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Effect of *Mentha piperita* and *Cymbopogon citratus* Essential Oils on Feed Intake and Nutrient Digestibility in Crossbred Calves

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ABSTRACT: A study was conducted to evaluate the effect of *Mentha piperita* and *Cymbopogon citratus* essential oils on feed intake and nutrient digestibility in crossbred calves. 18 healthy calves aged 15 to 90 days, were randomly allotted to 3 treatment groups in a completely randomized design. The treatments included a control diet (T_0) and diets supplemented with *M. piperita* essential oil @ 0.2% of calf starter (T_1), *C. citratus* essential oil @ 0.2% of calf starter (T_2), Feed intake and digestibility coefficients of nutrients were determined through a digestion trial at the end of 90 days. Results indicated that supplementation with *M. piperita* and *C. citratus* essential oils significantly ($P<0.01$) improved digestibility percentage of dry matter compared to the control. No adverse effects were observed on palatability or health status of the calves. The findings suggest that *M. piperita* and *C. citratus* essential oils may serve as effective natural feed additives to enhance nutrient utilization efficiency in crossbred calves.

Keywords: Crossbred calves, *Cymbopogon citratus* essential oil, Feed intake, *Mentha piperita* essential oil, Nutrient digestibility.

INTRODUCTION

The livestock industry faces growing challenges in maintaining animal productivity and health under the increasing restrictions on antibiotic usage as growth promoters. The misuse of antibiotics in animal production systems contributes to the emergence of antibiotic-resistant bacteria, posing serious threats to human and animal health (Coimbra *et al.*, 2022). Consequently, there is a global shift toward identifying natural feed additives that can enhance growth performance and nutrient utilization without promoting antimicrobial resistance. Among these alternatives, essential oils (EOs), derived from aromatic plants, have attracted attention due to their antimicrobial, antioxidant, and anti-inflammatory properties that can support rumen fermentation and improve nutrient digestibility (Tarigan and Harahap 2016; Nehme *et al.*, 2021; Tarasing *et al*., 2025).

Mentha piperita essential oil (MPEO) is rich in menthol, menthone, and other bioactive compounds that exert modulatory effects on rumen microbiota, enhancing fiber degradation and nutrient absorption while reducing methane emissions (Patra *et al.*, 2019). Similarly, *Cymbopogon citratus* essential oil (CCEO), primarily composed of citral and limonene, exhibits potent antimicrobial and antioxidant properties that support gut health and improve feed efficiency (Kiani *et al*., 2022). Both EOs may enhance ruminal fermentation efficiency by modulating microbial populations, thus improving nutrient digestibility and animal performance.

Despite promising evidence, the effects of MPEO and CCEO on nutrient utilization and feed intake remain inconsistent and dependent on factors such as dosage, diet composition, and rumen microbial adaptation. Therefore, the present study was designed to evaluate the influence of *Mentha piperita* essential oil (MPEO) and *Cymbopogon citratus* essential oil (CCEO) supplementation on feed intake and nutrient digestibility in crossbred calves. It was hypothesized that dietary inclusion of these essential oils at optimal levels could enhance nutrient digestibility without adversely affecting feed intake.

MATERIAL AND METHODS

A. Experimental Site and Animals

The present study was conducted on thirty (n = 18) crossbred calves aged between 15 and 90 days at the *Instructional Dairy Farm (IDF), Nagla*, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. All experimental procedures were

approved by the *Institutional Animal Ethics Committee (IAEC)* of the University.

B. Experimental Design and Dietary Treatments

The calves were randomly distributed into three treatment groups, each consisting of six animals, following a completely randomized design. The dietary treatments were as follows: T_0: Basal feed only (control); T_1: Basal feed + *Mentha piperita* essential oil (MPEO) @ 0.2% of calf starter; T_2: Basal feed + *Cymbopogon citratus* essential oil (CCEO) @ 0.2% of calf starter.

The experiment was conducted for 90 days. All calves were maintained under uniform management and hygienic conditions. Each calf was housed in an individual well-ventilated pen and identified using numbered ear tags for accurate record keeping. Animals were provided free access to clean drinking water, and for exercise and sunlight exposure, calves were allowed in an open paddock during the morning hours.

Digestion Trial. A digestion trial of 7 days duration was conducted at the end of the 90-day experimental period to evaluate nutrient digestibility. Twenty calves (four from each treatment group) were selected randomly for the trial. The selected calves were housed individually for complete collection of faeces and feed residues. Prior to the collection period, a 3-day adaptation period was provided. During the 7-day collection phase, daily records were maintained for feed offered, refusals, and faeces voided. Representative samples of feed, leftovers, and faeces were collected every 24 hours for dry matter determination.

Sampling of Feed, Fodder, and Residues. Representative samples of feed offered, residues, and faeces were collected daily. Samples were dried in a hot-air oven at 100 ± 5°C for 24 hours to determine dry matter (DM) content. At the end of the digestion trial, dried samples from each animal were pooled across the collection period, ground to pass through a 1-mm sieve, and stored in airtight plastic containers for subsequent chemical analysis.

Collection and Sampling of Faeces. Total faecal output from each calf was collected manually every 24 hours into pre-weighed, labelled plastic buckets with lids. A representative aliquot (1/20 of total faeces) was collected daily in duplicate for DM estimation. For nitrogen (N) analysis, a separate aliquot (1/200 of total faeces) was preserved in wide-mouth polypropylene bottles containing 25% H_2SO_4 to prevent nitrogen loss. After the trial, the bottles were weighed to determine the faecal sample weight with acid, and nitrogen estimation was performed using the Kjeldahl method.

Proximate Analysis. Representative samples of feed, fodder, residues, and faeces were analyzed for proximate principles: dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen-free extract (NFE), and total ash, following the standard procedures of the AOAC (2005).

C. Statistical Analysis

Data obtained during the experiment were subjected to statistical analysis using SPSS version 21.0. Results were expressed as mean ± standard error (SE). Treatment means were compared using one-way analysis of variance (ANOVA) followed by Duncan's multiple range test (DMRT) to assess significant differences among treatments. Significance was accepted at $P < 0.05$ and $P < 0.01$ (Snedecor and Cochran 1994).

RESULTS AND DISCUSSION

A. Feed Intake and Dry Matter Intake

The mean feed intake (FI) and dry matter intake (DMI) of crossbred calves are presented in Table 1. The average feed intake across the treatment groups (T_0–T_2) ranged from 6.52 ± 0.05 to 6.60 ± 0.05 kg/day, while DMI varied between 2.30 ± 0.01 and 2.34 ± 0.01 kg/day. The DMI, expressed as a percentage of body weight, ranged from 2.02 ± 0.02 to 2.06 ± 0.07 kg/100 kg BW. No significant differences were observed among treatments, indicating that supplementation with MPEO (0.2%) or CCEO (0.2%) had no adverse effect on feed palatability or intake.

Table 1: Effect of supplementation of *Mentha piperita* and *Cymbopogon citratus* EOs on feed intake and dry matter intake of crossbred calves.

Parameter	T_0	T_1	T_2
FI (kg/day)	6.56±0.04	6.60±0.05	6.52±0.05
DMI (kg/day)	2.33±0.01	2.34±0.01	2.30±0.01
DMI (kg/100kg BW)	2.04±0.04	2.06±0.07	2.02±0.02
DMI (kg/$BW^{0.75}$)	0.065±0.001	0.066±0.001	0.067±0.001

FI: Feed intake; DMI: Dry matter intake; BW: Body weight; T0: Control (Basal diet); T1: Basal diet + *Mentha piperita* essential oil (MPEO) @ 0.2% of calf starter/calf/day; T2: Basal diet + *Cymbopogon citratus* essential oil CCEO @ 0.2% of calf starter/calf/day

The lack of significant effect on feed intake in the present study corroborates earlier findings of Ishfaq *et al*. (2019), who reported non-significant changes in DMI in sheep supplemented with *Mentha piperita* EO. Similarly, Soares *et al.* (2023) and Del Valle *et al.* (2024) observed no alteration in feed or nutrient intake in steers and sheep fed with lemongrass EO.

However, some studies have reported increased DMI with EO supplementation (Liu *et al.*, 2020; Terre *et al.*, 2007; Hashemzadeh-Cigari *et al.*, 2015), suggesting that these effects may depend on the EO source, dosage, diet composition, and rumen microbial adaptation (Vakili *et al.*, 2013). The present findings indicate that both MPEO and CCEO at 0.2% inclusion levels neither depressed nor enhanced feed intake,

suggesting good dietary acceptability and tolerance among crossbred calves.

B. Nutrient Digestibility

The apparent digestibility coefficients of dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), and organic matter (OM) have been presented in Table 2. Supplementation of MPEO (T_1) and CCEO at 0.2% (T_2) significantly ($P<0.01$) increased dry matter digestibility compared to the control (T_0) group. However, no significant ($P>0.05$) differences were observed among treatments for CP, CF, EE, NFE, or OM digestibility.

Table 2: Effect of supplementation of *Mentha piperita* and *Cymbopogon citratus* EOs on digestibility coefficients of dry matter and nutrients of crossbred calves.

Digestibility%	T0	T1	T2
Dry Matter**	69.73±0.15^{c}	70.50±0.17^{b}	71.74±0.11^{a}
Crude protein	77.14±0.41	77.37±0.57	78.26±0.58
Crude fiber	76.26±0.12	76.50±0.15	76.65±0.32
Ether extract	64.89±0.43	64.68±0.63	65.69±0.46
Organic matter	73.79±0.20	73.93±0.15	74.31±0.10
NFE	76.17±0.30	76.54±0.28	76.99±0.35

NFE: Nitrogen free extract; T_0: Control (Basal diet); T_1: Basal diet + *Mentha piperita* essential oil (MPEO) @ 0.2% of calf starter/calf/day; T_2: Basal diet + *Cymbopogon citratus* essential oil (CCEO) @ 0.2% of calf starter/calf/day; Means bearing different superscripts vary significantly (**P<0.01) across the row (a,b,c) showing treatment effect

The improvement in DM digestibility in MPEO and CCEO-supplemented calves may be attributed to enhanced rumen fermentation efficiency and microbial balance, as CCEO possesses strong antimicrobial properties that selectively inhibit pathogenic bacteria while supporting fibrolytic microbial activity (Wanapat *et al.*, 2008; Kiani *et al.*, 2022). Similar improvements in digestibility with EO supplementation have been reported by Ando *et al.* (2003) and Wanapat *et al.* (2008), who observed significant increases in DM digestibility with peppermint and lemongrass EOs, respectively. Consistently, Soares *et al*. (2023) also observed non-significant effects of CCEO on OM and CP digestibility. Del Valle *et al*. (2024) reported a tendency toward decreased CP digestibility with lemongrass essential oil supplementation in sheep diets, although the apparent digestibility of other nutrients remained unchanged.

In contrast, other studies reported either no effect or reduced digestibility with higher EO inclusion levels (Zulfa *et al.*, 2019). Such variations may result from differences in EO composition, dose-dependent antimicrobial action, and animal adaptation to bioactive compounds (Castillejos *et al.*, 2006; Froehlich *et al.*, 2017). The improved DM digestibility observed in the current study at 0.2% inclusion of CCEO indicates that moderate EO supplementation can enhance nutrient utilization without negatively affecting rumen fermentation.

Overall, the results suggest that MPEO and CCEO supplementation at 0.2% of the calf starter diet maintained normal feed intake while improving dry matter digestibility, particularly with CCEO. These findings support the potential of essential oils as natural feed additives to enhance nutrient utilization efficiency and reduce reliance on synthetic growth promoters in calf nutrition systems.

CONCLUSIONS

In conclusion, supplementation with MPEO and CCEO at 0.2% inclusion levels showed no adverse effect on feed intake, indicating good palatability and tolerance in crossbred calves. The improved dry matter digestibility suggests enhanced rumen fermentation efficiency and microbial activity, contributing to better nutrient utilization and overall feed efficiency.

FUTURE SCOPE

Further studies can be conducted on optimizing essential oil combinations and dosages to maximize rumen fermentation and nutrient utilization. Long-term trials across different production stages and environmental conditions are needed to evaluate growth performance, immune response, and methane mitigation potential, establishing essential oils as sustainable feed additives in livestock nutrition.

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