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Nutrient Utilization, Milk Yield and Economics of Production in Crossbred Cows Fed Berseem Hay Meal Supplemented Diet

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ABSTRACT

The replacement effect of mustard cake protein with berseem hay meal protein in concentrate mixture was studied for nutrient utilization, milk yield and economics of production in crossbred cows. In control group (G1), the animals were fed control concentrate mixture with wheat straw *ad libitum* whereas in treated group (G2), 60% N of mustard cake was replaced with berseem hay meal (BHM) in the concentrate mixtures along with wheat straw *ad libitum* for a period of two and half months. Both the groups were provided iso-energetic and iso- nitrogeneous diets. The intake of dry matter either as percentage of body weight or per kg metabolic body size was comparable between the groups. Similarly, the digestibility of nutrients viz.DM, OM, NDF and ADF were similar in both the groups. Milk yield (7.02 Vs 7.21 kg/d) and composition of milk of animals fed with or without supplementation of BHM was also non- significantly different indicating that legumes did not change the composition of milk. Feed conversion efficiency for milk production and N utilization efficiency was also similar between the groups. Average daily feeding cost and cost of milk production(Rs/kg 4%FCM) reduced ($P<0.05$) by 13.89 and 17.53%, respectively in cows fed experimental diet, hence net daily income was increased ($P<0.05$) by Rs. 26.71 per cow. It was concluded that mustard cake can safely be replaced by berseem hay meal (BHM) in iso-caloric and iso-nitrogeneous diet in formulating least cost ration for economic milk production in small holders' dairy production without any adverse impact on crossbred cows.

KEYWORDS: Berseem hay meal, Crossbred cows, Economics of milk production, Milk yield, Mustard cake, Nutrient utilization

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INTRODUCTION

In India livestock contributes 16% to the income of small rural households. Livestock provides livelihood to two-thirds of the agricultural community. Indian milk production is contributed mostly by the rural small and marginal farmers. Milk yields in tropical dairy farms are commonly increased by inclusion of large proportions of concentrate feeds in cows' diet as forages with low CP concentration like dry grass, cereal straws, stovers etc are mostly used (Machado et al.,2014). Feed cost for milk production governs the major share (65-70%) of the total cost of livestock rearing that directly or indirectly affects the entire livestock production system as well as the environment (Makkar, 2016). Therefore, supplementation with protein-rich feedstuffs such as legume forages integrated in existing farming system, has been proved to be a better option for smallholder resource-poor farmers who cannot afford commercial concentrates (Kabirizi, 2006). One such forage legume is berseem (*Trifolium alexandrinum*), a green leguminous fodder grown by the farmers in northern India during rabi season. Berseem is high-quality forage characterized by a high concentration of nutrients, protein (15-25%), minerals (11-19%) and carotene and the dry matter digestibility in ruminants is around 70% (McDonald et al.,1995). Mpairwe et al. (2003) established that in order to maximize milk production by Friesian x Zebu crossbred cows, the proportions of legume herbage in total dry matter intake (DMI) should not exceed 0.48% of body weight. Therefore, the objective of the current study was to investigate the

effects of supply of CP from BHM as partial replacer of mustard cake in iso-nitrogeneous and iso-caloric diet of lactating crossbred cows on feed intake, nutrient utilization, milk yield and profitability.

MATERIALS AND METHODS

Feeding Trial

Twelve lactating crossbred cows weighing around 350±4.56 kg and mid lactation were randomly allocated into two dietary treatments. The effect of supply of BHM as partial replacer of mustard cake protein in concentrate mixture was studied for nutrient utilization, milk yield and economics of production in crossbred cows. In the control group (G1), the animals were fed control concentrate mixture with wheat straw *ad libitum* whereas in the diet of experimental group (G2),in the concentrate mixtures in which 60% N of mustard cake was replaced with berseem hay meal (BHM) along with wheat straw(WS) as basal roughage *ad libitum* for a period of two and half months (Table1). All the groups were provided iso-caloric and iso nitrogeneous diets. The animals were housed individually in well ventilated cleaned dry pacca pens and water was provided *ad libitum* . The daily allowance of the concentrate was offered in two equal meals in the morning (05:00 h) and in the afternoon (15:00 h) during the time of milking along with dry roughage as total mixed ration. Residues remaining were weighed 24 h post-feeding to ascertained daily feed consumption. Milking was done twice daily (5:00 h and 15:00 h) and daily milk yield of individual cows were recorded throughout the experiment. Milk samples (50 ml each) from each cow was drawn once a week for anal-ysis of milk composition and stored at 4°C after adding 2 to 3 drops of potassium dichromate as a preservative, until further analysis. A 7day digestion trial was conducted at the end of the experiment. Samples of feed offered and refused were collected daily. The daily feed intake and faecal output from individual animals were recorded.

Chemical Analysis

A suitable sub-sample of faeces was collected and dried at 80°C±2°C for 24 h in hot air oven for dry matter (DM) estimation. Pooled samples (7 days for each animal) were ground and stored for chemical analysis. Samples of feeds, residues and faeces were milled to pass through a 1 mm sieve and analyzed for proximate principles (AOAC, 2000). Fiber fractions were estimated using the methods of Van Soest et al.(1991). Milk samples were warmed in water bath at 38°C and mixed for homogenous solution and analyzed for total solids, total ash, total protein and fat content (ISI, 1961). Cost of each kg of concentrate mixture (including mustard cake and/ or BHM) were Rs. 17.81, 14.46, for cows of G1 and G2 groups, respectively. These costs were derived by multiplying feed ingredient contents of concentrate mixtures (of each kg with the current prices of Rs. 20.00, 13.25, 13.25, 19.00,9.00, 6.00, 6.00 and 110.00 per kg, respectively of mustard cake, maize, barley, wheat flour, BHM, urea, salt and mineral mixture. The cost of the wheat straw was Rs. 5.00/ kg.

Statistical Analysis

Data were subjected to analysis using SPSS version 20.0 (2011; IBM Corporation, Armonk, NY, USA) software package. Overall differences between treatment means were considered significant when $P<0.05$.

Table1. Ingredient Composition of concentrate mixtures and chemical composition of experimental feeds (% DM)

Ingredient	CM- I	CM-II		
Mustard cake	40	16		
Barley	50	-		
Maize	7	26		
Berseem meal	_	48		
Wheat flour	_	6.25		
Urea	_	0.75		
Salt	1	1		
Mineral mix.	2	2		
Cost/quintal (Rs)	1781	1446		
Chemical composition (%DM)				
	CM I	CM II	WS	BHM
DM	94.6	94.7	92.3	91.8
CP	18.7	19.0	4.18	16.1
NDF	47.6	51.0	74.9	51.0
ADF	11.0	18.6	47.4	39.5
Ash	6.60	8.96	9.94	14.9

CM I= Control concentrate mixture, CM II= Experimental concentrate mixture

RESULTS AND DISCUSSION

Chemical Composition of Feed stuffs

The CP content of (BHM) (Table 1) was in agreement with earlier finding of Kumar et al.(2018). However, Hafsa and Hassan (2021) recorded lower CP values for berseem hay compared to present findings, which might be due to harvesting at later stage of maturity or loss of leaves during preparation and processing of hay. Wheat straw had normal chemical composition reported earlier(Anjum et al.,2014). Crude protein and energy content of both the concentrate mixtures were comparable.

Nutrient Intake and Utilization

Animals in both the groups consumed similar quantity of dry matter (Table 2) which is one of the important parameters to determine the performance of milch animals. Similar to the present findings, replacement of legume meal with concentrates did not affect the total DM intake in lactating animals (Wangchuk et al.,2022). However, Nugroho et al. (2020) reported improvement in dry matter intake when *Leucaena Leucocephala* leaves was supplemented at different levels in the ration of Friesian Holstein dairy cows. Similarly, Rahman et al. (2015) also recorded higher DMI in crossbred cows fed Lathyrus hay supplemented diet. Richards et al.(1994), in contrast, observed reduced DM intake in lactating goats when *Gliricidia sepium* leaves was used as replacer of concentrate mixture in the ration. DM intake difference in different feeding experiments due to replacement of concentrates with leguminous forages could be due to the basal nature of the diet or anti-nutritional factor affecting palatability of the diet. DM intake as percent of body weight in the current study corroborated with the values being suggested for dry matter intake in lactating cows (ICAR, 2013).

Nitrogen intake per kg digestible organic matter (DOM) intake in both the groups were sufficient for efficient rumen fermentation and did not show any significant difference between the groups. DCP and

TDN intakes were sufficient for maintenance as well as production in lactating cows (ICAR, 2013). Similarly, Widiawati et.al. (2019) reported that concentrate substitution by using 15% *Gliricidia sepium* or Arachis pintoi didn't affect feed intake and utilization in dairy animals. However, Katuromunda et al. (2012) reported that supplementation of legumes in the diet of lactating cows improved ($P<0.05$) the nutrient intake.

In the present study replacement of mustard cake protein with berseem hay protein in milch cows did not affected the nutrient digestibility and was non-significantly different between the groups. Montoya et al.*(*2016) and Widiawati et al.(2019) also did not observed differences in nutrient digestibility when legume forage was included in the diet of milch cows as replacer of concentrate. However, in contrast to present findings, lower digestibility of different nutrients in lactating cows due to higher level (more than50%) of replacement of concentrate with cowpea hay as recorded by Mediksa et al.(2016) which was probably associated with inadequate intake of energy that limited the growth of rumen microbes.

The values for 4% FCM kg/kg DMI was comparable between the groups indicating similar feed conversion efficiency and corroborated with earlier findings of Kitaw et al.(2010). Corea et al.(2017) however, reported increased milk per kg DMI when cowpea hay was added in the diet of lactating cows.

Comparable values for N utilization efficiency for milk production (milkN/NI) in the present study indicated that similar utilization of CP from BHM and mustard cake for milk production. Garg et al. (2016) also reported similar vaues for nitrogen use efficiency in crossbred cows fed balanced ration. However, Rehman et al.(2020) reported higher values for NUE in mid lactation crossbred cows fed different proportions of rumen degradable protein in the diets.

Table 2. Intake and digestibility of nutrients in crossbred cows fed different treatment diets

Attributes	G1	G2	Pooled SEM
Body weight(kg)	340±11.90	362±22.23	25.22
DMI(%BW)	2.96±0.10	2.88±0.14	0.81
DMI($gkg^{-1}W^{0.75}$)	127±2.64	125±5.23	6.48
DCPI($gkg^{-1}W^{0.75}$)	8.19±0.32	8.07±0.50	0.88
TDNI $gkg^{-1}W^{0.75}$)	83.5±2.38	80.0±3.80	5.23
NI(g/kg DOMI)	28.7±0.58	29.2±0.50	0.76
DM	61.2±0.82	59.4±1.26	1.34
OM	64.9±0.65	62.7±1.00	1.02
CP	59.6±1.71	62.6±2.89	3.37
NDF	58.4±1.40	57.4±1.48	1.75
ADF	43.2±1.83	45.0±1.80	2.21
Nutritive value(%)			
DCP	6.43±0.23	6.48±0.38	0.48
TDN	65.6±0.79	63.8±0.69	1.30

Milk yield and composition

Milk yield and milk composition (Table 3) was not affected due to supplementation of BHM in the present study and corroborated with earlier findings of Wangchuk et al.(2022). Pailan et al. (2010) also observed that 25% replacement of concentrate mixture with stylo meal did not affect milk yield and its composition in lactating buffaloes. However, Phelan et al.(2015) reported an increase in milk yield when fed forage legumes.

Table 3. Milk yield and composition of crossbred cows fed experimental diets

Attributes	G1	G2	Pooled SEm
Milk yield (kg/d)	7.02±0.60	7.21±0.65	0.66
4% FCM(kg/d)	8.22±1.30	8.46±0.66	0.77
Milk composition (%)			
Protein	3.66±0.03	3.67±0.09	0.13
Fat	4.53±0.19	4.76±0.25	0.24
Lactose	4.47±0.11	4.48±0.11	0.16
SNF	8.16±0.20	8.37±0.24	0.30
Total Solid	12.6±0.55	13.1±0.23	0.46

Economics of production

The cost of feeding daily per cow was reduced significantly (P<0.05) by 13.83% using the experimental diet(Table 4) and it was in agreement with the earlier findings of Corea et al.(2017) where cowpea hay was supplemented in the diet of dairy cows. The incorporation of BHM as replacer of mustard cake protein resulted in reduction of milk production cost significantly (P<0.05) by 17.53 percent. Similarly, daily net profit was significantly (P<0.05) improved in experimental group (Rs. 26.71 per cow). Kiyothong and Wanapat (2004) also recorded improvement in income when cassava hay and stylo hay were supplemented in the diets of crossbred cows.

Table 4. Feed conversion and economic efficiency of crossbred cows fed experimental diets

Attributes	G1	G2	Pooled SEm
Feed conversion kg 4% FCM/kg DM intake	0.81±0.05	0.83±0.04	0.11
TDN kg/kg FCM	0.83±0.14	0.78±0.04	0.08
N intake(g)	174±9.86	169±5.12	0.01
Milk N (g)	41.0±3.51	42.2±1.60	3.87
Economics			
N utilization efficiency(NUE)	23.4±1.31	25.0±1.10	1.72
Average daily feed cost (Rs)	109^{b}±5.92	94.0^{a}±1.89	6.21
Feed cost/ kg FCM	13.5^{b}±0.94	11.1^{a}±0.46	1.05
Income from sale of 4%FCM(@Rs.50/kg)	411±5.25	422±6.08	18.74
Net daily income (Rs.)	302^{a}±7.67	328^{b}±8.45	11.42
Economic efficiency	3.75^{a}±0.21	4.51^{b}±0.20	0.29

[ab]Means bearing different superscript in a row differ significantly (P<0.05)

CONCLUSION

Results of the present study indicated that berseem hay protein can safely be used as replacer of mustard cake protein in iso-caloric and iso-nitrogeneous diet of lactating crossbred cows for economic milk production in small holders' dairy production without compromising the nutrient intake, nutrient utilization and milk yield .

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