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Effect of Protein Supplements on Nutrient Utilization and Production of Lactating Gir Cows

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ABSTRACT

A study was conducted on 16 lactating Gir cows, which were divided into four groups on the basis of body weight and average milk yield/day at Dairy farm (LPM Deptt.) S.K.N. College of agriculture, Jobner (Rajasthan) and subjected to four dietary treatments i.e. Wheat straw *ad-lib*.+ Green Lucerne (5 kg) + Concentrate (T_1), T_1 + Urea 75 g/cow (T_2), T_1 + Mustard oil cake 614 g/cow (T_3) and T_1 + Guar meal 505 g/cow (T_4). The studied for their nutrients utilization of protein supplements and milk yield of Gir cows. Average daily intake of CP and DCP in kg/100 kg body weight was significantly higher ($P<0.05$) in T_4 compared to other groups Average daily TDNI kg/100kg body weight was significantly higher ($P<0.05$) in T_4 (1.56) compared to T_3 (1.41), T_2 (1.32) and T_1 (1.24) groups. The nutrient utilization as DM, CP, EE and NFE was significantly ($P<0.05$) higher in T_4 compared to T_3, T_2 and T_1 groups Crude fibre was significantly ($P<0.05$) higher in T_3 compared to T_4, T_2 and T_1 groups. Average daily milk production (litre/cow) was significantly ($P<0.05$) higher in T_4 (7.85) than T_3 (7.13), T_2 (7.05) and T_1 (6.67). It can be inferred from this experiment that feeding of concentrate mixture on Wheat straw diet with Guar meal supplement increased the milk production.

HIGHLIGHTS

- We studied on effect of protein supplements on Nutrient Utilization and Production of Lactating Gir Cows
- Feeding of Guar meal increased the milk production and digestibility as compared to Urea and Mustard oil cake in Gir cows.
- Guar meal may be increased palatability and utility of poor quality roughage.

Keywords: Gir cows, Milk yield, Nutrient utilization, Protein Supplement, Total Digestive Nutrients

Livestock is an integral part of agriculture and plays an important role in contributing to national economy. Total Milk production in the India was 187.7 million tonnes during 2019. India is the world's largest milk producer, with 21 per cent global production. The per capita availability of milk in India was 394 g per day in 2018-19 (GOI, 2018-2019). Rajasthan is ranked 2nd in India and produces 23.6 million tonnes of milk every year. The per capita availability of milk in Rajasthan was 870 g (GOI, 2018-2019). Total cattle population in the India was 192.49 M (GOI, 2019) and total indigenous cattle population in India was 142.11M (GOI, 2019). Total cattle population in Rajasthan was 13.9 M (GOI, 2019). Gir is a most important milch cattle breed of India. The distribution of this breed is Gir hills and forest of Kathiawar and Amreli districts of Gujarat and also in some parts of Maharashtra and Rajasthan. The body of Gir animals is well proportioned, the head is moderately long but massive in appearance with prominent bony forehead straight and leveled back are the most the marking characters of the breed and body colour is red to white, Udder is well developed and round in Gir cattle. Cattle of this breed are good milk yielders in

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the Indigenous cattle. Total lactation milk yield averaged 2063 litres in an average lactation period of 326 days. Milk yield per day was 4.98 litres. Average fat percentage in the milk ranged between 4.69±0.04 and 4.97±0.02 (Gaur *et al.,* 2003). Nutrition plays crucial role in growth, reproduction and production of animals but the biomass resources are very limited and there is shortage of feed and fodder. There is a serious shortage of conventional feed resources. Hence, it is necessary to look for protein rich, nonconventional feed resources. In India there is shortage of 22.5 per cent dry fodder, 62.7 per cent green fodder (IGFRI, 2010) and 34 per cent concentrate to meet the requirement of vast bovine population. Urea is non-protein nitrogen compound. As an NPN-source urea can replace part of the dietary protein in the ruminant diet. Urea contains about 46 per cent nitrogen and protein contains 16 per cent nitrogen. The crude protein equivalent value of urea is about 287 per cent crude protein. Urea when used for treatment of straw boost the nutritional quality of straw in terms of increased nitrogen content, enhanced the palatability and digestibility.

The composition of mustard cake (MC) varies with the variety, growing conditions and processing methods. The crude protein content varies from 33-40 per cent in mustard cake. Mustard cake contains 21 per cent carbohydrate, 8.5 per cent crude fiber and 8 per cent ash (Sehwag *et al.,* 2015). Mustard cakes have D.C.P. and T.D.N. values 27 per cent and 74 per cent respectively. Guar meal is considered as a potential unconventional feed resource for livestock. Guar Meal used in concentrate rations for lactating dairy cows. Processed meal can be used as the sole protein component of cattle diets. Guar meal contains 38-50 per cent protein depending on the type of fraction (Salehpour *et al*., 2012). It is extensively used as emulsifier, thickener and stabilizer in food and oil industries. Guar meal have about 65 per cent T.D.N.. Being a rich source of proteins, nutrients and fibres with high digestibility, it is being used as feed after processing for animals. It is having upto 50 per cent of protein with a high digesting content, which improves digestive system of cows. As it is very high in protein it gives, extra fat in its milk and also increase the quantity of milk. In view of lack of protein resources, appropriate treatment on cakes may be one of the strategies to provide the collision us to efficiency of utilization of nutrients for development and milk. Mustard cake and Guar meal is relatively very rich in energy and protein contents than other feed ingredients. The supplementation of forages by oil cakes could be a potential way to improve the nutritional quality of low-quality feeds (Khandakar *et al.,* 2011).

MATERIALS AND METHODS

The experiment was carried out at Dairy farm, Department of Livestock Production Management, S.K.N. College of Agriculture, Jobner (Jaipur). Sixteen lactating Gir cows in mid stage of lactation were selected for the experiment. They were randomly divided into four groups of four in each group on basis of nearness in their production and body weight of cows and four dietary treatments were formulated i.e. Wheat straw *ad lib*. + 5.0 kg Lucerne + Concentrate palleted feed (T_1), T_1+ Urea @75 g per cow per day (T_2), T_1+ Mustard cake @614 g per cow per day (T_3) and T_1 + Guar meal @505 g per cow per day (T_4) and the studied for their feed intake and water intake in Gir cows. A system of housing is more or less synonymous to the system of management of dairy cattle. Similar housing and managemental facilities were provided to all the groups.

Feeds and feeding of animals

Animal were stall fed individually ad libitum of dry fodder and weighed quantities of rations were offered twice in a day. The concentrate used palleted prepared feed from RCDF which contain 18 per cent crude protein and 75 per cent DCP and Lucerne (*Medicago sativa*) green fodder and Wheat straw dry fodder were used as roughages. The animals were fed in the morning and evening as per their requirement the feeding schedule of gir cows is given table 1.

Parameters studied and observation taken

Collection of dung

The animal were housed in closed barn and fed twice a day. The faeces were collected quantitatively once a day before the morning meal. Total dung voided by each Gir cows during twenty four hours was collected and weighed. Adequate care was taken to avoid mixing of feces with urine. A 100 gm representative sample of 1/100th part of

Table 1: Feeding schedule of Gir cows

Sl. No.	Feed and Fodders	Quantity of feed and fodders
1	Concentrate pelleted feed	Maintenance ration production ratio 2 kg/animal and production ratio given to animal 1 kg/ 2.5 liter milk yield
2	Protein Supplements	Urea 75 g, Mustard cake 614 g and Guar meal 505 g per cow treatment wise.
3	Lucerne green	5.0 kg per cow
4	Dry fodder (Wheat straw)	Ad libtum

total feces of each animal was weighed in a silk dish daily and were kept in hot air oven at 105ºC temperature for overnight for the determination of dry matter.

Chemical analysis of feeds, fodder, refusal and feaces

The chemical and *in-vitro* analysis was done in the Dry matter content of dry fodder (Wheat straw), concentrate (pelleted feed) and feaces (cow dung) were determined. The samples of feed, fodder and feaces, residue left over were analyzed for proximate principles (AOAC, 2000). To formulate the ration values were taken from actual analysis of the sample at laboratory of Goat RKVY project and Nutrition laboratory of CSWRI, Avikanager. The methodology used for analysis was as follows:-

Determination of Dry matter

The representative samples were analyzed for dry matter (DM), total ash (TA), crude protein (CP), ether extract (EE) and crude fiber (CF). The DM was determined by dry samples at temperature 105ºC in a hot air oven for 24 hours. Dry the moisture cup in an oven at 100°C, cool it in a desiccators and record its weight. Take about 10 g of the material in the moisture cup and weigh out to calculate actual amount of material taken.

Moisture (%) =

$$\frac{\text{Initial wt. of moisture cup + Sample – Final wt. After drying}}{\text{Wt. of the sample}} \times 100$$

Dry matter = 100 – Moisture (%)

Crude protein estimation

Crude protein in various samples of feed and faeces was analyzed using semi auto analyzer Kelplus nitrogen estimation system (Pelican Equip). For this take 0.5 gm of sample and transferred it to the digestion tube. Add 10-15 ml of concentrated Sulphuric acid and 5-7 gm of digestion activator to the sample. Then the digestion tube is loaded into digester and the digestion block is heated by maintaining the block temperature between 360ºC-410ºC. The sample turns colorless or light green color at the end of digestion. After digestion, the measured quantity of aliquot was distilled in automatic distillation system by adding 40 per cent NaOH by auto mode until brown color develops. Then the digested sample was heated by passing steam and the ammonia liberated was trapped into 4 per cent boric acid and mixed indicator (0.3 g of 67 bromocresol green and 0.2 g methyl red in 400 ml of 90 per cent ethanol). The distillate was titrated against 0.1N H_2SO_4. The quantity of nitrogen was estimated, on the basis of fact that 1.0 ml of standard 0.1N H_2SO_4 is equivalent to 0.0014 g nitrogen. The CP content in the sample was determined as a multiple factor 6.25, following the equation-

Nitrogen (%) =

$$\frac{\text{10-15 ml of N/10 sulphuric acid} \times 0.0014 \times \text{D}}{\text{Sample weight (g)} \times \text{A}} \times 100$$

Where,

0.0014 = Standard factor

D = Dilution factor

A = Aliquot taken

Per cent CP = Per cent N × 6.25

Total fat/ Ether extract

Estimation of ether extract in feed and faeces was done with the help of Soxhlet's apparatus. For this 2 g of oven dried powdered sample was taken in a thimble. This

was placed in the extraction tube of Soxhlet's apparatus. The extraction tube was connected above with the water condenser and below with oil flasks through standard joints. Extraction was carried out for six hours with petroleum ether (AR) of boiling point 40 to 60ºC, at the rate of eight extractions per hour. At the end of each extraction the flask was then disconnected, it's contents were dried in an oven and the flask along with fatty residue was weighed after cooling in a desiccators. The difference in the two weights denoted the amount of ether extract in the sample. The results were expressed on percentage basis. The ether extract was calculated as follows:

$$\text{Ether extract (\%)} = \frac{100(W_1 - W_2)}{W}$$

Where,

W_1 = Weight (g) of oil flask with the dried ether extract

W_2 = Weight (g) of oil flask

W = Weight (g) of dried material taken

Crude fiber

Transfer the weighed fat free samples into oven dried crucibles. Place the crucible into the metal adopter of fiber plus hot extraction unit and Acid wash with pour 150 ml of 1.25 H_2SO_4 at 500°C for 40 min. After 40 min. boiling, drain the acid and wash the samples twice or thrice with distilled water. There after Alkali wash with pour 150 ml of 1.25 NaOH at 500ºC for 40 min. After 40 min. boiling, drain the acid and wash the samples twice or thrice with distilled water. After alkali wash take out crucibles and dry them in hot air oven until the crucibles are free from moisture. Weight the crucibles and place all crucibles in ignited the muffle furnace at 550ºC for four hours ashing. Weight crucibles after ashing record the reading.

$$\text{Crude fiber content (\%)} = \frac{A - B}{C} \times 100$$

A = weight of crucible with dry residue (g); B = weight of crucible with ash (g); C = weight of sample (g)

Total ash

5 g dried sample was placed in the pre-weighed silica crucible, smoked and then total ash was determined by ashing at a temperature 550ºC in muffle furnace for 6 hours (AOAC, 2000) and expressed as percent of the dried sample.

$$\text{Ash (g/100 g)} = \frac{\text{Weight of Ash}}{\text{Weight of sample}} \times 100$$

Calculation of Nitrogen-Free Extract (NFE)

$$\text{NFE (\%)} = 100 - (\text{CP\%} + \text{CF\%} + \text{EE\%} + \text{Total ash})$$

Where,

CP = Crude protein

CF = Crude fibre

EE = Ether extract

Total Digestible Nutrients (TDN)

$$\text{TDN} = \text{DCP} + \text{DCF} + \text{DNFE} + \text{DEE} \times 2.25$$

Where,

TDN = Total digestible nutrients (kg)

DCP = Digestible crude protein

DCF = Digestible crude fibre

DNFE = Digestible nitrogen free extra

DEE = Digestible ether extract

Milk yield

All cows were cleaned and washed before each milking throughout the experiment routine practices of farm. The record of daily milk yield of each cow were maintained throughout the experiment peroid of 90 days. The milk yield was be recorded daily in the morning and evening to nearest 50 gm with the help of 100 kg electronic weighing machine during the experiment. Milking of individual cows was done by hand and machine milking.

Statistical analysis of data

The data obtained was processed to analysis of variance as per standard method (Snedecor and Cochran, 1994). Different statistical tools such as mean, standard deviation (SD), standard error (SE) were worked out to compare the group.

RESULTS AND DISCUSSION

The data collected during the experimental trial were subjected to standard methods of statistical analysis and presented in this chapter in the form of tables, graphs along with the implications of the results to the effect of protein supplements on nutrients utilization and production of lactating Gir cows under following heads:—

Proximate composition of feed and fodders

The Chemical composition of different feed and fodders ingredients on laboratory is given in Table 2.

Crude protein and digestible crude protein intake

The average crude protein intakes (CPI) have been given in Table 3. The daily CP intake in T_1, T_2, T_3 and T_4 groups cows were 1.26±0.04, 1.21± 0.06, 1.34±0.04 and 1.36±0.03 g, respectively. The mean CPI/100kg body weight was 0.292±0.02, 0.278±0.07, 0.308±0.02 and 0.312±0.001 kg, respectively. The CP intake in the treatment T_4 was more ($P<0.05$) as compared to T_3, T_2 and T_1 groups. The average daily DCP intake (DCPI) was 0.620±0.085, 0.685±0.115, 0.745±0.072 and 0.798±0.075 g, respectively. The mean DCPI/100kg body weight was 0.143±0.041, 0.157±0.055, 0.171±0.035 and 0.183±0.036 kg, respectively.

The DCP intake in the treatment T_4 was higher than T_3, T_2 and T_1 ($P<0.05$). The higher crude protein and digestible crude protein intake in treatment T_4 group might be attributed to higher dry matter intake, which was due to better utility of nutrients through feed additive as Guar meal conditions. Crude protein intake by the animals was sufficient to meet the body requirements. Prasad *et al.* (1998) Found that the rate of CP digestion decreases with increasing the proportion of guar meal. The results are in agreement with the findings of Imaizumi *et al.* (2010). Wala *et al.* (2016) found that increasing level of Guar meal in buffalo's diet also increasing DCP.

Total digestible nutrients intake

The average total digestible nutrients intake (TDNI) has been given in Table 3. The daily consumption of TDN by cows was 5.38±0.177, 5.74±0.175, 6.13±0.219 and 6.79±0.308 kg in treatments T_1, T_2, T_3 and T_4 respectively. The feed supplements had significant ($P<0.05$) influence on TDN intake by Gir cows. The average daily TDN intake was more ($P<0.05$) in T_4 as compared to T_3, T_2 and T_1

Table 2: Chemical compositions (%) of feed and fodder (DM basis)

Sl. No.	Feed ingredients	DM	CP	EE	CF	NFE	ASH
1	Concentrate mix.	90.30	19.26	3.60	6.22	60.42	10.5
2	Wheat Straw	91.27	4.10	1.30	34.20	49.20	11.20
3	Green Lucerne	24.50	18.30	2.05	19.80	46.95	12.90
4	Mustard cake	90.70	35.00	10.25	9.87	35.28	9.60
5	Guar meal	93.40	42.5	4.75	9.12	37.92	5.71
6	Urea	—	287.5	—	—	—	—

Table 3: Average daily intake of crude protein, DCP and TDN in (kg) in cows under different treatments during winter season

Parameters	T_1	T_2	T_3	T_4
Crude protein intake (CPI)	1.26^{c}±0.04	1.21^{d}±0.06	1.34^{b}±0.04	1.36^{a}±0.03
CPI/100 kg BW	0.290^{c}±0.02	0.278^{d}±0.07	0.308^{b}±0.02	0.312^{a}±0.01
DCP intake	0.620^{d}±0.085	0.685^{c}±0.115	0.745^{b}±0.072	0.798^{a}±0.075
DCP intake/100 kg BW	0.143^{d}±0.041	0.157^{c}±0.055	0.171^{b}±0.035	0.183^{a}±0.036
Daily TDN intake	5.38±0.177	5.74±0.175	6.13±0.219	6.79±0.308
TDN intake/100 kg BW	1.24±0.085	1.32±0.084	1.41±0.105	1.56±0.148

Means having different superscripts differ significantly ($P<0.05$).

groups. When TDN intake was calculated on 100 kg body weight basis it was 1.24±0.085, 1.32±0.084, 1.41±0.105 and 1.56±0.148 kg in T_1, T_2, T_3 and T_4 cows, respectively.

The TDN intake was higher in T_4 group than other three groups T_3, T_1 and T_2. Improved nutrient utilization with higher feed intake resulted higher TDNI in Guar meal supplemented group. The higher DCP and TDNI in T_4 as compared to T_3, T_2 and T_1 group cows might be attributed to higher DMI. The results are in agreement with the findings of Rekhate, *et al*. (2008). Wala *et al.* (2016) indicated that increasing TDN intake with increasing level of Guar meal.

Digestibility co-efficient of feed nutrients

Apparent digestibility for sake of brevity will here after be called digestibility. The average digestibility co-efficient of various nutrients in different experimental groups are presented in Table 4, which indicated that the digestibility coefficient of all nutrients. The nutrient digestibility was significantly (P<0.05) higher in T_4 group.

The average digestibility of Dry Matter (DM) in T_1, T_2, T_3 and T_4 was 62.54±0.150, 62.89±0.190, 64.78±0.201 and 65.62±0.216 per cent, respectively. The digestibility of Crude protein (CP) in T_1, T_2, T_3 and T_4 was 52.47±0.105, 58.12±0.110, 61.08±0.167 and 62.11±0.145 per cent, respectively. Which was higher (P<0.05) in T_4 than T_3, T_2 and T1 groups. The digestibility of Ether extract (EE) in T_1, T_2, T_3 and T_4 was 55.55±0.278, 58.45±0.154, 61.06±0.245 and 63.09±0.115 per cent, respectively. The digestibility of Crude fibre (CF) in T_1, T_2, T_3 and T_4 was 61.88±0.450, 60.24±0.140, 62.19±0.354 and 61.70±0.102 per cent, respectively. The digestibility of Nitrogen free extracts (NFE) in T_1, T_2, T_3 and T_4 was 68.12±0.107, 68.84±0.169, 71.05±0.151 and 72.84±0.121 per cent, respectively.

The digestibility co-efficient of DM was higher (P<0.05) in T_4 than T_3, T_2 and T_1 groups. Felisberto *et al.* (2011) reported that DM digestibility was significantly higher by protein supplements. Similar trend were reported by Sharma *et al.* (2012). Crude protein was higher (P<0.05) in T_4 than T_3, T_2 and T_1 groups. Broderick (2003) agreed with adding protein supplements in animal diets to increase CP. Garg *et al.* (2003) agreed with crude protein intake increase by supplementing of protein sources in animal diet. Batista *et al.* (2016) founded that CP digestibility was increased with protein supplements. Similar result reported by Rufino *et al.* (2016). The digestibility co-efficient of EE was higher in T_4 group than T_3, T_2 and T_1 groups. Jongwe *et al.* (2014) reported that protein supplements also increase digestive EE. The digestibility co-efficient of CF was not also significant differ between the treatments. Jelantik *et al.* (2010) reported that crude fibre was significantly improved by supplementation of protein source.

The digestibility of nitrogen free extract was higher (P<0.05) in T_4 than T_3, T_2 and T_1 groups animals. Apparent digestibility of DM, CP, and NFE were significantly (P<0.05) higher in T_4, as compared to T_3, T_2 and T_1 groups due to higher DMI and VWI which was more palatable with the protein supplements. These results are in close agreement to the findings of Prasad *et al.* (1998). Khandakar *et al.* (2011) significant (P<0.01) increase is digestibility value are obtained for DM, OM, CP in rumen. The DM, OM, CP, digestibility were higher is treated than untreated rice straw. However these were no different between urea & urea-calcium. Etaman *et al.* (2014) who reported that the increasing Guar korma level in experimental ration tended significantly (P<0.01) increase DM, OM, CP, EE & CF digestibility. Wala *et al.* (2016) agreed the values of all parameter were slightly increase with increasing the

Table 4: Average digestibility coefficient of nutrient under different treatments during winter season

Nutrients	T_1	T_2	T_3	T_4
DM	62.54^{d}±0.150	62.89^{c}±0.190	64.78^{b}±0.201	65.62^{a}±0.216
CP	52.47^{d}±0.105	58.12^{c}±0.110	61.08^{b}±0.167	62.11^{a}±0.145
EE	55.55^{d}±0.278	58.45^{c}±0.154	61.06^{b}±0.245	63.09^{a}±0.115
CF	61.88^{b}±0.450	60.24^{d}±0.140	62.19^{a}±0.354	61.70^{c}±0.102
NFE	68.12^{d}±0.107	68.84^{c}±0.169	71.05^{b}±0.151	72.84^{a}±0.121

Means having different superscripts differ significantly (P<0.05).

replacement level of Guar meal concentrate in concentrate feed mixture.

Milk yield

The mean value of milk production data recorded under different treatments is presented in Table 5 and Fig. 1. The average milk production in morning was 3.63±0.29, 3.85±0.09, 3.85±0.09 and 4.33±0.15 litre/day in T_1, T_2, T_3 and T_4, respectively. The average milk production in evening was 3.04±0.20, 3.20±0.07, 3.73±0.17 and 3.52±0.10 litre/day in T_1, T_2, T_3 and T_4, respectively. The total milk production in T_1, T_2, T_3 and T_4 was 6.67±0.19, 7.05±0.06, 7.13±0.09 and 7.85±0.08 liter/day, respectively. Overall milk production was higher in T_4 Guar meal fed group as compared to T_3, T_2 and T_1 in Gir cows.

Milk is a complex mixture of fats, proteins, carbohydrates (Lactose), minerals, vitamins and other miscellaneous constituent's dispered in water. Milk yield in T_4 was higher ($P<0.05$) as compared to other treatments due to affected by Guar meal. The decling trend of milk due to seasonal effect as well as stage of lactation. Milk production was higher in cows with higher DM intake reported by Chatterjee and Walli (2003), Morteza and Quazvinian (2010). Increases yield of milk on the diets supplemented with the true protein reported by Brito and Broderick (2007). Selehpour *et al.* (2012) found that increasing milk yield with feeding of Guar meal diet, Sirohi *et al.* (2013) founded that protein supplements improved milk production in cow. Soliman *et al.* (2014) indicated that protein supplements in animal diet will have a positive effect on milk yield. Similar result also reported by Mishra *et al.* (2018).

Table 5: Daily milk production (liter)/cow under different treatments during winter season

Parameter	T_1	T_2	T_3	T_4
Morning	3.63^{d}±0.29	3.85^{b}±0.09	3.73^{c}±0.17	4.33^{a}±0.15
Evening	3.04^{d}±0.20	3.20^{c}±0.07	3.40^{b}±0.06	3.52^{a}±0.10
Total	6.67^{d}±0.19	7.05^{c}±0.06	7.13^{b}±0.09	7.85^{a}±0.08

Means having different superscripts differ significantly ($P<0.05$).

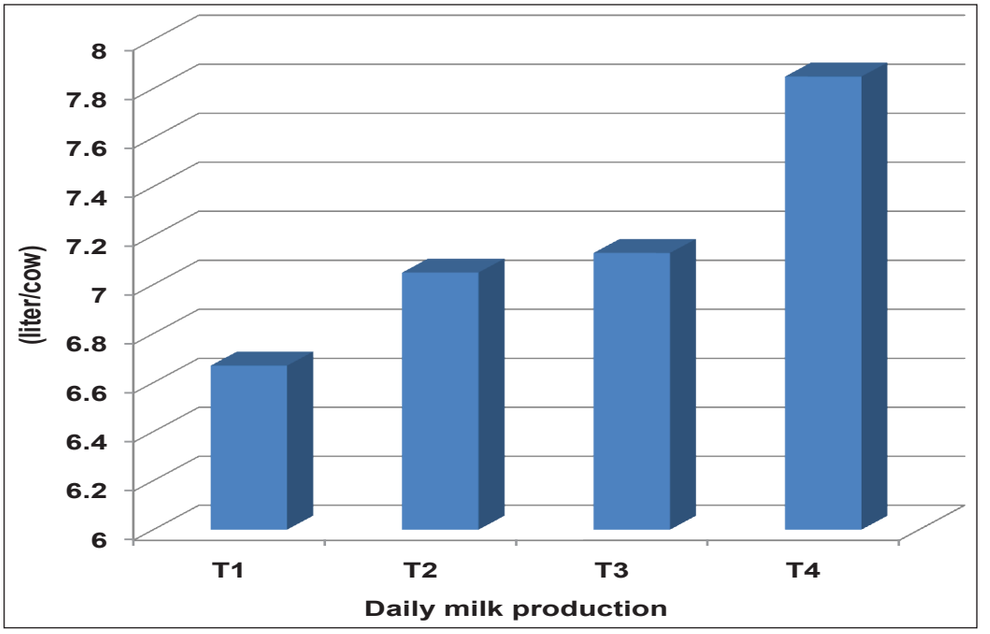

Fig. 1: Daily milk production (liter/cow) under different treatments during winter season

CONCLUSION

Therefore, It can be concluded that feeding of Guar meal (T_4) increased the milk production and digestibility as compared to Urea and Mustard oil cake feeding in Gir cows as well as increased palatability and utility of poor quality roughage (Wheat straw). Guar meal feeding group was also more economical as well as better perform of milk production of Gir cows during winter season.

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