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Impact of Herbal Feed Supplements and Sodium Sulphate on the Nutrient Utilization and Growth Performance of Indigenous Dairy Cattle Calves

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ABSTRACT

The present study is aimed to evaluate the effects of herbal feed additives and sodium sulphate on nutrient utilization and growth performance in growing Sahiwal cattle calves. A total of twenty calves were randomly assigned to four groups: The control group (C) received no feed additives, while Group T1 was supplemented with herbal feed additives, *Foeniculum vulgare* seeds, and *Terminalia chebula* fruits, @ 1% of DMI (1:1 ratio both). Group T2 was provided with Na_2SO_4 at 0.5% of DMI, and Group T3 received both herbal feed additives and sodium sulfate at the same rates, respectively. The basal diet offered to experimental groups consists of 50% concentrate and 50% roughage. The experiment lasted 90 days; during which daily dry matter intake and fortnightly body weight changes were recorded. A digestion trial was conducted over six days at the end of the study to assess nutrient digestibility. The results indicated no significant differences in body weight, average daily gain, feed conversion ratio, or dry matter intake among the groups throughout the study. The initial and final body weights were similar across all groups, and the average daily gain remained consistent. Nutrient digestibility, assessed during the digestion trial, showed higher mean values for various nutrients in supplemented groups; however, these differences were not statistically significant. In conclusion, supplementing herbal feed additives and sodium sulphate did not significantly impact the calves' growth performance or nutrient digestibility.

KEYWORDS: Calves, Cattle, Growth, Herbal additives, Sodium sulphate.

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INTRODUCTION

Livestock rearing plays a pivotal role in rural areas of the country, significantly contributing to the national economy. It serves as a source of income for households dependent on agriculture and those without land ownership. Moreover, livestock provides essential proteins like milk, eggs, and meat. Most livestock populations thrive on low-quality roughage, such as crop wastes like wheat straw, which have lower digestibility due to lignocellulose.

In recent years, herbal feed additives in livestock nutrition have garnered significant attention due to their potential to enhance nutrient digestibility and growth performance. Traditional feed additives, while effective, often raise concerns regarding antibiotic resistance, environmental impact, and consumer health. As a sustainable alternative, herbal feed additives offer a promising solution to these challenges. Herbal feed additives are increasingly used in ruminant nutrition due to their numerous benefits over conventional chemical additives. A mixture of rumen modifiers (RM-7; neem seed cake, mahua seed cake, Fennel seed seed, harad, fruit pulp of bahera, fruit pulp of amla and ajwain seed) in 2:2:2:1:1:1:1 proportion at 5, 10, 15 and 20% with 0.06% sodium sulphate of substrate did not affect total gas production but there was significant reduction in methane production upto 10% level (Lakhani et al., 2019). Bakshi et al. (2022) also reported that herbal feed additive supplementation reduces methane emissions. Derived from natural plant sources, these additives are safer for animals and humans, as they do not leave harmful residues in animal products such as milk and meat. This reduces the risk of antibiotic resistance and other health issues associated with chemical additives. The active principles in herbal feed additives are plant secondary metabolites (PSMs) and plant bioactive compounds.

PSMs such as tannins, saponins, and essential oils significantly influence ruminant dry matter intake (DMI), nutrient digestibility, and growth performance as well as methane emission. These naturally occurring compounds can have varying effects on DMI, with some PSMs decreasing intake due to their bitter taste or astringent properties, making the feed less palatable for animals. Conversely, certain PSMs can enhance the palatability of feed, thereby increasing DMI (Ebrahim and Negussie, 2020). The complex role of PSMs in modifying feed intake underlines their dualistic nature, where the specific impact is contingent on the type and concentration of the metabolites. Among these, Fennel seeds (*Foeniculum vulgare*) and Harad (*Terminalia Chebula*) have shown varying results in improving nutrient digestibility, growth performance, and overall health in cattle.

When it comes to nutrient digestibility, PSMs primarily exert their effects within the rumen. Tannins, for instance, can bind to proteins and reduce their degradation, leading to increased microbial protein synthesis. However, high tannin levels can inhibit microbial activity, ultimately lowering the overall digestibility of nutrients (Kamra et al., 2012). This dichotomous impact highlights the complexity of tannins' role in ruminant nutrition. Recent research has provided valuable insights into the effects of dietary supplements containing PSMs on dry matter intake (DMI) and nutrient digestibility. Studies such as those by Moosavi-Zadeh et al. (2023) and Singh et al. (2023) demonstrate that supplements like fennel seed powder (FSP) can enhance feed intake across various livestock species, whereas other studies, like those by Gunun et al. (2022), suggest a limited impact on DM intake but potential effects on nutrient utilization at higher supplement levels.

Growth performance, another critical parameter, is also influenced by PSMs. Singh et al. (2023) observed significant improvements in body weight and average daily gain in goats supplemented with FSP. Similarly, Pawar et al. (2024) reported higher body weights in Kankrej calves supplemented with FSP, though not statistically significant. Conversely, Santos et al. (2022) found that higher levels of dietary quebracho extract in growing lambs reduced both DMI and average daily gain, emphasizing the dose-dependent effects of PSMs on growth performance.

Therefore, in the present study, a combination of herbal feed additive and sulfate was tested in an *in vivo* trial for their effect on nutrient utilization and the performance of calves.

MATERIALS AND METHODS

Ethics Approval

Animal care procedures were approved (approval number IAEC/24/1/58) and conducted under the established standard of the Institutional Animal Ethics Committee (IAEC), constituted as per article number 13 of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) rules laid down by the Government of India.

Twenty growing Sahiwal cattle calves (16 male and 4 female calves) of about 9 to 16 months were selected from the herd maintained at Livestock Farm Complex (LFC), DUVASU Mathura (Uttar Pradesh), India. Calves were divided into four groups (5 animals each) in a randomized block design. The control group (Group C) received no feed additives. Group T1 was supplemented with herbal feed additives (*Foeniculum vulgare* seed and *Terminalia chebula* fruit) at 1% (1:1 ratio) of dry matter intake (DMI). Group T2 diet included sodium sulphate (Na_2SO_4) at 0.5% of DMI. Group T3 received both herbal feed additives at 1% of DMI and sodium sulphate at 0.5% of DMI. The basal diet contains 50% concentrate and 50% roughage. The composition of the diet and chemical composition of the diet is given in Tables 1 and 2, respectively. The experiment was continued for 90 days where all the calves were managed under similar conditions.

Table 1. Composition (% DM basis) of diet fed to calves during feeding trial

	Ingredients	Groups			
		C	T1	T2	T3
Concentrate	Oats	18	18	18	18
	Barley grain	15	15	15	15
	Wheat bran	18	18	18	18
	Gram chunni	15	15	15	15
	Mustard oil cake	32	32	32	32
	Mineral mixture*	2	2	2	2
Roughages	Jowar fodder	20	20	20	20
	Wheat straw	30	30	30	30

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate

The experimental calves were monitored daily for DMI and fortnightly for growth performance and feed efficiency measures. The feeds offered to the animals and the residue left was recorded daily to find out the total DMI of the experimental calves. Intake of DM was calculated as the difference between the amount of DM offered and the amount of DM residue left. The body weight of experimental animals was recorded at the start of the experiment followed by fortnight intervals.

Table 2. Chemical composition (% DM basis) of feeds and fodders fed during the experimental period

Attributes %	Concentrate	Jowar fodder	Wheat straw
Dry matter	91.50	17.50	91.10
Organic matter	92.10	88.80	86.70
Ether extract	4.50	4.10	1.20
Crude protein	20.68	10.20	3.53
Total ash	7.40	11.20	13.20
Nitrogen free extract	59.22	47.36	43.47
Crude fiber	13.7	32.5	40.23

To compare the efficiency of nutrient utilization in growing calves, a digestion trial for a period of 6 days was conducted at the end of the study. Calves were weighed before the start and at the end of the digestion trial. A weighted amount of feed and fodders was offered during the digestion trial. Representative samples of the feed offered and residue left was collected and analyzed for chemical composition. Faeces voided during 24 hours were collected and measured daily for 6 days. About 1% of thoroughly mixed total faecal matter (as such basis) was taken for chemical analysis. Additionally, for N estimation, approximately 0.1% of the total faecal sample was collected daily for 6 days and stored in glass containers having 25% sulphuric acid solution. The digestibility coefficient of nutrients was calculated from the nutrient intake and nutrient outgo in faeces during the digestion trial.

All statistical analyses were performed as per the standard method by using the SPSS computer package (SPSS Version 20.0, SPSS Inc, Chicago, USA). The data obtained were statistically analyzed by using one-way ANOVA procedures.

RESULTS AND DISCUSSIONS

Growth Performance

The effect of herbal feed additives and sulphate on the fortnightly BW change (Kg) and fortnight BW gain (Kg) of cattle calves is summarized in Tables 3 and 4, respectively. The initial BWs in the C, T1, T2, and T3 groups were 133.84 Kg, 128.48 Kg, 133.04 Kg, and 130.00 Kg, respectively. By the end of the study, the BWs in the C, T1, T2, and T3 groups were 166.12 Kg, 158.58 Kg, 162.84 Kg, and 160.68 Kg, respectively. The overall BW (kg) was found similar in all the experimental groups. Statistical analysis of data showed that variation between the groups for mean BW change was not significant (P>0.05). Whereas, the initial fortnight BW gains in the C, T1, T2, and T3 groups were 5.08 Kg, 4.68 Kg, 4.26 Kg, and 4.51 Kg, respectively. By the end of the feeding trial, the fortnightly BW gain for the C, T1, T2, and T3 groups were 6.65 Kg, 6.05 Kg, 6.32 Kg, and 6.18 Kg, respectively. Statistical analysis revealed no significant differences in the fortnightly BW gain among the groups (P>0.05). During the 1st fortnight, the DMI in the control, T1, T2, and T3 groups was 3.66 Kg/day, 3.59 Kg/day, 3.36 Kg/day, and 3.49 Kg/day, respectively, while, by the 6th fortnight, the DMI in the control, T1, T2, and T3 groups was 4.85 Kg/day, 4.58 Kg/day, 4.69 Kg/day, and 4.48 Kg/day, respectively (Table 5). Statistical analysis indicated no significant differences in fortnightly DMI among the groups (P>0.05), whereas the mean DMI per 100 Kg BW across all fortnights for these groups was 2.73, 2.86, 2.69, and 2.75 Kg per 100 Kg BW, respectively (P=0.096). All groups experienced slight fluctuations in their DMI per 100 Kg BW values, but these fluctuations were not statistically significant.

Table 3. Effect of herbal feed additive and sulphate on Fortnight BW change (Kg) of growing calves

Fortnight	Group				SEM	p Value
	C	T1	T2	T3		
Initial	134	128	133	130	7.22	0.994
1	139	133	137	135	7.35	0.994
2	144	138	142	140	7.52	0.994
3	149	143	147	144	7.76	0.994
4	155	148	152	150	7.92	0.993
5	159	153	157	155	8.11	0.993
6	166	159	163	161	8.37	0.992
Mean	149	143	147	145	2.99	0.888

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, p value >0.05: non-significant

Table 4. Effect of herbal feed additive and sulphate on fortnight BW gain (Kg) of growing calves

Fortnight	Group				SEM	p Value
	C	T1	T2	T3		
1	5.08	4.68	4.26	4.51	0.26	0.759
2	5.18	4.57	4.34	4.97	0.28	0.755
3	5.05	5.10	4.90	4.69	0.33	0.976
4	5.55	5.00	5.00	5.22	0.31	0.925
5	4.79	4.72	5.00	4.87	0.32	0.993
6	6.65	6.05	6.32	6.18	0.47	0.977
Mean	5.38	5.02	4.97	5.07	0.14	0.743

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, p value >0.05: non-significant

Table 5. Effect of herbal feed additive and sulphate on DMI (Kg) of growing calves

Fortnight	Group				SEM	p Value
	C	T1	T2	T3		
1	3.66	3.59	3.36	3.49	0.14	0.909
2	3.67	3.78	3.44	3.76	0.17	0.902
3	3.88	3.98	3.79	4.00	0.19	0.980
4	4.25	4.15	4.10	4.18	0.16	0.991
5	3.90	3.76	3.78	3.56	0.16	0.924
6	4.85	4.58	4.69	4.48	0.21	0.946
Mean	4.04	3.98	3.86	3.91	0.08	0.865

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, P>0.05: non-significant

The effect of herbal feed additives and sulphate on the ADG (Kg) and FCR of cattle calves is summarized in Tables 6 and 7, respectively. During the study, no significant (P>0.05) differences were observed in the ADG among the groups. In the 1st fortnight, the ADG in control, T1, T2, and T3 groups was 0.34 Kg/day, 0.31 Kg/day, 0.28 Kg/day, and 0.30 Kg/day, respectively, and by the 6th fortnight, the ADG for the control, T1, T2, and T3 groups was 0.44 Kg/day, 0.40 Kg/day, 0.42 Kg/day, and 0.41 Kg/day, respectively. The mean FCR across all fortnights for the control, T1, T2, and T3 groups was 12.05, 12.23, 12.01, and 12.21, respectively, with a P value of 0.989. The FCR values remained consistent across all dietary treatments, indicating no substantial impact from the supplements.

Table 6. Effect of herbal feed additive and sulphate on ADG (Kg) of growing calves

Fortnight	Group				SEM	p Value
	C	T1	T2	T3		
1	0.338	0.312	0.284	0.300	0.02	0.761
2	0.345	0.305	0.289	0.331	0.02	0.757
3	0.337	0.340	0.327	0.312	0.02	0.976
4	0.370	0.333	0.333	0.348	0.02	0.924
5	0.320	0.315	0.334	0.325	0.02	0.993
6	0.443	0.403	0.421	0.412	0.03	0.978
Mean	0.359	0.335	0.331	0.338	0.01	0.744

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, p value >0.05: non-significant

Table 7: Effect of herbal feed additive and sulphate on FCR of growing calves

Fortnight	Groups				SEM	p Value
	C	T1	T2	T3		
1	11.11	11.84	11.97	12.08	0.49	0.912
2	10.88	12.54	12.06	11.90	0.50	0.726
3	12.08	12.17	11.73	13.04	0.53	0.863
4	12.57	12.89	12.65	12.48	0.78	0.998
5	13.52	12.18	11.77	11.73	0.80	0.866
6	12.12	11.74	11.88	12.04	0.84	0.999
Mean	12.05	12.23	12.01	12.21	0.27	0.989

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, p value >0.05: non-significant

Similarly, Gunun et al. (2022) investigated the impact of *Terminalia chebula* meal (TCM) supplementation at different levels (0, 8, 16, and 24 g/kg of total DMI) on goats and reported that TCM did not significantly affect roughage, concentrate, and total DM intake ($p > 0.05$). In the same manner, Inamdar et al. (2015) also observed that supplementing mahua seed cake with or without harad seed pulp in buffaloes did not significantly affect DMI. Consistently, Uniyal et al. (2020) supplemented goats' diet with sulfur at levels of 0.08% and 0.16% of dry matter intake and observed no significant differences in DMI, BW gain, and FCR among the groups. The supplementation of amla fruit powder (*Emblica officinalis*) @ 0.75% enhanced the overall performance of broilers (Gaur et al., 2023). These findings support the results of the present study, indicating that the herbal feed additives and sulphate supplementation did not significantly influence DMI or growth performance in cattle calves. The non-significant differences in growth performance parameters in this study may be due to the lower dosages of herbal feed additives and sulphate used, which were likely insufficient to elicit

significant responses. Further research with varied dosages and combinations is needed for a better understanding of their potential effects.

Nutrient Utilization

The mean apparent nutrient digestibility across a 6-day digestion trial is shown in the Table 8. The ADG of the experimental calves during the digestion trial in the control, T1, T2, and T3 groups was 0.45, 0.48, 0.47, and 0.47 Kg/day, respectively. Although the mean digestibility of different nutrients DM, OM, CP, EE, CF, NDF and ADF was higher in the calves supplemented with various treatments, the results were not statistically significant (P>0.05) across the treatment groups. Similarly, Gunun et al. (2022) investigated the impact of *Terminalia chebula* meal (TCM) supplementation at different levels (0, 8, 16, and 24 g/kg of total DMI) on goats and found that TCM did not significantly affect digestibility. Likewise, Kumar et al. (2022) supplemented buffalo calves' diets with a mixture of eucalyptus and poplar leaf meal and found no significant impact on digestibility coefficients. Additionally, Inamdar et al. (2015) observed that supplementing mahua seed cake with or without harad seed pulp in buffaloes did not significantly affect nutrient digestibility. Moreover, Bostami et al. (2021) evaluated the effects of seeds and leaves from traditional medicinal plants (*Emblica officinalis, Terminalia bellirica,* and *Terminalia chebula*) feed additives on crossbred post-weaned bull calves. The treatments did not significantly affect the total tract digestibility of different nutrients. Consistently, Uniyal et al. (2020) reported no significant effect of sulfur supplementation on digestibility coefficients for DM, OM, CP, EE, NDF, and ADF in goats. These findings align with our study, indicating that the herbal feed additives and sulphate supplementation at present dose level did not significantly influence nutrient digestibility in cattle calves.

Table 8. Effect of herbal feed additive and sulphate on nutrient digestibility of growing calves

Attribute	Groups				SEM	P Value
	C	T1	T2	T3		
Initial B.Wt. (Kg)	165	161	160	160	8.57	0.997
Final B.Wt. (Kg)	168	164	163	163	8.62	0.998
ADG (Kg)	0.45	0.48	0.47	0.47	0.04	0.995
Nutrient Digestibility						
DM %	57.3	56.9	57.7	58.3	0.45	0.768
OM%	59.8	60.6	61.3	61.7	0.47	0.527
CP%	71.8	72.3	71.6	73.5	0.76	0.839
EE%	81.6	80.9	81.7	80.7	1.07	0.864
CF%	49.2	48.5	47.7	48.2	0.62	0.875
NDF%	53.1	51.3	50.6	52.3	0.60	0.502
ADF%	41.8	40.9	41.1	43.1	0.67	0.696

C: No feed additives, T1: Supplemented with herbal feed additives, T2: Supplemented with sulphate, T3: Supplemented with herbal feed additives and sulphate, p value >0.05: non-significant

CONCLUSION

In conclusion, the dietary supplementation of herbal feed additive (Fennel seed+*Terminalia chebula* in 1:1 ratio) @ 1% DMI) and sodium sulphate @ 0.5% of DMI has no significant (P>0.05) effect on BW, ADG, FCR, intake and digestibility of nutrients, indicating no impact of either herbal feed additive and sulfate supplementation on growth performance and nutrient digestibility. Further research with varied dosages is needed to better understand their potential effects.

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