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ORIGINAL ARTICLE

Effect of Supplementing Formaldehyde Treated Rape Seed Meal on Milk Production, Gross Milk Composition, Digestibility of Nutrients and Feed Conversion Efficiency in High Producing Crossbred Cows

S.K. Throat, R.S. Gupta, Sachin Shankhpal* and Subhash Parnerkar

Animal Nutrition Research Department College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand Campus, Anand 388110, Gujarat, India.

*Corresponding Author:

Sachin Shankhpal

Email: drshankhpalvet@gmail.com

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Abstract

A study was undertaken to investigate the effect of supplementing formaldehyde treated rape seed meal on milk production, milk composition and feed conversion efficiency. Dietary supplementation of formaldehyde treated rape seed meal had no significant effect on the dry matter intake of cows from different groups. The average milk yield and 4% FCM yield were significantly ($P<0.05$) higher in T2 groups, as compared to T1 group. The average milk fat and total solids were significantly ($P<0.05$) higher in T2 group receiving formaldehyde treated rape seed meal, as compared to T1 group. The average daily CP intake and TDN intake in T1 and T2 groups were similar and satisfactory during lactation trial. Dry matter intake to produce one kg milk and 4% FCM was found to be 0.902 and 0.792kg and 0.846 and 0.727kg under T1 and T2, respectively at ($P<0.05$). The average daily returns over feed cost (Rs/cow) was 27.33 higher in cows yielding daily 20-21kg milk fed formaldehyde treated rapeseed meal (bypass protein) diet than the cows fed control diet.

Keywords: Milk Production, Milk Fat, Feed Conversion Efficiency, Formaldehyde Treated Rape Seed Meal, Crossbred Cows.

1. Introduction

Protein meals are increasingly used in livestock feeding, as the oil finds other commercial applications. Proteins particularly rumen escape proteins, form one of the most valuable constituents of the ruminant ration. It is therefore, of paramount importance to ensure that this constituent is utilized with high efficiency (Garg, 1998). The most promising approach seems to be the modification of dietary protein by formaldehyde (HCHO) treatment (Faichney, 1971). Utilization efficiency of protein meals could be improved if they are subjected to suitable chemical treatment by a process known as bypass protein technology, in which the proportion of protein degraded by rumen micro organism is reduced, thereby increasing its availability to the ruminant animal (Garg *et al*., 2007) post-ruminally. Several feeding strategies have been developed to improve production performance of livestock in India, but met with limited success, because of cost involved in treatment or its field adoption and has found little acceptance by the farmers. A lot of work has been carried out on the formaldehyde treatment of groundnut cake (Gupta and Walli, 1987) however, very little work has been reported on rapeseed meal. Mustard cake is one of the cheapest protein supplements for livestock, having a very good amino acid profile (Chatterjee and Walli, 2002), but highly degradable in rumen (Sampath, 1990). Therefore, it may be worthwhile to feed this cake after protecting its protein with formaldehyde. Formaldehyde not only protects protein and the limiting amino acids like methionine and lysine, which is reported in higher quality in mustard-cake (Chattergee and Walli, 2002), but also prevents the degradation of glucosinolates of the cake in rumen to a more toxic form *i.e.* thiocynate, which disturbs the animal thyroid metabolism and also gets excreted into milk. With this concept in mind, a farm trial was conducted to study the effect of feeding formaldehyde treated rapeseed meal to high producing lactating crossbred cows.

2. Materials and Methods

2.1 Location of the Study

The study was conducted at organized dairy farm in village Bochason of Anand District, Gujrat, India.

2.2 Animals and Treatments

Eighteen lactating crossbred cows in their 2-4 lactation were selected and divided in two groups (n=9) according to daily milk yield, milk fat %, stage of lactation and parity. The animals in T1 (control) fed chaffed paddy straw, chopped green Napier grass (*Penesitumperpurium*) and Home-made concentrate mixture (HMCM) as per the requirement calculated by NRC (2001). While, the animals in T2 (Bypass protein group) were fed the same ration supplemented with formaldehyde treated rapeseed meal. One kg formaldehyde treated rapeseed meal (Bypass protein with 70% UDP level) was provided to the cows under treatment group (T2) by replacing two kg HMCM on protein equivalent basis to make the control and treatment ration isonitrogenous.

2.3 Feeding and Management of Experimental Animals

The experimental animals were housed in ideal sheds with proper ventilation, flooring and tying arrangements. Normal standards of hygiene, management, feeding practices, vaccination and deworming were followed for all the experimental cows throughout the experiment. Conventional practice of feeding concentrate and roughage separately was followed throughout the experiment. The concentrate mixture was compounded on the farm by hand mixing of different feed ingredients. The ingredients and their proportions used for preparation of home-made concentrate mixture (HMCM) are given in Table 1. The farmer procured the feed ingredients from local market in bulk quantities. All cows were cleaned and washed before each milking throughout the experiment as a routine practice of farm.

Table 1: The proportions (%) of ingredients used in home-made concentrate mixture.

Ingredients	Proportions		
	1	2	3
Mung bhardo	7.22	5.88	8.16
Legume mix.	15.46	-	-
Tur chunni	77.32	88.24	73.48
Cotton seed cake	-	5.88	8.16
Maize cake	-	-	10.20
Total	100.00	100.00	100.00
Calculated CP %	17.86	17.57	17.89
Calculated TDN %	68.25	67.99	68.72

The HMCM were prepared fresh every day by hand mixing and fed to the animals at 4.30 a.m. and 4.30 p.m. before milking. Thirty kg chopped green Napier grass (*Penesitumperpurium*) was fed to meet vitamin A requirement. The paddy straw was fed as basal roughage.

2.4 Sampling Technique

The crossbred cows were hand milked twice daily (5.00 A.M in morning and 05.00 P.M in evening) and yields were recorded. The milk samples were collected at fortnight intervals from individual animals during both times of milking. After through mixing, milk sample (100-150 ml) from each cows was taken by means of a dipper and transferred to a sample bottle with rounded corners (to avoid lodging of the milk solids) up to 3/4th level, and then the bottle was corked tightly. The sample bottles were labeled and dispatched to laboratory on same day for further analysis of fat, total solids and SNF, contents as per BIS (1981).

2.5 Analytical Technique

The amount of DM and TDN available to lactating crossbred cows were calculated from the records of intake of feeds and fodder, using digestibility coefficients/nutritive values given by Sen *et al.* (1978), Ranjhan (1991) and Anonymous (2005). The representative samples of concentrate mixture, paddy straw, green fodder, left over and faeces were collected during digestion trial and the pooled samples were analyzed for proximate constituents as per AOAC (1995).

2.6 Economics

Economics of feeding under different treatments was calculated from the records of daily feed consumption and by considering the procurement cost of feeds and fodder used for feeding of experimental cows. Gross returns from sale of milk from different groups were worked out considering average daily milk production per animal over 120 days period and price of milk fat per kg paid to the farmer by cooperative sector. Daily gross profit per cow, from different groups, was worked out taking into account, average daily feeding expenses per animal and sale price of milk.

2.7 Statistical Analysis

The data generated during the experiment were subjected to one way analysis of variance as per the methods of Snedecor and Cochran (1994), with the help of SPSS package programme (SPSS 9.00 software for Windows, SPSS Inc., Chicago, IL). The Completely Randomized Design was followed.

3. Results and Discussions

3.1 Chemical Composition of Feeds and Fodder

The feeds and fodder used for feeding of lactating crossbred cows during the experimental period were analyzed for proximate composition and the results are presented in Table 2. The Home-made concentrate mixture (HMCM) used for feeding of lactating crossbred cows during the experimental period was analyzed for proximate composition and results are presented in Table 3.

3.2 Effect on Feed intake, Milk Production and Gross Milk Composition

The average total dry matter intake of cows under T1 (control) and T2 (bypass protein) was 17.46 and 16.68kg per cow per day, respectively (Table 4). The higher dry matter intake was observed in T1, however, differences between the treatments were non-significant. These data suggested that cows under control consumed 4.46% more dry matter than the cows under treatment group. Similar non-significant effect on dry matter intake due to feeding of bypass protein was reported by Srivastava and Mani (1995), Ramachandra and Sampath (1995), Kumar *et al. (*2005), Kumar *et al.* (2006) and Pailan *et al.* (2007). The present findings are in agreement with the findings of these research workers. In contrast to the present findings Garg *et al*. (2002) reported that when only animals in experimental group were fed one kg protected fat/protein supplement, total dry matter intake was increased significantly ($P<0.05$) compared to animals under control group.

The average daily CP intake of cows fed T2 ration was higher (2.33±1.25 kg/day/animal) as compared to cows fed T1 ration (2.32±3.20 kg/day/animal) and the treatment differences were non significant. Similar non-significant effect on CP intake due to feeding of bypass protein was reported by Sampath *et al*. (2005). The average daily TDN intake of T2 cows was lower (10.94 kg/day/animal) but not significantly different as compared to cows fed T1 diet (11.44 kg/day/animal). Similar non-significant effect on TDN intake due to feeding of bypass protein was reported by Srivastava and Mani (1995). They reported non-significant differences on TDN intake, in different experimental group fed four types of concentrates using untreated soybean cake (group I, III) and formaldehyde treated soybean based ration (group II, IV). The result obtained under present study on dry matter and nutrient intake by lactating cows suggested that the feeding of formaldehyde treated rapeseed meal (bypass protein) have not show any adverse effect on feed and nutrient in lactating cows.

These data indicated that the average milk production (kg) of cows under T1 and T2 was 20.17 and 21.32 kg per cow per day, respectively (Table 4). The higher milk production was observed in T2, which differ significantly ($p<0.05$) between the treatments Daily increase in milk production was found to be 1.15 kg in cows fed T2 diet over the cows fed control diet (T1). Kalbande and Thomas (1999) obtained significant differences in total milk yield over a 100 days lactation period between animals fed on the 3 concentrate mixtures A, B, and C with UDP levels of 63.38, 47.55 and 29.75 %, respectively. Garg *et al*. (2002) fed 250, 500 and 1000 g bypass fat/protein to cows in 3 groups and recorded 0.4, 0.8 and 1.1kg, respectively, average increase in milk yield under three groups as compared to base level milk yield at initial stage of experimental feeding. The increase in milk yield was significantly ($P<0.05$) higher for the cows fed 500 and 1000g bypass supplement than other treatment. The effect of feeding chemically treated soybean meal on milk production was studied by Atwal *et al.* (1995). The increase in milk production was 2.2 kg in the cows fed the diet with 15% CP (diet 2 Vs. diet 1) and 1.9kg in the cows fed the diet with 17% CP (diet 4 Vs. diet 3). They concluded that the milk production was significantly increased during week 7 to 16 of lactation for cows fed treated soybean meal diets. Such positive responses of higher milk yield due to feeding bypass protein to lactating cows were also reported by (Ramachandra and Sampath, 1995; Sampath *et al*., 1997; Akbar *et al*., 1999; Chaturvedi and Walli, 2001; Garg *et al*., 2003 and Garg *et al.*, 2005).

The average FCM production under T1 and T2 was 21.38 and 23.15 kg per cow per day, respectively. The higher FCM production was observed in T2. Daily increase in FCM production was found to be 1.77kg in cows fed T2 diet which significantly ($p<0.05$) higher over the cows fed control diet. This increase in 4% FCM production was accounted to be 8.27%. Akbar *et al*. (1999) observed significant increase ($P<0.01$) in milk as well as FCM yields (kg/d/buffalo) when lactating Murrah buffaloes were fed a basic mustard cake based ration, partially replaced by commercially available bypass protein or supplemented with live yeast culture or combination of both. Effect of feeding graded levels of undegraded dietary protein on milk production in early lactating crossbred cows was studied by Chaturvedi and Walli (2001). Both the milk and FCM yields differed significantly ($p<0.01$) among the fort nights.

The average milk fat content of cows under T1 and T2 was 4.45 and 4.59%, respectively. The higher fat% was observed in T2 and the differences between the treatments were significant ($P<0.05$). Daily increase in milk fat was found to be 0.14% in cows fed T2 diet-over the cows fed control diet (T1). Akbar *et al*. (1999) reported that the milk fat % of buffaloes fed diets with bypass protein (7.43%) or supplemented with live yeast culture (7.28%) or different combinations of both (7.58 % and 7.52%) was significantly ($P<0.01$) higher than the buffaloes fed control group (6.91%) diet. Similar significant effect on average milk fat (%) due to -

Table 2: Average proximate composition (% on DM basis) of feeds and fodder used under by pass protein feeding experiment.

Particular	CP	EE	CF	NFE	Ash	Silica	P	Ca
Rapeseed meal	38.78	3.08	11.26	39.23	7.65	2.08	1.23	1.09
Cotton seed cake	20.31	1.80	19.00	54.59	4.30	1.21	0.44	0.44
Tur chunni	17.24	3.00	16.00	57.76	6.00	1.00	0.22	2.33
Mung bhardo	20.26	1.34	8.73	64.50	5.17	0.98	0.77	1.76
Legume mixture	19.86	3.35	10.36	61.19	5.24	1.02	0.36	1.40
Maize cake	18.80	9.10	11.00	57.20	3.90	0.45	1.25	1.02
Hybrid Napiergreen	9.55	2.55	30.61	47.08	10.21	6.12	0.41	0.51
Paddy straw	4.34	1.55	33.33	41.59	19.19	13.13	0.10	0.30

Table 3: Average proximate composition (% on DM basis) of HMCM fed to cows under bypass protein feeding experiment.

Constituents	Fortnight									
	Initial	I	II	III	IV	V	VI	VII	VIII	Av.
CP	17.77	17.86	17.97	18.12	18.80	17.88	17.80	17.90	17.90	18.03
EE	11.70	10.89	10.17	9.10	9.89	11.76	11.45	10.04	9.77	10.38
CF	2.90	2.93	2.89	2.82	2.63	2.77	2.91	3.43	3.39	2.97
NFE	61.78	62.50	63.22	64.21	63.30	61.88	62.00	63.12	63.36	62.95
Ash	5.85	5.82	5.75	5.75	5.38	5.71	5.84	5.51	5.58	5.67
Silica	0.28	0.28	0.32	0.32	0.36	0.28	0.28	0.36	0.39	0.32
P	2.19	2.15	2.09	2.09	1.66	2.02	2.18	1.89	2.00	2.01
Ca	1.00	1.00	1.00	1.00	1.05	1.03	1.00	0.98	0.96	1.00

Table 4: Effect of feeding bypass protein (formaldehyde treated rapeseed meal) on dry matter intake and milk production performance in lactating crossbred cow.

Particular	T1	T2
DM intake (kg/d)	17.46±1.06	16.68±0.70
CP intake (kg/d)	2.32±3.20	2.33±1.25
TDN intake (kg/d)	11.44±0.73	10.94±0.48
Milk yield (kg/d)*	20.17^{a}±2.35	21.32^{b}±1.54
Fat (%)*	4.45^{a}±0.02	4.59^{b} ±0.06
Total solids (%)*	13.82^{a}±0.06	14.05^{b}±0.06
SNF (%)	9.38±0.08	9.46±0.07
Fat yield (kg/d)*	0.895^{a}±0.10	0.981^{b}±0.06
4% FCM yield (kg/d)*	21.38^{a}±2.47	23.15^{b}±1.57

*Means with different superscripts in a row for a parameter differ significantly, * (p < 0.05).*

feeding of bypass protein was reported by Chaturvedi and Walli (2001), Garg *et al.* (2002), Garg *et al.* (2003), Garg *et al.* (2005) and Kumar *et al*. (2005). The findings observed under the present study are in close agreement with the findings reported by these research workers. In contrast to present findings, Pires *et al.* (1996) found that milk fat percentage (3.09-3.63%) was not different among the cows fed different levels of UDP in their diets. Similarly, Kumar *et al*. (2005) and Pailan *et al.* (2007) reported non-significant effect of bypass protein on milk fat %.

The average values for total solids content under T1 and T2 were 13.82 and 14.05%. The values observed for total solids % under two treatments were significant (P<0.05). Kumar *et al*. (2005) observed that the values for total solids (%) in milk differed significantly (p<0.05) among the different groups and were found to be higher for cows fed LUDP+HP diet followed by HUDP+HP diet. Significant effect of bypass protein feeding on total solids contents was reported by Chaturvedi and Walli (2001) and Sampath *et al*. (2005). However, Lundouist *et al.* (1986) reported that total solids percent (0-16 and 17-28 wks) did not differ significantly among all four dietary treatments including formaldehyde-treated soybean meal. Similar non-significant effect on total solids (%) due to feeding bypass protein was reported by Keery and Amos (1993), Ramachandra and Sampath (1995) –

Table 5: Effect of feeding bypass protein (formaldehyde treated rapeseed meal) on digestibility of nutrients feed conversion efficiency and cost of feeding in lactating crossbred cow.

Particular	T1	T2
Digestibility coefficient		
DM	70.75±1.58	71.91±0.57
OM	71.41±1.61	73.41±0.56
CP	62.04 ±1.54	65.73±1.49
EE	79.85 ±2.10	77.39 ±0.75
CF	73.03±1.52	75.13±0.32
NFE	73.73±1.75	75.08±0.62
Feed efficiency		
DM intake (kg/kg milk)*	0.902[b]±0.03	0.792[a]±0.02
TDN intake (kg/kg milk)*	0.590[b]±0.02	0.89[a]±0.01
DM intake (kg/kg FCM)*	0.846[b]±0.03	0.727[a]±0.02
TDN intake (kg/kg FCM)*	0.553[b]±0.02	0.477[a]±0.01
Daily feed cost/return over feed cost (Rs./cow)		
Av. daily feed cost	108.15	102.77
Return over feed cost	119.40± 16.53	146.73± 10.4

*Means with different superscripts in a row for a parameter differ significantly, * (p < 0.05).*

Atwal *et al.* (1995) and Pailan *et al.* (2007).

3.3 Digestibility of Nutrients, Feed Conversion Efficiency and Feed Cost

The digestibility of proximate nutrients (except for ether extract) was found to be higher for cows fed T2 diet as compared to the cows fed T1 diet. However, the differences among the treatment groups were found to be non-significant (Table 5). It is concluded that supplementation of bypass protein improves the digestibility of most of the proximate nutrients. Dry matter intake to produce one kg milk and 4% FCM was found to be 0.902 and 0.792kg and 0.846 and 0.727kg under T1 and T2, respectively (P<0.05) Table 5. The data suggested that more amount of DM was required by cows fed control diet (T1) than the cows fed treatment diet (T2) to produce one kg milk. Similar observations were also observed for FCM production. The requirement of TDN to produce one kg milk was 0.590 and 0.553kg under T1 and T2, respectively (P<0.05) and similar values for FCM production were 0.519kg and 0.477kg, respectively (P<0.05). In contrast to present findings Kalbande and Thomas (1999) reported non-significant effect of different levels of bypass protein treatments regarding feed efficiency in terms of milk produced/unit of dry matter intake 0.825, 0.732 and 0.703 in cows fed concentrate mixture A, B and C, respectively. Srivastava and Mani (1995) reported that the differences for milk production efficiency reflected non significant differences for cows fed diets with or without bypass protein. Chaturvedi and Walli (2001) found that the feed efficiency for milk production also showed a non-significant variation among the treatments as well as among the fortnights, but the feed efficiency was increased with the increase in UDP level. They concluded that by increasing the UDP level from 29 to 56 percent of CP in the diet of medium producing cows, the milk production was increased and cost of milk production was reduced. Kumar *et al*. (2005) reported that net efficiencies of nitrogen utilization for milk production were not significantly different among different groups and were also not affected significantly due to either UDP levels or plane of feeding.

The daily cost of feeding per animal was Rs 108.15 and 102.77 under T1 and T2, respectively. The daily cost of feeding (Rs/cow) was higher under T1 than T2 (P>0.05). The average daily returns over feed cost were Rs 119.40 and 146.73 for cows under T1 and T2, respectively. The returns over feed cost was more for cows fed bypass protein (T2) diet than the cows fed control diet (T1), however, these differences were (p<0.05) significant. The returns over feed cost for cows fed bypass protein diet (T2) were 22.89% higher than the cows fed control diet (T1). Garg *et al.* (2003) fed animals in control group 1.0kg untreated rapeseed meal (*Brassica campestris*; CP 39.76%, UDP 37.72% of CP) and in experimental group 1.0kg protected rapeseed meal (CP 39.76%, UDP 76.00% of CP). There was increase in net daily income by Rs.9.44 due to feeding of 1.0kg protected rapeseed meal in lactating cows. Thus supplementation of 1.0kg protected protein in the ration of milch cows was found to be economical, compared to feeding of similar quantity of untreated meal.

Garg *et al*. (2005) fed animals under two groups 1.0kg each of either untreated (Control) or formaldehyde treated (Experimental) rapeseed meal (*Brassica campestris*).

The degree of protein protection in treated rapeseed meal was 76.5 percent of CP, compared to an equivalent value of 36.3 percent in the untreated meal. Similarly average increase in net daily income by Rs.6.49 in cows fed feeding protected rapeseed meal was reported. Sampath *et al*. (2005) found that feed cost was reduced by Rs.0.81 and overall income of the farmers was increased by Rs.17.81/cow/d in experimental group containing cotton seed extraction in village 1. Similarly in village 2, cost was reduced by Rs.3.90 and overall income of the farmers was increased by Rs. 15.80/cow/d in experimental group containing cotton seed extraction. These finding suggested that feeding of bypass protein supplement to lactating animals was found to be economical.

4. Conclusion

Supplementation of 1.0kg of formaldehyde treated rapeseed meal (bypass protein) replacing 2kg of home-made concentrate mixture to crossbred cows yielding daily 20-21kg milk resulted in Rs.27.33 more daily returns per cow.

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