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Nutrient Utilization and Milk Yield in Crossbred Cows Fed Lathyrus Straw Supplemented Diet

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ABSTRACT

Lathyrus straw (LS) was supplemented to lactating crossbred cows weighing 370.7±10.42 kg to study the influence on nutrient intake, utilization and milk yield performance of the animals. In the control group (G_1), the animals were fed wheat straw plus concentrate based ration whereas in the diet of G_2 and G_3 wheat straw was replaced with lathyrus straw at 30% and 50% on DM basis for 90 days. All the groups were provided iso-nitrogeneous diet. Intake of dry matter (DM) was 2.36, 2.38 and 2.21 of the body weight in groups G_1, G_2 and G_3, respectively. Dry matter(DM) and fibre digestibility was comparable among the groups. However, digestibility of crude protein (CP) was significantly ($P<0.05$) higher (51.76%) in G_1 or G_2 (47.85%) as compared to G_3 (44.98%). Milk yield and milk composition did not revealed any significant difference among the groups. The experimental results revealed that the feed cost per day was reduced significantly ($P<0.05$) from ₹ 103.98 to ₹ 92.68 and cost of feed per kg FCM was reduced from ₹ 13.70 to12.12 in cows fed 50% LS straw supplemented diet as compared to con-trol. Thus, Lathyrus straw can be safely incorporated in the ration of dairy animals for economic milk production without having any adverse effect on feed intake, nutrient utilization and production performance of crossbred cows.

Key words: Crossbred cows, Lathyrus straw, Milk composition, Milk yield, Nutrient utilization

INTRODUCTION

In India, wheat straw constitutes the major component of diet for ruminants in all types of livestock farming systems in India. But the main constrain with such type of feeding system is that dry matter, protein and energy intake by the animals is very low that could not even support the maintenance requirement of the animals. Supplementation of catalytic nutrients in the form of concentrate mixture in the diet is needed for optimum utilization of straw. However, the resource poor farmer can not afford to supplement such concentrate ingredients in the ration due to its availability and cost. Therefore, the right way is the feeding of supplements that are grown in farmers' own field like grasspea straw to improve the nutritive value of rice straw. Supplementation of cereal crop residues, with legumes or legumes crop residues has been shown to increase their digestibility (Devendra 1982) or intake or both (Mc Meniman *et al.,* 1988; Das *et al.* 1999a,b; Das, 2002). Grasspea (Grasspea sativus L.) also called Khesari/ Teora/Lakh/Lakhadi is a popular pulse crop in India and area under grasspea cultivation during 2010-11 in India was 5.21 lakh hectres (Source: DES, DAC, Ministry of Agriculture, Krishi Bhavan, New Delhi). However, straw portion of the lathyrus plant contain some neurotoxic compound like β-oxalyl-L-α, β-diaminopropionic acid (ODAP) to the extent of 0.13-0.21% of DM (Denekew and Tsega 2009).The ingestion of ODAP through lathyrus grain or forage may cause neurolathyrism, a neurodegenerative disease and sometimes death in humans and animals (Spencer and Schaumburg, 1983). Hence, this study was designed to evaluate the effects of supplementation with lathyrus straw (a high protein forage legume) on diet utilization and subsequent milk production of crossbred cows (Jersey × Tharparkar) fed wheat straw based ration.

MATERIALS AND METHODS

Fifteen lactating crossbred (Jersey × Tharparkar) cows weighing around 370.7±10.42 kg (Average milk yield 6.67±0.48 kg/d) were randomly divided into three dietary treatments in a completely randomized block design. In the control group (T_1), the animals were fed wheat straw plus concentrate based ration, whereas in the diet of groups T_2 and T_3 wheat straw was

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supplemented with lathyrus straw (LS) replacing wheat straw at 30% and 50% on DM basis for 90 days. All the groups were provided iso-nitrogeneous diet. The concentrate mixture consisted of mustard cake 25, cottonseed cake 15, wheat bran 32, maize 25, salt 1 and mineral mixture 2 parts each. The animals were housed individually in well ventilated cleaned dry pacca pens and water was provided *ad libitum*. The concentrate mixture was offered as per requirement in to two installments in the morning (05:00 h) and in the afternoon (15:00 h) just half an hour before milking. The left over feed was weighed and recorded daily. The cows were milked twice daily (5:00 h and 15:00 h) and daily milk yield of individual cows were recorded throughout the experimental period. Morning and evening milk samples (50 ml each) from individual cows were collected once a week and pooled for anal-ysis. A 7 day digestion trial was conducted at the end of the experimental feeding during which feed offered and refused samples were weighed and recorded daily. Dry matter of faeces samples was estimated through oven drying at 80°C±2°C for 24 h. Pooled samples of feeds, residues and faeces were analysed for crude protein, total ash following the methods of the AOAC (1999) and fiber fractions (Van Soest *et al.* 1991). Neutral detergent insoluble crude protein (NDICP), acid detergent insoluble CP (ADICP), non-protein nitrogen (NPN) and soluble protein (SP) content of experimental feeds were estimated as per Licitra *et al.* (1996). ODAP content of straw sample was estimated following the method of Thippeswamy *et al.* (2007). Milk fat,total solids (TSS), total ash, milk protein content were estimated using the method of ISI(1961). Solid not fat (SNF) content of milk was calculated by subtracting fat percentage from total solids. The gross energetic efficiency for milk production was calculated using the standard formula (GEE) = 100 × [4% FCM (kg) × 750/ total digestible nutrients (TDN) consumed (kg) × 4000]. Similarly, gross protein efficiency was calculated using the formula GPE = 100 × [milk yield × protein (kg)/ digestible crude protein (DCP) intake (g)].

The data on intake, digestibility, milk yield and milk composition were subjected to analysis of variance using the general linear model procedures of the SPSS 11.0 software and treatment means were ranked using Duncan's multiple range tests according to Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Crude protein contents (%) were 4.35, 8.89 and 19.84 in wheat straw, lathyrus straw and concentrate respectively (Table 1). Protein content of lathyrus straw

Table 1. Chemical composition (%DM basis) of feeds and fodder

Parameter	Wheat straw	Lathyrus straw	Concentrate mixture
Dry matter	92.74	92.68	95.52
Organic matter	90.92	91.68	94.56
Crude protein	4.35	8.89	19.84
Neutral detergent fibre	73.87	69.73	57.44
Acid detergent fibre	59.38	56.03	14.32
β-ODAP	-	0.02	-
Primary protein fractions			
NDIP(%CP)	25.48	19.26	8.48
ADIP(%CP)	15.26	11.46	2.52
SP%(CP)	28.36	26.58	22.38
TP%(CP)	68.25	57.52	69.32
NPN(%CP)	31.74	42.48	30.68

β-ODAP, beta-oxalyl-diamino-propionic acid ; NDIP, neutral detergent insoluble protein; ADIP, acid detergent insoluble protein; SP. soluble protein; TP, true protein; NPN, non-protein nitrogen was comparable with lentil straw (Woldegeorgis, 2017) and similar to earlier report of Gizachew and Smit (2005) and Larbia *et al.* (2010). However, NDF and ADF content was higher than the earlier report of Lopez *et al.* (2005) and Larbia *et al.* (2010) which may be due to varietal difference and cultivation practices (Calderon *et al.,* 2012). The fibre content of wheat straw was comparable, however, protein content was higher than the earlier report of Das *et al.* (2017), which may be attributed to the harvest at later stage of maturity. Primary protein fractions *viz.* NDIP, ADIP and NPN values of wheat straw and lathyrus straw was similar with the earlier report of Singh *et al.* (2011) whereas Venkateswarulu *et al.* (2015) reported higher values in black gram and red gram straws than the present values of lathyrus straw. β-ODAP content of lathyrus straw was .02%, however, Denekew and Tsega (2009) reported much higher values (0.13-0.21% of straw) which might be due to varietal differences.

Average daily DM intake (DMI) was not influenced with supplementation of lathyrus straw and was comparable among the groups (Table 2). Similar to these findings, Kitaw *et al.* (2010) reported that there was no effect of supplementation with legume hays on intake of basal roughage in lactating cows. However, Richards *et.al.* (1994) recorded reduced total DMI when concentrate was replaced with *Gliricidia Sepium* leaves which may probably be due to some palatability problem and varied levels of condensed tannin in Gliricidia. Proportionate DMI (I% BW or per kg $W^{0.75}$) in all the groups were comparable with the suggested value (ICAR 2013). DM intake values of 96.6 to 103.8 g/kg $W^{0.75}$ in the present experiment corroborated with the earlier findings of (Kearl, 1982; Dey *et al.,*2009)

Table 2. Average daily intake and digestibility of nutrients in crossbred cows fed different treatment diets

Parameter	G_1	G_2	G_3	SEM
Body weight (kg)	376.60±13.05	357.72±13.76	377.78±15.54	18.94
Wheat straw (kg/d)	4.29±0.03	2.64±0.12	1.82±0.06	0.08
Lathyrus straw (kg/d)	-	1.65±0.05	2.58±0.13	-
Concentrates intake (kg/d)	4.58±0.24	4.16±0.26	3.78±0.25	0.18
Dry matter intake (kg/d	8.75±0.25	8.47±0.19	8.19±0.12	0.20
Dry matter intake (%BW)	2.36±2.88	2.38±2.86	2.21±2.85	0.09
Dry matter intake (g/kgBW$^{0.75}$)	103.85±3.03	103.16±3.26	96.61±2.49	2.95
DCP intake (kg/d)	0.567^b±0.01	0.523^b±0.01	0.478^a±0.02	0.02
DCP intake (g/kgBW$^{0.75}$)	6.64^b±0.16	6.39^b±0.17	5.60^a±0.22	0.19
TDN intake g$^{/kg}$BW$^{0.75}$)	57.43±1.57	55.88±2.83	52.72±2.43	1.93
N intake (g/kg DOMI)	37.68±1.24	40.10±0.97	39.85±0.93	1.06
Digestibility (%)				
Dry matter	52.28±5.02	51.79±4.23	53.29±4.80	1.93
Organic matter	56.74±4.95	55.45±3.96	56.36±4.42	1.71
Crude protein	51.76^b±2.01	47.85^b±1.94	44.98^{a}1.94	1.62
Ether extract	68.11±1.78	64.86±4.14	65.42±4.26	1.81
Nitrogen -frree extract	62.11±1.78	60.78±1.26	63.21±2.51	1.92
Nutritive value (%)				
DCP	6.64±0.27	6.17±0.30	5.82±0.24	0.21
TDN	55.25±2.13	54.04±1.14	54.76±1.59	1.66

DCP, digestible crude protein; TDN, total digestible nutrients; [a,b]Mean values bearing different superscript in a row differ significantly (P<0.05) and clearly indicates that the supplement was palatable. Similar dry matter intake per kg metabolic body weight in sheep fed legume crop residues supplemented diet was also recorded by Ngwa and Tawah (2002). However, Rahman *et al.* (2015) recorded higher DMI in crossbred cows fed Lathyrus hay supplemented diet. DM, OM and NFE digestibility did not differ significantly among the groups fed experimental diets. Das *et al.* (2008) recorded similar trend in crossbred calves fed berseem straw based diet (Table 2). Similarly, Konka *et al.* (2015) also reported comparable digestibility of NDF and ADF with total mixed ration incorporating 60% of maize stover *vs.* black gram straw. However, Nagalakshmi *et al.* (2014) observed that the digestibility of DM and OM was comparable on feeding iso-nitrogeneous complete ration (roughage to concentrate ratio of 50:50%) having 30% red gram stalk, but was reduced with 40 and 50% level as compared to control.

CP digestibility was significantly($P<0.05$) higher in group G_1 and G_2 than G_3 indicating that up to 30% replacement of wheat straw with lathyrus straw in isonitrogeneous diet did not affect the CP digestibility. Similarly, Das *et al.* (2012) observed higher protein digestibility in crossbred heifers fed concentrated supplemented diet than with 100% concentrate replaced diet with stylo meal diet. Nagalakshmi *et al.* (2014) also observed lower CP digestibility values when red gram stalks (RGS) was incorporated at 30, 40 and 50 % level in a complete diet as compared to a diet containing 50% sorghum stover in Murrah buffaloes. However, Lunagariya and Pande (2016) recorded comparable CP digestibility in Kankrej crossbred bullocks fed 50,60 and 70% lucern straw based total mixed iso-nitrogeneous diet. TDN intake was comparable among the groups. It was observed that replacement of wheat straw with lathyrus straw up to 30% had no effect on DCP intake, however, 50% replacement, reduced DCP intake significantly($P<0.05$). On the contrary, Rao *et al.* (2003) reported no effect on DCP and TDN intake in goats while concentrate was replaced with stylo leaf meal up to 100%. CP and TDN intake were sufficient for maintenance as well as production in lactating cows. (ICAR 2013) in all the groups. N intake per kg digestible organic matter (DOM) intake in all the groups was sufficient for efficient rumen fermentation and did not show any significant difference among the groups. Similar result was reported earlier by Sharma *et al.* (1998) in goats fed rice straw supplemented with *Leucaena leucocephala* hay or concentrate. DCP intake per kg FCM was higher in control group though not statistically significant, however, TDN intake/kg FCM was comparable among the groups.

Milk yield (kg/d) was similar among the groups (Table 3). Similarly, Kehaliew *et al.* (2010) also recorded no difference in milk yield in cows when 20, 30 and 40% of the basal diet was replaced with vetch hay. Thus the findings of the present study clearly showed that milk yield of crossbred cows can be maintained by supplementing lathyrus straw in the diet. There was

Table 3. Average milk yield and milk composition of cows fed experimental diets

Parameters	G_1	G_2	G_3	SEM
Milk yield (kg/d)	6.59±0.48	6.71±0.30	6.58±0.41	0.41
4% FCM (kg/d)	7.73±1.08	7.87±0.80	7.71±1.27	0.09
Milk composition (%)				
Protein	3.35±0.06	3.23±0.40	3.30±0.10	0.08
Fat	5.09±0.23	4.73±0.22	5.15±0.52	0.34
Lactose	4.80±0.07	4.77±0.14	4.73±0.06	0.06
Solids not fat	7.56±0.12	7.31±0.25	7.58±0.27	0.20
Total Solid	12.65±2.86	12.04±2.71	12.73±0.78	0.52

FCM, fat corrected milk

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

Attributes	T_1	T_2	T_3	SEM
Feed conversion				
DM kg/kg FCM	1.16±0.08	1.08±0.04	1.07±0.05	0.06
TDN kg/kg FCM	0.65±0.06	0.58±0.02	0.59±0.03	0.04
DCP g/kg FCM	75.35±7.82	66.51±2.76	62.72±4.28	5.39
GPE%	26.63±1.60	28.01±2.20	30.35±2.01	3.12
GEE%	29.81±2.34	32.32±1.43	32.20±1.56	1.82
Economic efficiency				
Average daily feed cost (₹)	103.98^{b}±1.70	98.11^{a}±2.85	92.68^{a}±1.92	2.02
Feed cost/ kg FCM	13.70±1.01	12.51±0.29	12.12±0.37	0.68
Economic efficiency	2.54±0.10	2.73±0.06	2.83±0.08	0.08

DM, dry matter; TDN, total digestible nutrients; GPE, gross protein efficiency; GEE, gross energetic efficiency; FCM, 4% fat corrected milk; ^{ab}Means bearing different superscript in a row differ significantly ($P<0.05$)

no significant difference ($P>0.05$) in milk fat, milk protein, lactose and total solids content among groups suggesting efficient utilization nutrients in all groups. The cost (₹/kg) of wheat straw, lathyrus straw and concentrate mixtures were ₹ 5.00 and ₹ 6.00 and ₹ 18.00, respectively. The cost-benefit analysis revealed that the cost of feeding (₹/d) was reduced significantly ($P<0.05$) from 103.98 to ₹ 92.68 (Table 4). Replacement of wheat straw with LS at 50% resulted in reduction of feed cost per kg FCM yield (₹ 13.70 vs 12.12). Similarly, Dey *et al.* (2016) also recorded that the cost of milk production (₹/liter) reduced from ₹ 10.61 to7.98 when wheat bran was completely replaced with black gram foliage.

CONCLUSION

Experimental results suggest that Lathyrus straw can be safely incorporated in the ration of dairy animals for economic milk production without having any adverse effect on feed intake, nutrient utilization and production performance of crossbred cows.

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