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Performance of growing lambs on rations containing *Lathyrus* grains as protein source

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In India, the traditionally used protein sources, i.e. oil cakes (groundnut cake, mustard seed cake, etc) are not only scarce but also high in cost, which imposes most significant obstacles for animal production. There is a need to look for locally available, cheap sources of feed ingredients for small ruminants. One such possible source of protein from unconventional protein sources is the *Lathyrus* Grain (LG) which is much cheaper than the other legumes and involves low cost in cultivation, especially in non-irrigated areas. The protein content of the grain is around 21-25% (Barpete *et al*. 2021) and like other legumes, LG are rich in amino acids and vitamins (Ramya *et al*. 2022).Additionally, LG can successfully replace soybean meal in dairy calves diet (Rastpuor *et al*. 2019). However, the seeds contain a variety of anti-nutritional substances such as 3 N-oxalyl_L-2,3-diaminopropionic acid or β–ODAP. This indicates that the grain may be exploited as a protein source in the rations of ruminants despite the presence of anti-nutritional factor like β-ODAP. However, the information on feeding of *Lathyrus* grain in place of groundnut cake is scanty in sheep feeding practice. Therefore, the present study was planned to evaluate the LG as replacer of GNC in rations of lambs for nutrient intake, nutrients utilization and growth performance of lambs.

Jalauni lambs (n=18) weighing around 16.45±1.50 kg were randomly allocated into three dietary treatments in a completely randomized block design. In the control group (LG0), the animals were fed *ad lib.* green chaff of fodder sorghum var. M P Chari with concentrate mixture as per requirement, whereas in the LG50 and LG100, the crude protein of groundnut cake (GNC) was replaced @50% and 100% with LG protein in the concentrate mixture (Table 1), respectively for 90 days. After 60 days of the experimental feeding, a metabolism trial was conducted for seven-day collection period. At the end of trial, rumen liquor samples were collected from individual lambs. About 50-60 ml of rumen liquor was collected at 2 h post-feeding into 0.5 L pre-warmed thermos using esophageal tube with light suction. Rumen liquor *p*H was recorded immediately with the help of digital *p*H meter (Systronic-310). Rumen liquor was then strained through double layer muslin cloth and stored in plastic bottles after adding few drops of saturated mercuric chloride and then preserved in freezer until rumen metabolite analyses. Blood samples were collected by jugular vein puncture in heparanized test tubes. Fortnightly body weights were recorded up to 90 days.

Table 1. Ingredient composition of concentrate mixtures fed to animals of different groups

Ingredient	LG0	LG50	LG100
Groundnut cake	35	18	-
Wheat bran	15	30	40
Maize	47	27	13
Lathyrus grain	-	22	44
Mineral mixture	1	1	1
Common salt	2	2	2

Samples of feed offered, feed refusals and faeces were analysed for proximate principles (AOAC 1999) and fibre components (Van Soest *et al*. 1991). Nitrogen content of urine samples was estimated by Kjeldhal method. Strained rumen liquor samples were analyzed for total N and ammonia N by the method of McKenzie and Wallace (1954) and Conway (1962), respectively. Total volatile fatty acids (TVFA) were analyzed by the methods of Briggs *et al*. (1957). Various blood metabolites were estimated for glucose (Somogyi 1945), urea (Rahmatullah and Boyde 1980) and protein (Reinhold 1953). The results obtained were subjected to analysis of variance using the general linear models procedures of the SPSS 11.0 software and treatment means were ranked using Duncan's multiple range tests according to Snedecor and Cochran (1994). Crude protein content of LG (26.71%) was lower than the GNC (34.12%), similarly, the cell wall contents (NDF and ADF) were also lower in LG than GNC (Table 2). CP and fibre fractions in LG reported by Karadag and Yavuz (2010) are consistent with the present findings. Sujata

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Table 2. Chemical composition (%) of M P Chari, concentrates mixture and feed ingredients

Ingredient	OM	EE	CP	NDF	ADF	Cellulose	Hemicellulose
Lathyrus grain	95.2	1.84	26.71	11.84	6.78	5.52	5.06
GNC	92.16	5.12	34.12	38.21	27.36	15.20	10.85
Maize	95.66	2.74	10.22	20.62	8.65	6.12	11.97
Wheat bran	94.32	2.66	12.16	34.56	11.54	7.86	23.02
M P Chari green	90.82	2.66	8.70	68.73	44.44	34.85	24.29
LG0	93.40	3.62	18.64	22.21	10.37	6.96	11.84
LG50	93.42	2.74	18.52	19.36	12.09	8.80	7.27
LG100	94.42	2.24	18.46	21.52	11.76	9.81	9.76

and Gowri Shankar (2014), however, reported that CP content of *Lathyrus* grain varied from 22.79% to 28.26% in different states of India.

Supplementation of LG (Table 3) did not influence (P>0.05) the total DMI (g/day) in animals of LG50 and LG100 compared to LG0. Similarly, DM intake as % bodyweight or per kg metabolic body size was also comparable among the groups. Janamp *et al*. (2016) also observed similar DM intake in kids when GNC was replaced with guar meal at different levels in kids diet. Digestibility(%) of DM, OM, and cell wall polysaccharides (NDF, ADF, cellulose) was comparable amongst the different dietary groups. Similarly, Rastpuor *et al*. (2019) also recorded that digestibility of dry matter, organic matter, crude protein, natural detergent fibre, acid detergent fibre and ether extract were not statistically (P>0.05) affected when soyabean meal was replaced with LG in the diet of calves. The digestibility of EE, however, was significantly (P<0.05) higher in LG0 group as compared to LG50 or LG100. Decreased EE digestibility with supplementation of cowpea grains in sheep has also been reported earlier (Singh *et al.* 2006). The higher EE digestibility in LG0 than LG50 or LG 100 diets, may probably be because of the superior EE content of GN cake. CP digestibility was higher (P<0.05) in LG50 group than LG0 or LG100. However, Gilbery *et al*. (2007) reported that replacing rapeseed meal (RSM) with pea seed (PS) or chickpea seed in cow diets did not affect CP digestibility. The N balance data showed a decline (P<0.05) in N utilization (N retained, N retained as per cent of intake and absorbed) at 100% level of LG inclusion which could be attributed to relatively higher urinary excretion of N and corroborated with the earlier findings of Chaturvedi and Sahoo (2013). All the groups met the requirement for DM, DCP and TDN recommended by ICAR (2013).

All the blood parameters were comparable among the groups and within the normal physiological range (Table 4). Rastpuor *et al*. (2019) observed non-significant difference in blood glucose and protein content when soyabean meal was replaced with LG in the diet of calves. However, Tufarelli *et al.* (2012) reported reduced blood urea concentrations in cows when fed diets in which SBM was replaced by pea grains, which might be due to decreased degradability of pea protein leading to the decreased ammonia level in the rumen and subsequently reduced urea level in blood. In general, changes in urea concentration are correlated with the content of ruminal ammonia, which depends on the metabolic activity of ruminal microorganisms that transform ammonia nitrogen into a bacterial protein. However, in the present study, the blood urea values were similar among the groups, which might be due to similar effective rumen degradability of

Table 3. Nutrient intake, digestibility, nitrogen balance and rumen metabolites in lambs fed different experimental diets

Attribute	LG0	LG50	LG100	Pooled SEM
Total DMI (g/d)	641	615	608	19.52
% Body weight	3.39	3.34	3.31	0.15
DMI (g kg/W $^{0.75}$)	70.6	69.2	68.6	2.62
Green intake (% body wt)	1.9	1.8	1.8	0.11
DCP intake (g/d)	53.82	56.33	52.57	1.24
DCP intake (g kg/W $^{0.75}$)	5.93	6.35	5.92	0.21
TDN intake (g kg/W $^{0.75}$)	44.63	44.18	42.62	2.21
N intake (g/kg DOMI)	35.56	35.72	35.80	1.08
Digestibility coefficient (%)				
DM	63.3	64.6	62.4	1.89
OM	65.5	66.8	64.9	1.79
EE	70.3[c]	63.2[ab]	60.8[a]	2.16
CP	63.0[a]	66.8[b]	63.3[a]	1.38
NDF	49.8	48.4	49.0	2.34
ADF	48.9	51.9	50.2	2.23
Cellulose	62.9	63.3	61.9	2.30
NFE	69.3	69.8	67.3	1.91
Nitrogen (N) balance (g/d)				
Intake	13.6	13.5	13.0	0.21
Faecal	5.0	4.5	4.8	0.21
Absorbed	8.6	9.0	8.4	0.19
Urinary	3.0	3.0	3.4	0.28
Balance	5.6	6.0	4.9	0.39
% of total intake	40.8[b]	44.3[b]	37.6[a]	1.42
% of absorbed	64.7[b]	66.3[b]	58.3[a]	1.34
Intake	13.6	13.5	13.0	0.21
Ruminal attributes				
*p*H	6.62	6.69	6.59	0.06
TVFA (mmol/L)	131	134	132	3.67
Total-N (mg/100 ml)	93	96	94	1.14
Ammonia-N (mg/100 ml)	20.53	22.49	21.56	0.43

[ab]means bearing different superscript in a row differ significantly (p<0.05).

Table 4. Nutritive value and blood metabolites in lambs fed different diets

Attribute	LG0	LG50	LG100	Pooled SEM
Nutritive value				
DCP%	8.4[a]	9.2[b]	8.7[a]	0.71
TDN%	63.0	63.9	62.1	1.70
DE kcal g/DM	2.90	2.80	3.2	0.14
Blood metabolites				
Glucose(mg/dl)	55.08	56.35	58.62	1.04
Protein(g/dl)	5.38	4.51	4.34	0.39
Urea(mg/dl)	20.50	18.78	20.65	1.06
Live weight change				
Initial weight(kg)	16.5	16.2	16.7	1.59
Final weight(kg)	22.9	22.7	23.3	1.60
Total gain(kg)	6.4	6.5	6.6	
Growth rate(g/d)	71.3	72.1	73.7	6.26

[ab]means in the same row for each parameter with different superscripts are significantly different ($P<0.05$).

GNC and ground lathyrus grain. The rumen metabolites were not affected due to incorporation of LG as substitute of GNC in the diet and corroborated with the earlier findings of Rastpuor *et al*. (2019). Daily body weight gain was comparable among the groups fed different experimental diets. Filleau *et al.* (2018), Keller *et al.* (2021) also reported that partial or total replacement of soyabean or rapeseed protein by faba beans, lupin seeds, or peas did not significantly alter ADG in growing sheep or cattle. Similarly, Rastpuor *et al*. (2019) also observed that *Lathyrus* grain may replace soyabean meal in the diet of Holstein calves until 80 days of age without harming the growth performance.

SUMMARY

The effect of feeding *Lathyrus* grain as substitute of GNC protein in the diet of lambs was studied for nutrient utilization, blood and rumen metabolites and growth performance. *Jalauni* lambs (n=18) weighing around 16.45±1.50 kg were randomly allocated into three dietary treatments in a completely randomized block design. In the control group (LG0), the animals were fed *ad lib.* green chaff of fodder *Sorghum bicolor* cv. M. P. Chari with concentrate mixture as per requirement whereas in the LG50 and LG100, the crude protein of groundnut cake was replaced @50% and 100% with *Lathyrus* grain (LG) protein in the concentrate mixture, respectively. Supplementation of LG did not influence the total DMI (g/day) in animals of different experimental groups. Digestibility(%) of DM, OM, and cell wall polysaccharides (NDF, ADF, cellulose) was also comparable amongst the different dietary groups, while CP digestibility was higher in LG50 group than LG0 or LG100 group. Digestible crude protein (DCP) content was higher in LG50 than LG0 or LG 100 whereas total digestible nutrients (TDN) contents were comparable amongst the treatment groups. Similarly, rumen metabolites and all the blood parameters were comparable among the groups and within the normal physiological range. The daily body weight gain was not affected with the experimental diets. It could be concluded that *Lathyrus* grain could be used as an alternative source of protein in the concentrate mixture without any adverse impacts on nutrient utilization, rumen fermentation, blood metabolites and growth performance of *Jalauni* lambs.

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