in a deep freezer at -20^{o} c. At the end of trial, the pooled faecal samples were thawed to room temperature mixed thoroughly and the representative samples of 10 g were taken for nitrogen estimation. For further analysis, faeces were dried at 60^{o}C and ground to pass through 1mm sieve size screen and preserved in air tight bottles.

Analytical techniques

Proximate analysis

Dried samples of experimental feeds, left over fodder and faeces were analysed for proximate constituents viz., CP, TA, EE, CF & NFE according to (AOAC, 2019) methods.

Analysis of cell-wall constituents

Cell wall constituents*viz.,* neutral detergent fibre (NDF), acid detergent fibre (ADF), cellulose and acid detergent lignin (ADL) were determined for feeds and faeces by using the methods described by VanSoest et al.(1991).

Statistical analysis

The results obtained were subjected to analysis through software version 20.0 (2011; IBM Corporation, Armonk, NY,USA)by applying one-way analysis of variance through generalized linear model and the treatment means were ranked using Duncan's multiple range test (Duncan, 1955) with a test of significance at $P<0.05$. All the statistical procedures were done as per Snedecor and Cochran (1980).

Results and Discussion

Chemical composition of feeds and forages

The chemical composition of the experimental diets fed to lactating punganur cows in different feeding regimes is summarized in Table 1&2

Table 1. Chemical composition (% DM) of concentrate ingredients, green fodders and dry roughages fed to lactating Punganur cows on different feeding regimes

Nutrient	Concentrate ingredients			Green fodders and dry roughage		
	Maize grain	De-oiled rice bran	Soybean meal	Hedge lucerne	Super napier	Paddy straw
			Proximate principles			
Dry matter	88.2	89.0	90.3	22.4	20.1	90.7
Organic matter	95.5	84.4	88.6	94.5	88.9	85.5
Crude protein	9.11	11.1	36.9	14.8	6.56	4.54
Ether extract	2.20	0.33	0.50	2.81	2.18	1.34
Crude fibre	3.50	25.59	10.5	25.2	33.4	35.6
Total ash	4.50	15.5	12.4	5.45	11.10	14.4
Acid insoluble ash	0.45	8.90	4.88	4.21	4.35	6.75
NFE	80.6	47.4	39.6	51.5	46.6	43.9
			Cell wall constituents			
NDF	62.7	80.6	48.0	36.4	69.4	72.5
ADF	8.58	42.6	26.0	49.8	43.8	45.8
Hemicellulose	54.2	38.0	21.9	13.4	25.5	26.6
Cellulose	5.90	26.8	18.9	24.8	36.7	38.6
Acid detergent lignin	1.93	0.40	10.3	10.2	13.4	5.25

Table 2. Chemical composition (% DM)of concentrate mixture, UMMB and TMR used in experimental Diets

Parameters	Concentrate Mixture	Urea Molasses Mineral Block (UMMB)	TMR
		Proximate principles	
Dry matter	90.3	88.4	92.8
Organic matter	89.5	74.2	90.4
Crude protein	18.7	33.2	8.94
Ether extract	1.13	0.87	1.81
Crude fiber	10.8	2.88	22.5
Total ash	10.4	25.7	9.53
Acid insoluble ash	2.65	3.54	5.58
Nitrogen free extract	58.7	37.2	57.1
		Cell wall constituents	
Neutral detergent fiber	20.3	16.1	45.8
Acid detergent fiber	36.8	9.85	71.4
Hemicellulose	16.4	6.27	25.6
Cellulose	12.5	2.06	34.8
Acid detergent lignin	5.50	3.24	6.86

Lactation trial

Milk yield

The average daily milk yield (kg/d) was significantly ($P<0.05$) higher in T4 or T3 as compared to T2 or T1(Table 3). While average 4% Fat Corrected Milk (FCM) yield was found to be significantly ($P<0.05$) highest in T4.Results of present study is corroborated with the results of Venkataramana (1996) and Manjunatha et al. (2020) was within the observed range in the present study in punganur and malnadgidda cows which are dwarf breeds. The milk yield predominantly depends on breed and feeding practices. There was 0.28-0.80 and 0.40-0.74 kg/d increase in milk and FCM yield of Punganur cows among the different treatments as the experiment progressed. Providing optimum nutrients to the Punganur cows could only marginally increased the milk production by 0.2 kg/d on an average as opinioned by Narendranath (1993).The

higher milk and FCM yield (kg/d) in TMR (T4) group might be due to higher propionate production as the combination of feed ingredients increases nutrient density and efficiency of ME utilization which might have resulted in higher milk production than those fed concentrates and roughages separately as in the conventional ration (Walli, 2015, Mohammad et al., 2017; Teshome et al.,2017) in cross bred cows. The higher milk and FCM yield (kg/d) in paddy straw, concentrates and UMMB (T3) group are in accordance with the results reported by Mohini and Singh (2010), Murthy et al. (2013) and Meelet al. (2015) in cross bred cows who opinioned that UMMB feeding increased voluntary straw intake which was associated with the higher cellulolytic fibre utilization by the microbes in the presence of the optimum urea ammonia provided by UMMB (Perera et al., 2007). However, increase in milk production indicated that if basal diet was deficient in major nutrients, part of it can be fulfilled through UMMB supplementation.

Table 3. Average milk yield (Kg/d) and milk composition (%) of lactating Punganur cows

Parameters	T1	T2	T3	T4
Milk yield (kg/d)				
Daily milk yield (kg) *	1.54±0.11^{a}	1.69±0.06^{a}	2.35±0.30^{b}	2.48±0.20^{b}
FCM (kg) *	1.67±0.13^{a}	1.97±0.26^{ab}	2.70±0.31^{bc}	2.86±0.22^{c}
Milk composition (%)				
Fat	4.51±0.10	5.05±0.72	4.79±0.30	4.99±0.14
SNF	9.40±0.01	9.36±0.18	9.39±0.06	9.63±0.05
Protein*	4.05±0.04^{bc}	3.95±0.01^{ab}	3.84±0.06^{a}	4.23±0.09^{c}
Lactose*	4.35±0.01^{a}	4.37±0.02^{ab}	4.31±0.08^{a}	4.42±0.02^{b}
Total solids	13.8±0.17	14.4±0.62	14.1±0.36	14.6±0.09
Ash	0.74±0.05	0.74±0.05	0.75±0.05	0.73±0.08

^{abc}Values in a row bearing superscripts differ significantly *($P<0.05$)

Milk composition

The average milk fat (%) ranges 4.51-5.05% in T1 to T4, respectively and non-significant (Table 3). Venkataramana (1996) reported marginally higher fat (4.65-5.85%) of punganur cows, whereas Manjunatha et al. (2020) reported lower fat (4.10-4.39%) in malnadgidda cows which are dwarf breeds.Similar trend was also observed with milk SNF (9.36-9.63%). The present findings are in agreement withVenkataramana (1996), while Manjunatha et al.(2020) reported slightly lower SNF (8.91-8.96%) in malnadgidda cows.

It was interesting to know that the average milk protein (%) indicated significant ($P<0.05$) improvement in T4 as compared to other treatments, Venkataramana (1996) reported marginally higher protein content (4.31-4.41%) in Punganur cows, while Manjunatha et al. (2020) reported lower protein (3.27-3.29%) in malnadgidda cows. Increase in protein content of milk might be due to significant increase in Gross protein efficiency (Kumar, 2012). Similar to the present study, Macleod et al. (1983) found that protein content of milk increased from 3.11-3.26% when reducing the ratios of forage: concentrates from 80:20 to 65:35. The ratio of Roughage to concentrate in the present study was 60:40, that would have resulted in the optimal protein utilization. The average lactose (%) was found to be significantly ($P<0.05$) highest in T4 followed by T2 and lowest in T1 or T3. Manjunatha et al. (2020) reported higher lactose (%) content and lactose yield in malnadgidda cows. The average total solids (%) ranged 13.83-14.63% in T1 to T4, respectively and non-significant. The values observed in the present study for total solids (%) are within the reported range by Venkataramana, (1996) and Manjunatha et al. (2020) in punganur and malnadgidda cows.

It is evident that there are lots of genetic and non-genetic factors responsible for variability in milk yield and composition like breed, heredity, parity, diet, time and frequency of milking, season etc. (Sarker et al., 2019, Pandiyan et al., 2022).

Digestion trial

Nutrient digestibility

The digestibility coefficient (%) of the DM in present study (Table 4) was significantly (P<0.05) higher in T3 than T1 and T4 but similar with T2.Present findings were comparable with the values reported by Venkataramana, (1996) and Manjunatha et al. (2020) in punganur and malnadgidda cows. Similar trend of increased DM digestibility in crossbred cowswas reported by Kumar et al. (2021) in paddy straw,concentrate mixture and UMMB. OM digestibility coefficient was significantly (P<0.05) higher in T3 than T1 or T4 but not different from T2. Whereas higher values of OM digestibility reported by Srinivas et al. (2017) in malnadgidda cows. Similar trend of increased OM digestibility in cross bred cows reported by Mohini and Singh, (2010) with supplementation of UMMB to animals fed on wheat straw improved the OM digestibility has certainly indicated enhancement on the fermentation capacity of rumen ecosystem due to improved and synchronous availability of nitrogen and energy for protein synthesis (Leng, 1984; Schiere et al., 1989). Digestibility coefficient (%) of CP and EE was comparable and were within the reported range by Manjunatha et al.(2020) and Venkataramana, (1996) in malnadgidda and punganur cows. In contrary to the present study (Garg and Gupta, 1993; Madhu Mohini and Gupta, 1993; Jongweet al.,2014) reported higher EE digestibility in paddy straw, concentrates and UMMB supplemented group in crossbred cows.CF digestibility coefficient was comparable among present study and were within the reported range by Srinivas et al. (2017) in malnadgidda cows. Jelantik and Belli, (2010) stated that crude fiber digestibility (%) was non-significantly improved by supplementation of protein source in cross bred cows. In contrary to the present study, increased CF digestibility (%)by 9.44 percent with paddy straw due to UMMB supplementation was reported by Sudhakar et al. (2002) in cross bred cows. The digestibility of crude fiber depends largely upon the concentration and availability of cellulose and hemicellulose portion which is affected by the degree of lignification (Smith et al., 1971). The digestibility coefficient (%) of NDF, ADF, HC and Cellulose were non-significant and also corroborated with the research reports of Venkataramana, (1996) in punganurcows and Manjunatha et al. (2020) in malnadgidda cows.

The marginal variation observed in digestibility of different nutrients could be due to variation in roughage sources, feeding regimes, levels of intake, (Beecher et al., 2014).

Table 4. Effect of feeding different methods on nutrient digestibility in lactating Punganur cows

% Digestibility	T1	T2	T3	T4
DM*	56.7 ± 1.83^{a}	59.2 ± 1.60^{ab}	61.1 ± 0.38^{b}	55.6 ±0.43^{a}
OM*	60.5 ± 1.67^{a}	62.4 ± 1.43^{ab}	65.4 ± 0.35^{b}	59.4 ± 0.31^{a}
CP	60.3 ± 2.07	61.4 ± 1.50	58.8 ± 2.95	59.0 ± 3.05
EE	80.7 ± 2.18	70.4 ± 3.63	74.3 ± 4.50	73.2 ± 1.53
CF	68.1 ± 1.82	60.3 ± 1.35	72.3 ± 3.55	61.4 ± 5.74
NFE	57.2 ± 4.21	62.5 ± 2.32	60.2 ± 0.49	60.3 ± 0.79
NDF	55.6 ± 3.65	56.9 ± 1.18	60.6 ± 1.45	60.4 ± 0.36
ADF	53.3 ± 3.10	52.1 ± 0.11	54.6 ± 0.83	57.0 ± 1.11
Hemicellulose (HC)	60.0 ± 5.01	63.1 ± 3.07	66.8± 3.80	58.7 ± 1.33
Cellulose	55.4 ± 5.74	65.5 ± 0.37	62.8 ± 0.71	63.0 ± 1.66

^{abc} Values in a row bearing superscripts differ significantly *(P < 0.05)

Plane of nutrition

Nutritive value

Data on nutritive value of different feeding methods and plane of nutrition in lactating Punganur cows during the digestion trial presented in Table 5. The DCP (%) content in the present study was significantly ($P<0.05$) higher in T1 (6.49)& T4 (6.33) than T2 (5.21) and T3 (4.80). The TDN (%) ranges 58.56 to 62.90 in T1 to T4, respectively and non-significant. The values observed in the present study were in accordance with the reported range by Venkataramana, (1996) in punganurcows, Srinivas et al. (2017) and Manjunatha et al. (2020) in malnadgidda cows. The marginal difference might be attributed to the difference in the digestibility of different nutrients under different feeding practices.

Table 5. Effect of feeding different regimes on plane of nutrition and nutritive value in lactating Punganur cows

Parameter	T1	T2	T3	T4
Nutritive value				
DCP (% DM) *	6.49 ± 0.44^{b}	5.21 ± 0.12^{a}	4.80 ± 0.19^{a}	6.33 ± 0.33^{b}
TDN (% DM)	62.9 ± 4.56	58.5 ± 1.50	60.5 ± 1.56	61.7 ± 1.99
Dry Matter Intake (kg/d)				
DMI from Roughage	3.77±0.10	4.86± 015	4.84± 0.13	3.00± 0.01
DMI from Concentrate	0.45± 0.03	0.90± 0.01	1.10± 0.05	2.00 ± 0.03
Total DMI	4.23 ± 0.12^{a}	5.76 ± 0.03^{c}	5.94 ± 0.13^{c}	5.00 ± 0.04^{b}
DMI (% B. Wt) *	2.35 ± 0.07^{a}	3.32 ± 0.39^{b}	3.22 ± 0.30^{b}	2.47 ± 0.01^{ab}
DMI (g/kg $W^{0.75}$) *	86.2 ± 1.59^{a}	120 ± 10.98^{b}	118 ± 8.05^{b}	93.2 ± 0.10^{a}
Plane of nutrition				
B. Wt (kg)	180 ± 11.92	178 ± 21.26	188 ± 19.42	202 ± 2.18
Kg $W^{0.75}$	49.1 ± 2.42	48.7 ± 4.34	50.7 ± 3.95	53.6 ± 0.43
CP intake (g/d)	454 ± 30.14	488 ± 2.23	486 ± 25.81	535± 4.44
CP intake (g/kg $W^{0.75}$)	9.23 ± 0.15	10.1 ± 0.92	9.66 ± 0.57	9.98 ± 0.01
DOMI (kg/d) *	2.32 ± 0.09^{a}	3.27 ± 0.08^{c}	3.47 ± 0.06^{c}	2.72 ± 0.02^{b}
DOMI (% B. Wt) *	1.29 ± 0.06^{a}	1.88 ± 0.23^{b}	1.87 ± 0.17^{b}	1.34 ± 0.01^{a}
DOMI (g/kg $W^{0.75}$) *	47.2 ± 1.84^{a}	68.3 ± 6.63^{b}	69.1 ± 4.70^{b}	50.8 ± 0.20^{a}
DCP intake (kg/d)	0.27 ± 0.02	0.30 ± 0.01	0.28 ± 0.01	0.31 ± 0.01
DCP intake (g/kg $W^{0.75}$)	5.58 ± 0.27	6.27 ± 0.65	5.65 ± 0.22	5.90 ± 0.31
TDN intake (kg/d) *	2.65 ± 0.17^{a}	3.37 ± 0.09^{bc}	3.59 ± 0.02^{c}	3.09 ± 0.07^{b}
TDN intake (g/kg$W^{0.75}$)	54.2 ± 4.24	70.4 ± 6.74	71.7 ± 5.62	57.5 ± 1.79
Cost economics of milk production				
Total cost of feeding (□) *	$6,255^{a} \pm 4.95$	$7,050^{a} \pm 2.61$	$6,198^{a} \pm 3.60$	$10,080^{b} \pm 1.80$
Total milk production (kg) *	$139.27^{a} \pm 10.07$	$152.49^{a} \pm 5.94$	$212.27^{b} \pm 27.24$	$221.70^{b} \pm 19.33$
Total FCM yield (kg) *	$236.55^{a} \pm 34.10$	$305.73^{ab} \pm 51.76$	$596.86^{bc} \pm 1.35$	$647.79^{c} \pm 1.10$
Feed cost/kg of milk *	$45.26^{b} \pm 4.00$	$46.24^{b} \pm 0.08$	$29.72^{a} \pm 2.07$	$46.23^{b} \pm 4.51$
Feed cost/kg of FCM *	$27.4^{c} \pm 3.93$	$24.1^{bc} \pm 3.12$	$11.3^{a} \pm 2.14$	$16.4^{ab} \pm 2.70$

^{abc} Values in a row bearing superscripts differ significantly *($P < 0.05$)

Nutrient intake

Dry matter intake (DMI)

The DMI (kg/d) was significantly (P<0.05) highest in T3 and lowest in T1, with the order T3 > T2 > T4 > T1 (Table 4). When expressed as % B. Wt and g/kg $W^{0.75}$ was significantly (P<0.05) higher in T2 or T3 than in T4 and T1. This clearly indicated that paddy straw, which is deficient in nitrogen, energy and minerals was consumed in higher quantities, when these deficiencies were overcome by supplementing with UMMB plus concentrate. This might also be due to the better palatability of concentrate and UMMB and theavailability of readily fermentable nitrogen from UMMB which enhanced the proliferation and growth of microbes (Leng, 1984; Jayasurya, 1987), which consequently improved the dry matter intake. These results are in agreement with (Madhu Mohini and Gupta, 1993; Hosamani et al., 1995; Toppo et al., 1997) who opinioned that supplementation of limiting nutrients either for degradation in rumen or utilization of nutrients by animals increases the voluntary intake of straw in crossbred cattle. Present findings were comparable within the range reported by Srinivasa et al. (2017) and Manjunatha et al. (2020) for DMI (kg/d) in malnadgidda cows. Whereas slightly lower values than the present study were reported by Venkataramana, (1996) in punganur cows. The marginal variation in the DMI (kg/d)observed in the present study and earlier reports attributed to the variation in the live weight of the animal and the nutrient composition of the experimental rations.

Crude protein intake (CPI)

The CPI (g/d) was in the range of 454.90 to 535.87 in T1 to T4 and non-significant. Numerically higher CPI in cows fed with TMR might be due to higher palatability, reduced particle size and increased nutrient density of the rations (Haloi et al., 2021).

Digestible organic matter intake (DOMI)

The DOMI (kg/d) was significantly (P<0.05) higher in T3 & T2 than T4 &T1. DOMI when expressed as % B. Wt and g/kg$W^{0.75}$ has significant (P<0.05) difference among the experimental rations. The highest DOMI in T3 might be due to UMMB supplementation and higher DMI, that have higher amount of digestible organic matter which might have increase digesta flow and microbial yield (ARC, 1984).

Digestible crude protein intake (DCPI)

The DCP intake (kg/d) in the present study ranges 0.246 to 0.332 in T1 to T4, respectively without any difference. Present findings were coinciding with the values reported by Srinivas et al. (2017) and Manjunatha et al. (2020) in malnadgidda cows. In contrast to the present study higher DCP intake reported by Patel et al. (1984) in Kankrej cows and Chowdary et al. (2019) in Gir cows.

Total digestible nutrient intake (TDNI)

The TDN intake (kg/d) in the present study was significantly (P<0.05) higher in T3 (3.59) followed by T2 (3.37), T4 (3.09) than in T1 (2.65).Results of present study are also supported by the findings of Manjunatha et al., (2020) in malnadgidda cows. In contrast to the present study higherTDN intake reported by Patel et al. (1984) in Kankrej cows and Chowdary et al. (2019) in Gir cows. The higher TDN intake in T3 group observed in the present studymight be due to higher DMI and UMMB supplementation as reported by Sudhakar et al.(2002). The difference in DCPI and TDNI observed in other groups might be attributed to the difference in the digestibility of different nutrients.

Cost economics of milk production

The total feed cost (Rs.) offered during 90 days lactation trial was significantly (P<0.05) highest in T4 as compared to T2 or T1 or T3 (Table 5).The feed cost (Rs.) per kg milk production and per kg FCM was found to be significantly (P<0.05) lower in T3. The present findings are in agreement with (Yadav et al*.,* 2012: Suresh babu et al., 2013) who opinioned that the feed cost (Rs.) per kg FCM was economical in paddy straw, concentrates and UMMB group in cross bred cows. This study indicated that feed cost per kg milk and FCM yield was lower in T3. In addition, there is a demand for urine for preparation of medicines and sanitary solutions and

dung is extensively used for organic manure purpose, but both were excluded for economics calculation. If these two components are included with milk, the margin of the profit would have further been increased (Sabapara et al., 2015).

CONCLUSION

Based on the results of the present study, it may be concluded that TMR and Paddy straw, concentrates and UMMB significantly improved both milk and FCM yield of the Punganur cows whereas milk composition was not affected by the experimental rations. The digestibility coefficients of different nutrients did not differ among the experimental rations except for DM and OM. The plane of nutrition satisfied the ICAR (2013) requirements. Studies on the large number of animals to access exact nutrient requirements need to be carried out.

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