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Cowpea Green Fodder as a Concentrate Substitute: Effects on Milk Yield and Composition in Lactating Ongole Cows

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Abstract
The study evaluated the effect of different green-fodder-based diets on dry matter intake, milk yield and milk composition of lactating Ongole cows. Eighteen cows were randomly allotted to three groups of six animals each. Cows in T1 received 10 kg Hybrid Napier, 6 kg paddy straw and 2 kg concentrate; T2 received 15 kg Hybrid Napier, 6 kg paddy straw and 1 kg concentrate; and T3 received 15 kg Hybrid Napier, 6 kg paddy straw and 5 kg cowpea green fodder per cow daily. Following a 15-day adaptation period, the feeding trial continued for 90 days. Total dry matter intake was 9.67, 9.90 and 9.95 kg/cow/day in T1, T2 and T3, respectively. Mean daily milk yield was 2.79, 2.36 and 2.70 L in T1, T2 and T3, with no significant treatment difference. Milk fat, protein, solids-not-fat and lactose also did not differ significantly, although all were numerically highest in T3. Cowpea green fodder could therefore replace concentrate partially without materially reducing milk production in Ongole cows.

Keywords: Cowpea; dry matter intake; indigenous cattle; milk composition; milk yield; Ongole cows

Introduction
Green fodder is an important component of dairy-cattle diets because it supplies fermentable nutrients, supports rumen function and can reduce dependence on costly concentrate feeds. Seasonal fodder scarcity and the high price of concentrates, however, constrain economical milk production under Indian farming conditions [1, 2]. Ongole cattle are a prominent indigenous Bos indicus breed of Andhra Pradesh, valued for adaptation, hardiness and ability to perform under tropical conditions [3]. Although the breed is primarily known for draught capacity, conservation herds include lactating cows whose productivity may benefit from locally available, nutritionally balanced fodder resources. Hybrid Napier is widely used as a high-biomass perennial grass, whereas cowpea is a protein-rich leguminous fodder that can improve dietary nitrogen supply and palatability [4, 5]. Previous studies in dairy cattle have shown that forage legumes may maintain milk production and improve nutrient-use efficiency when they replace a proportion of concentrate [6, 7]. Information on replacing concentrate with cowpea green fodder in lactating Ongole cows is limited. Therefore, the objective of this study was to determine the effect of three green-fodder-based diets on dry matter intake, milk yield and major milk constituents in Ongole cows.

Materials and Methods
Study location and experimental period
The experiment was conducted at the Livestock Research Station, Lam, Guntur, Andhra Pradesh, India (16.37° N, 80.43° E; 33 m above mean sea level). The study lasted 105 days, comprising a 15-day adaptation period from 15 to 30 December 2025 and a 90-day experimental period from 31 December 2025 to 30 March 2026. During the experimental period, mean maximum and minimum temperatures were 32.98 ± 0.23 °C and 20.56 ± 0.27 °C, respectively; relative humidity was 55.35 ± 0.67%, and the mean temperature-humidity index was 74.7 ± 0.27.

Experimental animals and dietary treatments

Eighteen lactating Ongole cows were selected based on age, stage of lactation and milk yield. The cows were randomly divided into three treatment groups, with six animals per group. Mean age, lactation number and pre-experimental milk yield were comparable across groups. All cows were dewormed before the trial and were maintained under the same semi-intensive housing and management conditions with individual feeding and free access to clean drinking water.

Table 1. Daily dietary treatments offered to lactating Ongole cows.

Treatment	Hybrid Napier	Paddy straw	Supplement
T1	10 kg	6 kg	2 kg concentrate mixture
T2	15 kg	6 kg	1 kg concentrate mixture
T3	15 kg	6 kg	5 kg cowpea green fodder

The diets were formulated with reference to Indian Council of Agricultural Research recommendations for cattle and buffalo [8].

Feed analysis and dry matter intake

Representative samples of Hybrid Napier, paddy straw, concentrate mixture and cowpea were analysed for dry matter, crude protein, crude fibre, ether extract, total ash and nitrogen-free extract according to standard procedures of the Association of Official Analytical Chemists [9].

Feed offered and refusals were recorded, and dry matter intake (DMI) was calculated from the dry matter content of the offered and refused material. DMI was expressed as kg/cow/day and kg/100 kg body weight.

Milk yield and composition

Cows were milked twice daily. Morning and evening yields were measured using a digital weighing balance, and their sum was recorded as daily milk yield. Milk samples were collected fortnightly and analysed for fat, protein, solids-not-fat (SNF) and lactose using standard procedures [10].

Milk fat was determined by the Gerber method, and milk protein was estimated by the Kjeldahl method using a nitrogen-to-protein conversion factor of 6.38. Mean daily milk yield and mean milk composition were calculated for each treatment.

Statistical analysis

The thesis reports analysis of variance followed by comparison of means using the least significant difference procedure, with significance assessed at $P < 0.05$ [11]. one-way ANOVA. Significant differences among seasonal means were identified using Duncan's multiple range post-hoc test. Statistical significance was accepted at $P \leq 0.05$.

Results

Nutrient composition and dry matter intake

Table 2: Proximate composition of feeds and fodders on a dry matter basis

Feed/fodder	DM (%)	CP (%)	CF (%)	EE (%)	NFE (%)	Ash (%)
Hybrid Napier	22.80	7.87	32.30	1.83	45.30	12.71
Paddy straw	92.76	4.02	33.08	0.81	48.48	13.61
Concentrate mixture	91.50	20.00	10.50	4.20	57.80	7.00
Cowpea green fodder	18.49	24.35	6.40	0.76	57.00	11.49

Cowpea contained the highest crude protein concentration (24.35%), whereas concentrate mixture contained 20.00% crude protein. Total DMI was similar among treatments and was numerically highest in T3 (Table 3).

Table 3: Dry matter intake of Ongole cows receiving different green-fodder-based diets

Dry matter source	T1	T2	T3
Hybrid Napier (kg)	2.28	3.42	3.42
Paddy straw (kg)	5.56	5.56	5.56
Concentrate mixture (kg)	1.83	0.92	0.00
Cowpea green fodder (kg)	0.00	0.00	0.925
Total DMI (kg/cow/day)	9.67	9.90	9.95
DMI (kg/100 kg BW)	2.42	2.48	2.49

Milk yield

Mean daily milk yield was 2.79 ± 0.55, 2.36 ± 0.51 and 2.70 ± 0.51 L/cow/day in T1, T2 and T3, respectively. The treatment effect was not significant ($P > 0.05$). T1 showed the numerically highest mean yield, whereas T3 maintained a yield close to T1 despite complete replacement of concentrate by cowpea green fodder. Weekly yield followed a similar pattern in all groups, increasing up to approximately weeks 6-7 and declining thereafter (Figure 1).

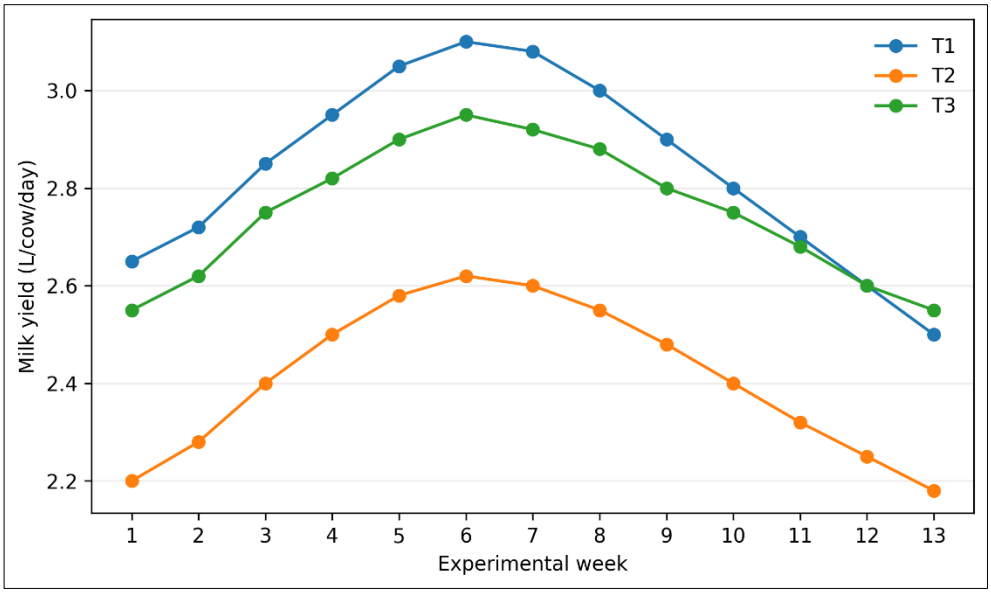

Fig 1: Weekly milk yield of Ongole cows receiving T1, T2 and T3 diets. Values are treatment means. The thesis reports no significant difference among treatments

Table 4: Milk composition of Ongole cows receiving different green-fodder-based diets

Constituent (%)	T1	T2	T3
Milk fat	4.41 ± 0.08	4.25 ± 0.12	4.53 ± 0.07
Milk protein	3.74 ± 0.04	3.70 ± 0.03	3.80 ± 0.04
SNF	9.49 ± 0.03	9.36 ± 0.08	9.56 ± 0.01
Lactose	5.54 ± 0.06	5.46 ± 0.03	5.62 ± 0.04

\ Milk composition

Values are mean ± SE. No significant treatment differences were reported ($P > 0.05$). SNF, solids-not-fat. Milk fat, protein, SNF and lactose did not differ significantly among treatments. Nevertheless, each constituent was numerically highest in T3 and lowest in T2.

Discussion

Dry matter intake

The small numerical increase in DMI from T1 to T3 suggests that replacing concentrate with cowpea did not depress voluntary intake. Cowpea had the highest crude protein concentration and may have improved diet palatability and ruminal nitrogen availability. Similar responses have been reported when tropical legumes were incorporated into dairy-cow diets [6, 7].

The limited variation among treatment means may also reflect the common paddy-straw basal allowance and the adaptation of Ongole cattle to fibrous tropical diets. Studies with Napier grass and forage-legume supplementation have likewise shown that forage quality and digestibility, rather than offered fresh weight alone, determine DMI [12, 13].

Milk yield

The numerically higher milk yield in T1 may be related to the greater concentrate allowance, which provided readily fermentable energy for milk synthesis. Concentrate supplementation has frequently increased milk yield, although the magnitude of response depends on basal forage quality, lactation stage and energy balance [14, 15].

Importantly, the T3 cows produced 2.70 L/day compared with 2.79 L/day in T1, indicating that cowpea green fodder maintained most of the production achieved with 2 kg concentrate. The absence of a significant treatment effect supports the practical possibility of replacing concentrate with a locally grown legume in low-producing Ongole cows. However, the study involved only six animals per treatment, and the relatively large standard errors reduced power to detect modest differences.

Comparable milk production from tropical legume-based diets has been reported in dairy cows, although responses vary with the amount and quality of legume included [6, 7, 16].

Milk composition

All measured milk constituents were numerically highest in T3. The higher protein content of cowpea may have supported microbial protein synthesis, while the forage component may have maintained ruminal acetate production needed for milk-fat synthesis. Because treatment differences were not significant, these numerical trends should not be presented as confirmed improvements.

Previous work with Hybrid Napier and cowpea-based diets has reported maintenance or improvement of milk fat, protein and SNF, depending on forage quality and nutrient balance [17, 18, 19]. The present results are most relevant to indigenous cows producing approximately 2-3 L milk daily. Extrapolation to high-yielding dairy cows would be inappropriate because their energy requirements and response to concentrate replacement are substantially greater.

Limitations

The study was conducted in a single herd with six cows per treatment. The thesis does not clearly resolve whether the analysis accounted for repeated weekly and fortnightly measurements within cows. The absence of treatment-specific feed refusals and individual nutrient-intake data limits mechanistic interpretation. In addition, digestibility, energy intake and body-condition change were not measured. Reanalysis of the original longitudinal data using

a mixed-effects model would strengthen the statistical inference.

Conclusion

Replacing concentrate with additional Hybrid Napier and cowpea green fodder did not significantly alter milk yield or milk composition in lactating Ongole cows during the 90-day study. The cowpea-based diet produced the highest DMI and numerically highest milk fat, protein, SNF and lactose, while maintaining milk yield close to the higher-concentrate treatment. Cowpea green fodder may therefore be used as a partial or complete concentrate substitute for low-producing Ongole cows when it is locally available, although confirmation in larger trials with repeated-measures analysis is required.

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Conflict of interest

The authors declare no conflict of interest.

Author contributions

A.S.G.: investigation, data collection, laboratory analysis and original draft; S.S.: conceptualization, supervision, methodology and critical revision; K.A.R.: supervision and critical revision; P.R.B.: animal nutrition methodology and interpretation; K.R.: fodder production and agronomic support. All authors reviewed and approved the final manuscript.

Data availability

The data generated during this study are available from the corresponding author on reasonable request.

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