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The Effect of Replacing Levels of Compounded Feed by Cowpea bean (*Vigna marina*) Stems and Leaves in The Diet on the Growth of Bach Thao Goat

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ABSTRACT

Background: The study aimed to identify the impact of Cowpea bean replacement on goat growth as a basis for developing a sustainable meat-goat farming model under climate change conditions.

Methods: The experiment was conducted over a period of 60 days (including a 10-day adaptation period), on 18 Bach Thao male goats, approximately 4 to 5 months old, arranged in a completely randomized design with 3 treatments and 6 replications. Treatment1: 30% compound feed + 70% para grass, Treatment 2: 15% compound feed + 15% Cowpea Bean stems and leaves + 70% para grass and Treatment 3: 0% compound feed + 30% Cowpea Bean stems and leaves + 70% para grass.

Result: Results showed that live weight gain (g/head/day) had a statistical difference between the experiment treatments (P<0.01), with the highest gain in 30% compound feed of diet at 104 g/head/day; following 15% compound feed of diet at 52g/head/day and finally 0% compound feed in the diet at 57 g/head/day.

Key words: Compound feed, Cowpea bean, Live weight gain.

INTRODUCTION

The intrusion of seawater salinity and drought in Vietnam's Mekong Delta pose severe challenges to agricultural production, particularly livestock farming. Ensuring a sustainable feed source for ruminants in saline-affected areas is critical. Cowpea Bean (*Vigna marina*), a salttolerant legume native to tropical coasts, shows potential as a forage crop for such conditions but remains underutilized in Vietnam.

Despite its adaptability and nutritional benefits, including 3% protein and 24% carbohydrates per 100 g of fresh material (Aguilar, 2016), research on using Cowpea Bean for livestock feed is limited. Goats, known for their resilience and suitability for smallholder systems, offer a viable model for evaluating alternative feed sources (Ngambi *et al.,* 2013).

This study aims to assess the impact of replacing compounded feed with Cowpea Bean stems and leaves on the growth performance of Bach Thao goats, contributing to the development of sustainable goat farming models for climate-resilient agriculture.

MATERIALS AND METHODS

Location and experiment design

The experiment was conducted in Co Co hamlet, Ngoc To commune, My Xuyen district, Soc Trang province and Laboratory E104, Department of Animal Science, College of Agriculture, Can Tho University. It starts from 2021 to 2023, including selecting sites, planting beans, building barns, purchasing goats, conducting experiments, processing data and writing Experiment reports. The experiment was conducted over 60 days, including a 10-day adaptation phase, using 18 Bach Thao male goats aged 4 to 5 months. The goats were arranged in a completely randomized design with 3 treatments and 6 replications.

For green fodder (Cowpea Bean stems and leaves, Para grass), cut to about 2 to 3 cm and mix the ingredients to form a complete mixture (TMR: Total Mixed Ration). Feed twice daily at 8 AM and 3 PM, providing ad libitum access. The data presented in Table 1 showed nutrition composition of experimental ingredients that green feed (grass, stems and leaves of Cowpea bean) is cut into pieces of about 2 to 3 cm. After that, the ingredients are mixed into a complete mixture: Total Mixed Ration (NRC, 1985; Nuru, 1985).

Measurements

Feed intake (kg/head/day); Growth (kg/day): Goats were weighed every 15 days, continuously for 2 months; Feed

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conversion ratio (kg feed/kg growth); The chemical composition of the feed used in the experiment includes DM, OM, CP, NDF and ADF were analyzed using AOAC (1990) methods.

Statistical analysis

Data analysis was done using Minitab's ANOVA General Linear Model tool. Sources of variation were treatments and errors.

RESULTS AND DISCUSSION

The data presented in Table 1 reveals that the dry matter (DM) content of cowpea bean (*Vigna marina*) is 17.20%, while the crude protein (CP) content is 19.20%. These values deviate significantly from typical ranges reported in previous studies, where DM content ranges between 33.3% and 45.88% and CP content can reach up to 24.44% under optimal growing conditions (Thuc *et al.,* 2022). Such discrepancies are indicative of suboptimal environmental conditions, including increased soil salinity, drought stress, or nutrient deficiencies, which are known to reduce nutrient uptake efficiency, protein accumulation and dry matter concentration in legumes (Serra *et al.,* 1996; Rahman *et al.,* 2016). It aligns with findings by Septiana (2019), who reported that *Vigna marina*, a salt-tolerant legume, can thrive under elevated salinity conditions (NaCl 200-400 mM) without significant biomass reduction. Interestingly, while DM levels were affected, the study noted increased chlorophyll and antioxidant production in response to salinity stress, suggesting a compensatory mechanism to maintain photosynthetic activity and mitigate oxidative stress. The current DM (17.20%) and CP (19.20%) values likely reflect similar salinity stress or water scarcity conditions, where plant resilience mechanisms were activated but resulted in reduced nutrient deposition. These findings reinforce *Vigna marina*'s potential as a forage option for degraded or marginal lands, though environmental management is key to optimizing its nutritional value. From a practical perspective, these results highlight the need for site-specific management strategies to improve cowpea bean production. Implementing irrigation systems, soil conditioning and salinity mitigation techniques could enhance DM and CP content, ensuring higher feed quality.

Nevertheless, the CP value remains sufficient to meet the basic requirements for goat maintenance and moderate growth, particularly during forage-scarce periods. However, further studies on the nutrient utilization efficiency of livestock fed with such suboptimal forages are needed to determine their feeding value. In contrast, the Para Grass analyzed in Table 1 exhibited a CP content of 12.20%, within the typical range of 3.2% to 15% reported under varying environmental and management conditions (Serra *et al.,* 1996). The high CP content observed here suggests favorable growth conditions, such as adequate moisture availability, appropriate maturity stages and effective management practices. It highlights the importance of optimal harvesting schedules, as delayed harvesting can lead to lignification, reducing digestibility and nutrient availability. Para Grass is a valuable forage resource capable of providing moderate protein levels in extensive grazing systems when harvested appropriately. The observed deviations in cowpea bean's DM and CP values emphasize the critical role of integrating environmental assessments with nutritional evaluations. Unlike compound feeds, which benefit from controlled production, natural forages such as cowpea beans and Para Grass are significantly influenced by environmental variability. While *Vigna marina* demonstrates resilience to salinity stress, its reduced DM and CP content underlines the need for further research on the effects of drought, salinity and soil amendments on its nutritional quality. Notably, mechanisms such as enhanced chlorophyll and antioxidant production observed under stress (Septiana, 2019) warrant further exploration to identify strategies for improving biomass yield and nutrient deposition.

Furthermore, while the CP content of Para Grass meets livestock requirements, its variability due to harvest timing and management remains a concern. Optimizing harvest schedules to prevent lignification can enhance its feed value. Integrating Para Grass with protein-rich legumes like *Vigna marina*-even under suboptimal conditions-could create a balanced nutrient supply, addressing seasonal forage shortages and improving overall feeding strategies. For the experimental compound feed, the DM content of 90.20% closely aligns with the values reported by Rahman *et al.* (2016) (90.71%). This consistency underscores the reliability and stability of compound feed formulations, which are essential for maintaining nutritional integrity. High DM content ensures minimal moisture, thereby reducing risks of spoilage, microbial contamination and nutrient losses during storage. This stability is crucial for maintaining palatability and energy density, directly influencing feed intake and livestock growth performance.

Table 1: Chemical composition of experimental feeds (%).

	% DM						
	DM	Ash	OM	CP	NDF	ADF	EE
Cowpea bean	17.2	6.1	93.9	19.2	36.54	27.67	6.1
Para grass	13.8	6.3	93.7	12.2	28.43	24.3	5.75
Compound feed	90.2	5.96	94.04	20.5	26	12.8	5.6

DM: Dry matter, Ash: Total minerals, OM: Organic matter, CP: Crude mrotein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, EE: Ether extract.

In summary, the data in Table 1 highlights notable deviations in cowpea beans' DM and CP content due to environmental stress, particularly salinity and drought. Despite these reductions, *Vigna marina* remains a viable forage option for degraded lands, supported by its resilience mechanisms. The CP content of Para Grass (12.20%) aligns with typical values, underscoring its potential as a reliable forage when managed effectively. Meanwhile, the consistent DM content of the compound feed (90.20%) reaffirms its stability and reliability as a nutrient source. These findings emphasize the importance of integrated management approaches to optimize forage production, ensure feed quality and sustain livestock productivity in variable environments.

Table 2 demonstrates that the experimental treatments provided equal DM and CP content, with the TMR containing 14.2% CP. This value aligns well with the recommended maintenance range of 8.9%-16% CP for small ruminants (NRC, 1985; Nuru, 1985). The inclusion of cowpea beans into TMR diets has been shown to positively affect goats' feed efficiency, digestion and growth performance. Salem *et al.* (2013) and other studies like Shitaneh *et al.* (2021) demonstrated that supplementing diets with cowpea hay improved DMI, nutrient digestibility and weight gain in small ruminants. Specifically, Shitaneh *et al.* (2021) reported that replacing noug seed cake with cowpea hay at 100% inclusion increased DMI (945.39 g/day), enhanced NDF digestibility and notable improvements in ADG. Such findings highlight the potential of cowpea-based diets to provide an effective alternative protein source for improving livestock productivity. From a metabolic perspective, cowpea supplementation improves the rumen environment, enhancing microbial fermentation and nutrient utilization. It was evidenced in studies like Mthetho *et al.* (2015), where Boer goats supplemented with cowpea seed hulls maintained positive body weight gains (0.58 kg) compared to weight losses observed in goats grazing natural pastures alone.

Although the CP content of cowpea seed hulls was lower than commercial concentrate, its inclusion still provided sufficient protein and energy levels to sustain production during dry seasons, underscoring its value as a strategic supplement (Mthetho *et al.,* 2015). The observed DM and CP stability in the current study's TMR further ensures a balanced nutrient supply for goats. In contrast to natural forages, which are highly variable due to environmental conditions, TMR formulations offer consistent nutrient quality, as demonstrated by Rahman *et al.* (2016). Such consistency minimizes risks associated with nutrient deficiencies, particularly during periods of forage scarcity and enhances goats' feed conversion efficiency and growth rates. Furthermore, the balance between cowpea bean inclusion and other protein sources, such as Para Grass, is key to achieving synergistic effects on feed utilization. Cowpea, being a legume, improves overall diet quality by providing degradable protein and increasing the microbial nitrogen supply in the rumen, as noted by Shitaneh *et al.* (2021). Integrating such legumes into TMR systems thus not only enhances nutrient digestibility but also supports higher weight gains and carcass quality in ruminants.

The findings suggest that incorporating cowpea beans into TMR diets at 14.2% CP contributes to optimal growth performance in goats. However, the success of such formulations depends on feed availability and proper management. Strategies such as optimizing cowpea production under variable environmental conditions (*e.g.*, salinity or drought stress) and ensuring timely harvesting to maintain nutrient content are critical for maximizing the benefits of cowpea inclusion. The results demonstrate that TMR diets containing cowpea beans at 14.2% CP meet the nutritional requirements of goats, aligning with established recommendations. Supplementing with cowpea hay or seed hulls improves feed efficiency, digestion and growth performance, as evidenced in multiple studies. These findings emphasize the value of integrating cowpea-based supplements into small ruminant feeding systems, particularly during forage-scarce periods, to ensure sustainable livestock production. The mean performance of Bach Thao goats fed on cowpea bean (*Vigna marina*) as a replacement for commercial compound feed, as shown in Table 3, indicates that the final body weights of goats supplemented with cowpea bean were statistically similar (P>0.05). However, goats supplemented with commercial compound feed achieved the highest final body weight (24.36 kg; P<0.05). These findings align with previous studies where Boer goats grazing natural pasture and supplemented with commercial concentrate demonstrated superior body weight gains compared to those supplemented with cowpea seed hulls or natural pasture alone (Mthetho *et al.,* 2015).

The observed superiority of commercial feed in achieving higher final body weights can be attributed to its balanced

Table 2: Proportion of ingredients and nutrition composition in the experimental diet.

	Treatment 1	Treatment 2	Treatment 3
		Ingredients in diet, %	
Compound feed	30	15	0
Cowpea bean stems and leaves	-	15	30
Para grass	70	70	70
		Nutrition composition of diet, %	
DM	18.50	16.36	14.66
CP	14.70	14.50	14.35

Table 3: Effect of different levels of substituting mixed feed in the diet with cowpea bean *(Vigna marina)* on weight gain (g/head/day), feed intake and feed conversion ratio in experiment.

Items	Treatment 1	Treatment 2	Treatment 3	SEM	P
Initial weight (kg/head)	20	18.66	18.5	0.48	0.13
Final weight (kg/head)	24.36[a]	20.86[b]	20.90[b]	0.39	0.01
Weight gain (g/head/day)	104[a]	52[b]	57[b]	0.05	0.01
Dry matter intake (g/head/day)	560[a]	459[b]	503[b]	0.01	0.01
Feed conversion ratio (kg VCK/kg)	5.48[b]	8.60[a]	8.82[a]	0.41	0.01

Mean values with different letters (a, b, c) on the same row indicate statistically significant differences (P<0.05).

nutrient profile, including higher CP, energy density and better digestibility compared to cowpea-based supplements. Commercial feeds are formulated to meet specific nutrient requirements for growth and production, providing consistent quality that minimizes variations in nutrient intake. In contrast, the variability in DM and CP content of cowpea beans may result from environmental stressors (*e.g.*, salinity, drought), as discussed in previous sections, which can reduce their nutritive value. Despite these differences, cowpea bean supplementation still supported satisfactory weight gain, demonstrating its potential as a viable alternative protein source for ruminants. Shitaneh *et al.* (2021) reported that replacing noug seed cake with cowpea hay in lamb diets improved DMI, digestibility of fiber components (NDF and ADF) and overall body weight gain, albeit at slightly lower rates compared to traditional concentrates.

It highlights cowpea's ability to provide sufficient protein and energy to support moderate growth, particularly in resource-limited systems where commercial feed may be unavailable or cost-prohibitive. From a metabolic perspective, the leguminous nature of cowpeas contributes to improved rumen fermentation through its higher nitrogen content, promoting microbial protein synthesis and enhancing fiber degradation in the rumen. However, compared to compound feed, cowpea-based diets may lack the energy density and optimized nutrient balance required for maximum growth rates. Mthetho *et al.* (2015) observed that Boer goats supplemented with cowpea seed hulls gained weight during the dry season (0.58 kg) but at a lower rate than goats supplemented with commercial concentrate (4.74 kg), emphasizing the energy limitations of cowpea-based forages under certain conditions.

The findings in Table 3 also suggest that while commercial feeds ensure superior growth performance, integrating cowpea beans into feeding systems provides significant economic and environmental advantages. Cowpea is a locally adaptable legume that can be cultivated on marginal lands and contributes to soil fertility improvement through nitrogen fixation. Moreover, its use as a supplement can help reduce dependency on costly commercial feeds, making it a sustainable option for smallholder farmers. The results highlight a trade-off between the growth performance of goats fed commercial feed versus those supplemented with cowpea beans. While commercial feed maximizes weight gain due to its high energy density and consistency, cowpea bean remains a practical and cost-effective alternative that supports moderate growth. Future strategies should consider combining cowpea beans with energy-dense supplements or basal diets to optimize performance and address its energy limitations.

Additionally, improving cowpea cultivation practices to enhance nutritional quality (*e.g.*, through soil management, irrigation and selective breeding) can increase its efficacy as a livestock feed. These results suggest that Cowpea Bean (*Vigna marina*) can effectively replace up to 15% of compound feed in goat diets, potentially offering a cost-effective feeding strategy without compromising weight gain. Bach Thao goats supplemented with commercial compound feed achieved the highest final body weight, consistent with findings in Boer goats fed similar diets. However, cowpea bean supplementation remains a promising alternative, particularly for regions where commercial feed is economically unfeasible. Future research should focus on optimizing the nutrient balance of cowpea-based diets to maximize their contribution to livestock productivity while promoting sustainable and cost-effective feeding practices.

CONCLUSION

The results demonstrated that supplementing goat diets with compound feed produced the best growth performance. However, incorporating cowpea bean (*Vigna marina*) stems and leaves as a partial replacement for compound feed proved a viable alternative. Replacing up to 15% of the compound feed with Cowpea Bean maintained satisfactory growth performance while offering a practical and cost-effective feeding strategy for goat production.

Conflict of interest

All authors declared that there is no conflict of interest.

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