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EFFECT OF FEEDING SALVADORA OLEOIDES LEAVES ON GROWTH AND NUTRIENT UTILISATION IN CAMEL CALVES

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ABSTRACT

Study was conducted to evaluate extent of incorporation of *Salvadora oleoides* leaves on growth and nutrient utilisation in the diet of camel calves. Feeding trial of 60 days duration was followed by digestibility trial of 7 days duration. Twelve growing female camels having similar age (1-2 years) and body weight were selected and distributed randomly into three groups of four each (T_1, T_2 and T_3). T_1 group received basal roughage diet containing crop residues of groundnut (*Arachis hypogea*) and guar (*Cymopsis tetragonaloba*) in equal proportions. Treatment groups T_2 and T_3 group were provided basal roughage along with 5% and 12.5% *Salvadora oleoides* leaves (on dry basis). Live weight, ADG, nutrients intake, rumen fermentation and haemato-biochemical parameters were monitored. Observations revealed no significant change in live weight change and digestibility of dietary nutrients. However, significant effect was observed with respect to protozoal numbers; concentration of NH3N, total nitrogen and total VFA concentration. Results indicated that intake of dry matter, organic matter and crude protein significantly ($P \leq 0.01$) improved when supplemented at 5% level. However, digestibility of nutrients, haemato-biochemical parameters, water intake and faecal pellet attributes of animals were not affected. *Salvadora oleoides* leaves can be used as a cheaper feed resource at a level of 5% of diet due to its availability in the arid region wherein it can be pruned and fed as fresh or in dry form without any adverse effect.

Key words: Camel calves, *Salvadora oleoides* leaves

Camel, a unique animal species of desert ecosystem is adapted to sustain on a variety of feeds and fodders like grasses, tree leaves, crop residues and agro-industrial by products (Nagpal *et al*, 2002). The feeding system involving conventional forages seems inadequate and thus, it is imperative to use other non-conventional resources like leaves from trees and bushes as they form substantial biomass and could be of potential use in animal feed industry. A good and less expensive supply of protein and minerals is provided by trees leaves (Moyo *et al,* 2012; Sahoo and Sawal, 2021). *Salvadora oleoides* found in the dry arid regions of India (Khatak *et al,* 2010), locally known meetha jal, bada jal, pilu etc; it has immense ecological, economical as well as ethno-medicinal value. Salvadora with its remarkable drought resistance and high nutritional value, stands out as an excellent fodder option for animals in arid regions. Studies consistently show improvements in growth performance, milk production, digestibility, nutrient utilisation and overall health in animals fed with *Salvadora persica* leaves highlight the plant's utility in enhancing livestock productivity and sustainability in challenging environments (Priyanka *et al,* 2024). Leaves are bluish green and have leathery appearance (Garg *et al,* 2013), they have been found to contain a variety of chemical components including carbohydrates, alkaloids, steroids, glycosides, saponins, tannins, triterpenes, mucilage, lipids and oil (Arora *et al,* 2015). It also possesses anti-inflammatory, analgesic, antiulcer, anthelmintic, antibacterial and antifungal properties (Arora *et al,* 2015). Feeding experiments in cows have revealed 12% increase in milk yield and improved milk fat content by 1.5% indicating salvadora could enhance both the quantity and quality of milk produced (Khan *et al,* 2016). Ahmed *et al* (2017) reported 18% increase in milk production in buffaloes; additionally, there was improvement in the overall health and body condition of the which was attributed to the higher nutritional content of the *Salvadora persica* foliage. El-Shaer and Tawfik (2020) identified the anthelmintic properties of *Salvadora persica*, noting a significant reduction in parasite load and improved health and weight gain

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in treated camels. The present study was done with the objective to evaluate nutritional value of *Salvadora oleoides* and extent of utilisation in the diet of camel.

Materials and Methods

Twelve growing female camels of similar body weight and age (1-2 years), uniform conformation was selected from camel herd of ICAR-NRCC, Bikaner and randomly distributed into 3 groups of 4 each and fed experimental diets for 60 days followed by 7 days digestibility trial. The animals were housed in hygienic, well-ventilated shed with sandy floor, asbestos roofing, equipped with mangers for individual feeding. Incorporation of fresh leaves of *Salvadora oleoides* was assessed on the basis of palatability, intake of nutrients, body weight change and practical nutritional worth. Rumen fermentation attributes i.e. ruminal fluid pH, ammonia nitrogen, total nitrogen and TCA precipitable nitrogen, total protozoal count and total volatile fatty acid were estimated. Blood samples were also collected by jugular venipuncture and estimated for haemato-biochemical parameters to ascertain physiological health status of animal.

The camels were given prophylactic dose of anthelmintic and allowed to acclimatise for a period of one month prior to conduct of the experiment. Control group T_1 received combination of Guar and groundnut crop residue (1:1) was replaced with *Salvadora oleoides* leaves at 5% (T_2) and 12.5% (T_3) group (on dry basis).

Feeds offered, residues and faeces collected during the study along with leaves of *Salvadora oleoides* and *Salvadora persica* were analysed as per AOAC (2016). Phytochemical fractions were evaluated in different plant, viz. Total phenols (Hagerman *et al,* 2000), non-tannin phenolics by Folin-Ciocalteu method (Makkar, 2003) and saponin (Hiai *et al,* 1976).

The rumen liquor pH was estimated using digital pH meter, ammonia nitrogen content was estimated by Conway diffusion disc method (Conway, 1962). Rumen liquor was analysed for total nitrogen and TCA precipitable nitrogen by Kjeldahl procedure (AOAC, 2016). Total volatile fatty acid concentration was determined using Markham apparatus (Barnett and Reid, 1957). Haemato-biochemical parameters were estimated to ascertain physiological status of camel. Data generated during the studies was analysed by using randomised block design (Snedecor and Cochran, 1994).

Results and Discussion

Evaluation of both the available species of Salvadora revealed that *Salvadora persica* contained higher ether extract, total ash, acid insoluble ash, lignin content whereas it contained, lower organic matter, protein NDF and ADF and Calcium though phosphorus content was similar among species. Chemical composition of the feeds consumed by the animals (Table 1) revealed that the basal feeds were high in protein content. However, Salvadora leaves from both the species contained higher protein than the basal feed provided, it was low in NDF and ADF content but high in calcium and phosphorus content compared to groundnut and *Cymopsis tetragonaloba* crop residues. Relative to crude protein content observed in the present study, higher protein content has been reported earlier (Chaudhary, 2015). Variation could be due to season of sampling or leaves maturity. Higher content of total phenols, total tannin, condensed tannin and hydrolysable tannin have been reported in Khejri (*Prosopis cineraria*) leaves and Pala (*Zizyphus nummularia*) leaves which are also used for animal feeding in arid regions (Kumari

Table 1. Chemical and phyto chemical fractions of experimental feeds (% DM basis).

Feed stuff	Groundnut chara*	Guar chara**	*Salvadora oleoides*	*Salvadora persica*
DM	91.28	90.58	32.02	34.7
OM	91.25	90.2	82.71	78.78
CP	8.51	7.13	10.91	10.29
EE	0.976	1.15	1.2	1.85
TA	8.75	9.80	17.28	21.21
NDF	47.7	47.00	31.2	25.6
ADF	35.80	37.00	17.2	14.8
AIA	1.91	2.30	6.24	10.72
Lignin	4.50	6.00	1.6	2.6
Ca	1.68	0.89	8.80	7.5
P	0.52	0.17	0.65	0.63
Phytochemical fraction				
Total Polyphenols	1.38	0.65	3.87	3.89
Non-Tannin Phenolics	0.53	0.42	1.19	1.21
Total Tannin	0.38	0.09	2.85	2.86
Condensed Tannin	0.32	0.27	0.80	0.86
Hydrolysable Tannin	0.53	0.22	2.06	2.09
Saponin	3.12	2.96	5.16	5.75

**Arachis hypogea* crop residue, ***Cymopsis tetragonaloba* crop residue, Salvadora leaves.

et al, 2023). However, the cultivated legume crop residues contained lower quantities as tree forages accumulate more phenolic constituents as a defense mechanism against browsing by herbivores (Salminen and Karonen, 2011).

Dry matter intake in the treatment groups (Table 2) was observed to be higher in T_2 which decreased in T_3 which could be due to presence of fresh leaves in the form of soft twigs. However, DMI and OMI were observed to be similar when expressed on metabolic body size. Dry matter consumption (kg/d) was lower ($P<0.05$) in camels fed 12.5% tree leaves as compared to T_2 group which might be attributed to the effect of tannins on voluntary feed intake. Similar findings were reported by Olafadehan *et al* (2014). Crude protein intake improved significantly ($P\leq0.05$) with increase in *Salvadora oleoides* leaves in the diet due to supplementation of leaves with higher protein content. The findings of present investigation regarding CPI was in accordance with earlier observations on neem leaves in the diet of goats (Dida *et al,* 2019). Water consumption was observed to improve with supplementation of Salvadora leaves though the differences were not significant.

Table 2. Effect of feeding salvadora leaves on DMI and digestibility of nutrients.

Attributes	T_1	T_2	T_3	SEM	P value
Initial weight (kg)	366.52	371.0	370.32	17.5	0.987
Final weight (kg)	385.97	391.5	390.12	18.27	0.963
Daily gain Kg/d	0.324	0.343	0.330	0.031	0.978
DMI kg/d	6.17a	6.27b	6.19a	0.015	0.001
DMI kg/100kgBW	1.70	1.69	1.71	0.010	0.672
DMI g/kgW0.75	74.29	74.40	75.40	0.317	0.316
OMI (g/kgW0.75)	66.49	66.53	67.43	0.250	0.242
CP Intake (kg/d)	0.487^a	0.497^b	0.512^c	0.003	0.000
CP Intake (g/ kgW0.75)	5.90^a	5.89^a	6.18^b	0.048	0.002
Water intake L/d	24.90	27.05	29.10	0.822	0.104
Water intake L/100kg BW	6.77	7.18	8.27	0.372	0.253
Water intake L/ kgW0.75	0.30	0.32	0.33	0.007	0.128
Digestibility of nutrients (%)					
DM	61.00	64.39	62.17	0.946	0.364
OM	63.45	65.02	62.82	1.371	0.828
CP	67.15	69.26	68.61	0.665	0.455
EE	49.04	53.90	52.81	1.116	0.180
NDF	41.18^b	32.55^a	30.32a	1.706	0.006
ADF	31.59	29.10	28.76	0.726	0.236
TCHO	52.72	48.03	46.87	1.613	0.320
DCP	5.30	6.04	5.85	0.196	0.299
TDN	59.20	56.37	55.77	1.516	0.473
NR	10.19	8.46	8.68	0.454	0.255

Figures bearing different superscripts differ significantly, ($P\leq0.05$), ($P\leq0.01$).

Digestibility of Nutrients and Nutrient Intake

Live weight of animals was observed to be similar among the groups at the beginning and at end of 60 day feeding trial. Change observed was similar among groups reflecting diet had a insignificant effect on the growth of calves. Studies on impact of *Salvadora persica* as fodder in goats fed 25% and 50% salvadora showed an increase in average daily weight gain by 15% and 22%, respectively, relative to control reflecting that incorporating *Salvadora persica* leaves in the diet significantly enhanced growth performance in goats (Ali *et al,* 2012).

Digestibility of nutrients (Table 2) indicate that dry matter, organic matter crude protein, ether extract it improved at 5% level of inclusion however at higher levels the advantage faded off. Digestibility of NDF decreased significantly in T_2 and further in T_3, similar trend was observed with respect to ADF and total carbohydrates. DCP intake improved at 5% level of inclusion; however, it decreased when Salvadora leaves was incorporated at higher level, whereas TDN content decreased in T_2 and further in T_3 reflecting energy utilisation was affected due to incorporation of leaves in the diet. Evaluation of nutritional worth revealed that DCP content in the diet improved with supplementation of Salvadora leaves at lower level of 5%; however, TDN content reduced marginally at T_2 and incrementally in T_3 reflecting energy available in the diet was not efficiently utilised. Contrary to the present finding digestibility dry matter, crude protein and crude fibre improved significantly in goats fed Salvadora leaves and found that 20% and 40% of diets Rahman *et al* (2015). Weight of the faecal pellet (Table 3) was observed to be higher in the supplemented groups and density of faecal pellet decreased though the observations were non-significant. Length was observed to be similar but the diameter increased reflecting increase in size. Considering higher intake of DM; DM voided and its retention was less in T_2 which reflected better digestion then in other groups. Though the digestibility values in the present study were observed to be similar, it could be inferred that at a low level of 5% of the diet, supplementation of salvadora leaves supports better utilisation of dietary protein and energy as well.

Rumen Fermentation Pattern

Protozoal numbers (Table 4) decreased incrementally (P≤0.05) with increase in salvadora leaves in the diet of camel calves possibly due to defaunating action of the leaf metabolites. Mean values of pH were found to vary among treatments, however, no trends could be inferred as they were statistically similar among treatments. Singh *et al* (2011) studied effect of tannin rich Pakar (*Ficus infectoria*) leaves in goats and observed no difference in pH of rumen liquor of both the groups. Ammonia nitrogen in the present study was decreased in T_2 but partly recovered in T_3 suggesting that it was utilised in T_2 for microbial protein synthesis which is evident from the TCA nitrogen concentration, whereas higher levels might have suppressed rumen function. Vaithiyanathan *et al* (2007) assessed the effect of feeding different levels of tannin-containing *Prosopis cineraria* leaves in lambs and kids and observed lower ruminal ammonia nitrogen. Total nitrogen content in the rumen liquor was observed to increase at low level of supplementation, however, at higher level of supplementation it was further decreased which could be due to decrease in microbial activities contributing to the solubilisation. NPN content was marginally higher at low level of supplementation but were statistically similar among groups.

Table 3. Different attributes of faecal pellets in different treatment groups.

Attributes	T_1	T_2	T_3	SEM	P value
Faecal pellet weight (gm)	1.75	1.95	1.89	0.092	0.706
Faecal pellets volume (cm^3)	29.42	35.52	35.03	2.390	0.558
Density (gm/cm^3)	0.0581	0.0555	0.0567	0.001	0.626
Faecal pellet length (cm)	2.49	2.52	2.48	0.061	0.971
Faecal pellet diameter (cm)	3.95	4.20	4.06	0.065	0.315
DM intake	6.17a	6.27b	6.19a	0.015	0.001
DM voided	2.48	2.07	2.35	0.091	0.164
DM retained	3.69	4.18	3.82	0.098	0.092

Figures bearing different superscripts differ significantly, (P≤0.05), (P≤0.01).

Table 4. Rumen fermentation pattern in camel calves supplemented *Salvadora oleoides* leaves.

Attributes	T_1	T_2	T_3	SEM	P value
Total protozoal count ($*10^3$)	6.70^b	5.72^{ab}	5.18^a	0.284	0.059
pH	6.45	6.29	6.82	0.181	0.538
TVFA (meq/dl)	8.08^a	9.41^b	8.54^{ab}	0.247	0.053
NH3N(mg/dl)	5.83^b	2.33^a	4.08^{ab}	0.583	0.016
Total Nitrogen (mg/dl)	49.77a	56.38^b	51.72^a	1.158	0.022
NPN (mg/dl)	36.01	42.85	37.02	1.532	0.137
TCA-N (mg/dl)	13.53	14.7	13.76	0.969	0.902

Figures bearing different superscripts differ significantly, (P≤0.05), (P≤0.01)

Haemato-Biochemical Attributes

Haemato-biochemical attributes (Table 5) were recorded at the beginning and after 4 fortnights of feeding of experimental diets. Haemoglobin content in all the treatment groups was observed to be higher after feeding in 4 fortnights; however, differences among the groups due to diet were not evident. Similar observations were recorded on feeding of phytochemical rich diets containing *Prosopis cineraria / Zizyphus nummularia* leaf containing diets (Poonia *et al,* 2022). Similar results were observed for packed cell volume (%). Differences were not observed due to period and treatment in the values of Mean Corpuscular Haemoglobin. Glucose content marginally improved after 4 fortnights however, difference due to treatment were not evident. SGOT values decreased with supplementation before

Table 5. Effect of feeding *Salvadora oleoides* leaves on blood biochemical profile.

Attributes	Fortnight	T_1	T_2	T_3	SEM	P value
Haemoglobin (g/dl)	0	8.65	8.8	8.45	0.336	0.766
	4	12.2	12.3	14	0.639	0.136
Packed Cell Volume (%)	0	25.8	26.2	26.8	1.117	0.819
	4	37.42	39.15	40.57	1.42	0.336
MCH (pg/cell)	0	12.40	12.13	12.04	0.235	0.551
	4	12.31	12.73	12.85	0.224	0.305
Glucose (mg/dl)	0	90.75	89.5	107.75	4.514	0.189
	4	96.75	102.25	110.75	2.926	0.141
SGOT (IU/dl)	0	75.21	66.02	60.50	3.260	0.182
	4	69.46	84.13	80.40	7.827	0.766
SGPT (IU/dl)	0	8.615	9.22	8.71	0.498	0.889
	4	8.96	7.96	11.78	0.811	0.132
Blood Urea Nitrogen (mg/dl)	0	21.25	14.75	16.75	1.368	0.135
	4	27.75	25.75	22.00	3.382	0.812
Serum Protein (mg/dl)	0	6.98	7.45	7.42	0.762	0.968
	4	6.98	4.45	5.04	0.655	0.278
Ca (mg/dl)	0	8.64	8.38	9.11	0.368	0.755
	4	8.78	8.88	8.86	0.373	0.994
P (mg/dl)	0	3.80	4.24	4.00	0.170	0.615
	4	3.73	4.29	3.85	0.195	0.505

feeding, however, after 4 fortnights values improved but differences among the groups were not observed. Similarly, no definite pattern was observed in case of SGPT either due to period or treatment. Blood urea levels decreased with supplementation of 5% salvadora leaves before and after end of 4 fortnights; however, the values were higher after 4 fortnights reflecting better nitrogen recycling in animals. Serum protein was observed to be higher in the salvadora supplemented groups though the values were statistically similar, however, at the end of 4 fortnights, values decreased but non-significantly. Serum calcium and phosphorus levels were also observed to be similar among periods and treatments; they were in the normal range of experimentation. Non-significant difference in values of haematological and biochemical parameters at the start and end of trial in treatment supplemented with 5% and 12.5% *Salvadora oleoides* leaves as compared to control group. The results of haemato-biochemical attributes are in accordance with Dey *et al* (2015) and Sireesha *et al* (2021). Ali and Ahmed (2019) observed enhanced health and immunity in camels supplemented with 25% *Salvadora persica* leaves, including higher haemoglobin levels and reduced incidence of common ailments.

Conclusion

Findings of the present study corroborate that inclusion of *Salvadora oleoides* leaves in the diet of camel resulted in improvement in dry matter, organic matter and crude protein intake. The leaves of *Salvadora oleoides* can be used as a cheaper feed resource at a level of 5% and 12.5% of the diet as it could efficiently maintain feed intake, body weight and rumen fermentation pattern without any adverse effects on the digestibility and haemato-biochemical parameters of camels but 5% level of incorporation of *Salvadora oleoides* leaves proved more beneficial since safe limits for consumption of saponins depends on several factors such as source of saponin, type of saponins and many others due to which it is likely that less growth response was elicited when higher levels of *Salvadora oleoides* leaves was fed. As *Salvadora oleoides* tree is abundantly available in the arid region of western Rajasthan and Gujarat, it could be utilised as a browse species/ dietary supplement as fresh forage/ dry leaves in the dietary of camel without any adverse effect.

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