Original Article

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EFFECT OF BERSEEM HAY MEAL AS REPLACER OF MUSTARD CAKE PROTEIN IN DIET OF LACTATING BHADAWARI BUFFALOES ON NUTRIENT UTILIZATION, MILK YIELD AND ITS COST OF PRODUCTION

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ABSTRACT

The effect of mustard cake (MSC) replacement with berseem hay meal (BHM) as protein source in concentrate mixture (CM) was studied for nutrient utilization and economic milk production in Bhadawari buffaloes. Animals in Control group (T_1), were fed wheat straw *ad libitum* and CM while in Experimental group (T_2), wheat straw *ad libitum* and CM in which 60% nitrogen of MSC was replaced with BHM and added 0.75% non-protein nitrogen for two and half months. Both diets were iso-energetic and iso-nitrogeneous. Dry matter intake both as % of body weight or g/Kg $w^{0.75}$ was comparable between dietary groups. The DM, OM, NDF and ADF digestibility were alike in groups. The DCP content of T_2 was significantly higher ($P<0.05$) than T_1. Animals milk yield (4.80 vs 4.96 kg/d) and its composition was also similar indicating that BHM supplementation did not alter milk fat, protein, or lactose contents. Efficiency for feed conversion for milk production and N utilization was also similar between dietary groups. Buffaloes daily feeding cost and milk production cost (Rs/kg 4% FCM) reduced ($P<0.05$) by 14.49 and 16.80%, respectively in T_2 diet resulting daily net income increase ($P<0.05$) by Rs. 24.82 per buffalo. Study concluded that MSC can safely be replaced by BHM in iso-caloric and iso-nitrogeneous diets in formulating least cost ration for economic milk production in small holders' dairy production without compromising intake, nutrient utilization and milk production in Bhadawari buffaloes

Keywords: *Bubalus bubalis*, buffaloes, mustard cake, berseem, lactating

INTRODUCTION

In India's agricultural sector livestock has important role and contributes to socio economic development, food security and rural livelihoods. Small and marginal farmers produce more than 80% of milk in our country. Total cost involved in milk production mainly comes from feeding (>70%) which has direct and indirect bearing on livestock production system and environment (Makkar, 2016). For profitable dairying animal's protein, energy, minerals and vitamins requirement need to be met from low cost resources preferably from locally available feed resources. Green fodder plays a major role in feeding dairy animals, thereby

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providing required nutrients for health, productive and reproductive efficiencies of dairy animals. Green fodder, an economic source of nutrients provides alternative option to costlier concentrate feed ingredients and also highly palatable and digestible (Mohini *et al*., 2007). Devendra and Leng (2011) suggested the use of superior forage legumes integration with prevailing farming systems as economically viable alternate to purchased protein rich concentrates solution for on-farm small holder dairy production. Berseem (*Trifolium alexandrinum*) is one of such forage legumes grown in Northern and Central India in Rabi season (winter). Berseem is rich in nutrients containing 15 to 25% protein, 11 to 19% minerals and carotene with 70% dry matter digestibility in ruminants (McDonald *et al*., 1995). In another study Chauhan *et al.* (1992) reported that berseem crude protein content ranges from 11 to 21% with 17.2 kj/g gross energy content. Considering these nutritional facts, the present study was planned to determine replacement effect of mustard cake protein with berseem hay meal in iso-nitrogenous and iso-caloric diet on nutrients intake and their digestibility, milk yield and its composition in lactating Bhadawari buffaloes.

MATERIALS AND METHODS

Second and mid lactation 12 lactating Bhadawari buffaloes weighing 426.5±3.65 kg were randomly allocated into two dietary treatments (T_1 and T_2). Animals in T_1 (Control group) were fed wheat straw *ad libitum* with control concentrate mixture whereas in T_2 (Experimental group) animals were offered wheat straw *ad libitum* and concentrate mixture in which 60% nitrogen of mustard cake was replaced with berseem hay meal containing 0.75% non-protein nitrogen for a period of 75 days (Table1). Both the Dietary groups were iso-caloric and iso nitrogenous. Animals were housed individually in well-ventilated cleaned dry cemented pens and water was provided *ad libitum*. Concentrate mixture daily allowance was offered in two equal meals each in morning (05:00 h) and in afternoon (15:00 h) during milking time along with dry roughage as total mixed ration. Animal dietary refusals were weighed at 24 h post-feeding to determine daily feed intake. Animals were milked twice daily at 5:00 h and 15:00 h and daily milk yield of each animal was recorded during experimental feeding. Milk samples (50 mL) from each animal were drawn weekly and after adding 2 to 3 drops of potassium dichromate as a preservative stored at 4^{o}C for milk composition analysis. At the end of the feeding experiment a 7-day digestion trial was conducted during which feed was offered, refusal and feces voided samples were collected daily from individual animal. An aliquot from feces voided was collected and dried at 80^{o}C±2^{o}C in hot air oven till a constant weight for dry matter estimation. Feed, refusal and feces samples collected for individual animals for 7 days were pooled and ground to pass through a 1 mm sieve for chemical analysis. Ground samples were analyzed for proximate principles (AOAC, 2000), neutral detergent fibre and acid detergent fibre (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 berseem hay meal) were Rs. 17.81, 14.46, for T_1 and T_2 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 grain, barley grain, wheat flour, berseem hay meal, urea, salt and mineral mixture. Wheat straw cost was Rs. 5.00/ kg. Data on intake, nutrients digestibility, milk yield and its composition were statistically analyzed with SPSS version 20.0 (2011; IBM Corporation, Armonk, NY, USA) software package. Differences between treatment means were considered significant at P<0.05 level.

RESULTS AND DISCUSSIONS

Berseem hay meal (BHM) CP values of are at par with previous results (Das *et al*., 2015; Rehman *et al*., 2020), while Mohamed *et al*. (2020) reported lower CP for berseem hay than present values, which might be due to crop harvesting at later stage of maturity or shattering of leaves during preparation and processing of hay. Wheat straw chemical composition was like that reported by Mahesh *et al*. (2013). The chemical composition of both the concentrates was similar in-terms of crude protein and energy content. In our study, concentrate intake was at par between the dietary groups (Table 2) as it is one of the important factors influencing milch animal's performance. Wangchuk *et al.* (2022) reported that replacement of home-based concentrate with legume meal had no significant effect on total dry matter intake in dairy cows. In another study with lactating dairy cows Kiyothong and Wanapat (2004) recorded no significant variation in total feed intake on replacing concentrate with cassava hay or stylo hay in the diet. Similarly, Pailan *et al*. (2010) also reported no significant effect on dry matter intake of lactating buffaloes when diet supplemented with legume meal. On the other hand, replacement of concentrate mixture with vetch hay improved dry matter intake of lactating cows (Kitaw *et al*., 2010). The dissimilarity in dry matter intake in different feeding experiments on substituting concentrate mixture with leguminous fodder might be due to the nature of basal diet or presence of anti-nutritional factors in supplementing leguminous fodder affecting diet palatability. In present study berseem hay meal was used as replacer of mustard cake protein which was highly palatable and there is no report indicating presence of anti-nutritional factor in berseem which may decrease intake. The mean total dry matter intake of buffaloes in our study was 97.40 g/kg w0.75 which corroborates with earlier results in lactating Horo cows (Mediksa *et al*., 2016). The dry matter intake as percent of body weight in the current study corroborated with the findings of Pailan *et al.* (2010) with the values being in the range of the recommended dry matter intake of milch buffaloes (ICAR 2013).

Similar digestible crude protein (DCP) and total digestible nutrients (TDN) intake recorded in our study coincides with Kitaw *et al.* (2010) results who recorded comparable DCP and TDN intake between dietary groups. Mediksa *et al.* (2016) reported that 50% replacement of concentrate with cowpea hay improved DCP intake, but TDN intake was comparable in lactating cows. Mahanta *et al.* (2010) however, reported higher TDN intakes in sheep fed diet containing green berseem as replacer of mustard cake which might be due to a combination of poor-quality crop residues like sorghum stover and green fodder resulting in better ruminal environment and ultimately higher nutrient intake and their utilization in animals. In present study, although TDN content (%) was comparable between the groups, DCP% was higher in experimental groups. In our study dietary DCP and TDN intake of lactating Bhadawari buffaloes were adequate for their maintenance and production (ICAR, 2013).

Digestibility of DM, OM, CP, NDF and ADF were non-significantly different between the groups and these digestibility values of different nutrients were at par with Singh *et al.* (2018). Widiawati *et al.* (2019) also observed comparable nutrient digestibility in lactating cattle when concentrate mixture was replaced with *Arachis pintoi* and *Gliricidia sepium* leaves. Nonsignificant variation in nutrients digestibility was also observed when concentrate mixture was replaced with vetch hay in milch cows diet (Kitaw *et al*., 2010). Montoya *et al.* (2016) also did not observe differences in apparent DM and nitrogen digestibility when legume forage was included in the diet as replacer of soyabean meal in the diet of crossbred milch cows. Das *et al*. (2012), however, reported higher OM, NDF and ADF digestibility in calves when concentrate mixture protein was substituted with stylo meal. Inversely, Mediksa *et al*. (2016) recorded poor nutrients digestibility when concentrate was replaced above 50% with cowpea hay in the diet of lactating cows. Decreased microbial growth due to inadequate energy intake may be the probable reason for lower nutrients digestibility. In the present experiment the diet offered to the animals was iso-energetic so there was no inadequacy of energy for the growth of rumen microbes resulting in similar digestibility of different nutrients. In our study, N intake per kg digestible organic matter intake in both the groups was adequate for efficient rumen fermentation and did not alter nutrients digestibility between groups.

Feed conversion efficiency usually reflects nutrients conversion efficiency into animal products (milk, meat, growth etc.) and for milk production is expressed as kg of FCM produced per kg of dry matter intake. These feed conversion efficiency values for milk production recorded in our study are identical to earlier reported values in lactating cows (Kitaw *et al*., 2010), however, El- Bordeny *et al*. (2017) reported higher feed conversion efficiency for milk production in buffaloes. Dietary nitrogen use efficiency (NUE) is the ratio of nitrogen output in milk to unit of nitrogen intake. In present study nitrogen utilization efficiency was comparable between the groups indicating similar nitrogen use efficiency from BHM and mustard cake for milk production. Seresinhe *et al*. (2012) also reported similar values for nitrogen use efficiency when tree fodder was incorporated in the diet of lactating Murrah type buffaloes. However, El-Bordeny *et al*. (2017) reported higher nitrogen use efficiency values in lactating Egyptian buffaloes fed balanced rations as per NRC requirement which may be due to differences in breed**.** Practically nitrogen use efficiency values vary between 0.16 to 0.37 g milk N/100 g feed nitrogen (Jonker *et al*., 2002) and our nitrogen use efficiency values lies within these values.

Milk yield and composition and economics of production

In present study milk yield and its composition was equal between dietary groups (Table 3) which corroborates with findings of Wangchuk *et al*. (2022) who observed that home-based concentrate replacement with legume meal had no significant influence on milk yield and its composition. Similarly, Mediksa *et al*. (2016); Kitaw *et al.* (2010) also observed that cowpea hay or vetch hay substitution in lactating cows diet did not change milk production or milk composition. Montoya *et al*. (2016) did not observe any change in fat, protein, or lactose contents of milk when legume forage was included in lactating crossbred cows diet.

Table 1. Concentrate mixtures (CM) ingredients and chemical composition of experimental feeds (%DM).

Ingredient	CM-I	CM-II		
Mustard cake	40	16		
Barley	50	-		
Maize	7	26		
Berseem hay 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	96.53±0.30	96.23±0.36	96.74±0.53	95.72±0.25
CP	18.46±0.04	18.94±0.13	4.36±0.05	15.79±0.07
NDF	50.49±0.10	50.80±0.26	75.04±0.34	52.80±0.36
ADF	17.56±0.32	25.37±0.43	47.44±0.45	39.52±0.49
Ash	7.56±0.08	12.22±0.09	9.97±0.07	14.74±0.10

Table 2. Nutrients intake and their digestibility in Bhadawari buffaloes fed different diets.

Parameter	T_1	T_2	Pooled SEm	P-Value
Body weight (kg)	430.33	423.34	24.10	0.77
WS (kg/day)	5.05	4.37	0.45	0.16
CM (kg/day)	4.31	4.55	0.30	0.43
DMI (kg/day)	9.36	8.93	0.64	0.51
DMI (%BW)	2.17	2.11	0.10	0.53
DMI (g/kg w0.75)	99.02	95.75	4.64	0.49
DCPI (kg/day)	0.636	0.672	0.04	0.42
DCPI (g/kg w0.75)	6.75	7.21	0.41	0.29
TDNI (g/kg w0.75)	60.97	58.06	3.84	0.46
NI (g/kg DOMI)*	32.91	37.69	1.48	0.01
Digestibility coefficients (%)				
DM	56.95	56.15	1.72	0.65
OM	58.95	56.82	1.67	0.23
CP	62.07	63.33	1.16	0.30
NDF	55.93	53.92	1.88	0.31
ADF	40.31	42.14	2.29	0.44
Nutritive value (%)				
DCP*	6.83	7.53	0.28	0.03
TDN	61.42	60.65	1.67	0.65

*Differ significantly ($P<0.05$)

Table 3. Milk yield and composition of buffaloes fed different diets.

Parameters	T_1	T_2	Pooled SEm	P-Value
Milk yield (kg/day)	4.80	4.96	0.52	0.76
4% FCM (kg/day)	5.76	5.82	0.61	0.76
Milk composition (%)				
Protein	3.46	3.43	0.09	0.70
Fat	7.56	7.12	0.70	0.53
Lactose	5.13	5.26	0.12	0.50
SNF	9.46	9.61	0.22	0.52
Total Solid	17.03	16.72	0.85	0.72

Table 4. Feed conversion efficiency and milk production cost of buffaloes fed different diets.

Attributes	T_1	T_2	Pooled SEm	P-Value
Feed conversion				
kg 4% FCM/kg DM intake	0.61	0.65	0.07	0.60
TDN kg/kg FCM	1.04	0.96	0.13	0.53
N intake (g)	164.18	169.84	10.52	0.60
Milk N (g)	26.33	27.47	2.88	0.70
N utilization efficiency (NUE)	16.24	16.05	1.51	0.90
Average daily feed cost* (Rs)	102.04	87.25	6.34	0.05
Feed cost/ kg FCM*	18.45	15.35	1.73	0.11
Income from sales of 4% FCM (Rs.55/kg)	309.43	319.96	33.76	0.76
Net daily income* (Rs.)	207.39	232.21	9.07	0.02
Economic efficiency*	3.07	3.61	0.22	0.04

*Significant at P<0.05

Entire daily feeding cost for milk production reduced significantly (P<0.05) by 14.50% in T_2 than T_1 dietary group. Similarly, Hossain *et al.* (2017) also recorded lower feed cost for milk production when ration of lactating buffaloes was supplemented with green fodder. Corea *et al.* (2017) also reported economic reduction of daily feed cost by 6.09% when sorghum silage was replaced with cowpea hay partly in lactating cow's diet. Milk production cost (Rs/kg FCM) also reduced (16.80%) significantly (P<0.05) in our study. Lower feeding cost for milk production in present study may be the result of incorporation of low cost BHM than mustard cake. Daily income improved substantially (P<0.05) in T_2 (Rs. 24.82/buffalo). These observations corroborated with previous findings (Hossain *et al.*, 2017; Khan *et al.*, 2009) in lactating buffaloes and crossbred cows where farmer's income increased two folds when green fodder was incorporated in the ration. Similarly, feeding cost/kg milk production declined when the green forage quantity increased gradually in ration of lactating cows (Sanh *et al.*, 2002).

It can be concluded that berseem hay meal (BHM) can substitute 60% of mustard cake protein in iso-caloric and iso-nitrogenous diets for formulating the least cost ration for small holders' economic milk production without impacting feed intake, nutrient utilization and milk yield of Bhadawari buffaloes.

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