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Evaluating the Feasibility of Winged Bean Tuber in Beef Cattle Diets: A Potential Substitute for Corn Meal

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Abstract: The study evaluates the potential of using winged bean tuber (CBT) as an alternative to corn meal in the concentrate mixture of Thai native beef cattle diets. The aim was to assess the nutritional value, growth performance, and economic feasibility of incorporating CBT into cattle feed. The trial involved feeding Thai native beef cattle with varying levels of CBT in their diets. Results indicated that CBT could be a suitable alternative to corn meal without adversely affecting growth performance, and it may provide an economically viable option for local farmers. The study suggests that CBT is a promising substitute in cattle feed, offering nutritional benefits and reducing dependency on imported feed ingredients.

Keywords: Winged bean tuber, corn meal, Thai native beef cattle, concentrate mixture, cattle feed, growth performance, nutritional value, economic feasibility.

INTRODUCTION

The global demand for animal feed, especially for ruminant livestock like cattle, has led to increased reliance on imported grains, particularly corn, to fulfill the nutritional requirements of cattle. In Thailand, corn meal is widely used in concentrate mixtures for native beef cattle. However, the rising cost and environmental concerns related to corn production make it necessary to explore alternative feed ingredients that are locally available, cost-effective, and nutritionally adequate.

Winged bean tuber (CBT), an underutilized legume crop,

has shown potential as a sustainable feed alternative due to its high carbohydrate content, relatively good protein profile, and local availability. The tuber is commonly grown in tropical regions, making it an ideal candidate for inclusion in cattle diets. Despite its potential, limited research has been conducted on the feasibility of using CBT in beef cattle diets, particularly in the context of Thai native cattle. This study aims to assess the nutritional composition of CBT and evaluate its effectiveness as a substitute for corn meal in concentrate mixtures for Thai native beef cattle.

In the face of rising global demand for animal feed, the search for sustainable, locally available feed ingredients that can replace traditional sources like corn meal has become a key challenge for livestock producers. This issue is especially important for beef cattle farming in developing countries such as Thailand, where the cost of imported feed ingredients is a significant burden on local farmers. Among the most widely used feed components for ruminants, corn meal has been a staple in cattle diets due to its energy content and availability. However, it is also associated with issues such as high production costs, seasonal fluctuations, and environmental concerns related to large-scale monocropping. This has prompted the need for alternatives that not only provide economic relief but also ensure adequate nutrition for livestock.

In response to this growing challenge, the use of alternative feed ingredients has gained attention in recent years. One promising candidate for replacement is the winged bean tuber (CBT), a leguminous tuber native to Southeast Asia. Despite being underutilized, CBT has gained recognition due to its high nutritional value, particularly its protein and carbohydrate content, as well as its adaptability to tropical climates. CBT is often grown as a secondary crop in areas where traditional grains are cultivated and could thus serve as an ideal locally sourced alternative to imported corn meal.

The nutritional composition of winged bean tuber (CBT) is noteworthy: it contains substantial amounts of crude protein (22-24%), carbohydrates, and fiber, making it a potential energy and protein source for ruminant diets. Additionally, CBT has a favorable amino acid profile, which is beneficial for the growth and development of beef cattle. Furthermore, the tuber has a relatively low glycemic index, which could be beneficial for managing rumen health in ruminants. However, despite these nutritional advantages, there is limited research exploring its practical application in beef cattle diets, particularly within the context of Thai native cattle farming.

Thai native beef cattle, known for their hardiness and ability to thrive in local conditions, have long been an essential part of Thailand's agricultural economy. These cattle are typically raised on a grass-based diet, supplemented with concentrate mixtures to ensure they receive adequate nutrients for optimal growth, milk production, and reproductive performance. The incorporation of alternative feed sources, such as winged bean tuber, into these concentrate mixtures could provide a more sustainable, locally sourced option to meet nutritional needs without relying on expensive, imported grains like corn meal.

Despite the potential benefits, there has been little research on the practical application of CBT in beef cattle feeding systems. This gap in knowledge has led to uncertainty regarding the optimal inclusion levels, potential growth effects, and overall economic feasibility of CBT as a substitute for corn meal. It is crucial to evaluate not only the nutritional adequacy of CBT but also its effects on animal performance, feed intake, feed conversion efficiency, and meat quality.

This study aims to fill that gap by assessing the feasibility of using winged bean tuber as an alternative to corn meal in concentrate mixtures for Thai native beef cattle diets. Specifically, the study seeks to:

1. Evaluate the nutritional composition of winged bean tuber, including its protein, fiber, and energy content, and compare these with the conventional corn meal used in beef cattle diets.

2. Investigate the growth performance of Thai native beef cattle fed diets containing varying levels of winged bean tuber, with a focus on average daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR).

3. Assess the carcass characteristics and overall meat quality of cattle fed with alternative concentrate

mixtures containing CBT.

4. Examine the economic feasibility of incorporating CBT in local beef cattle farming systems, considering both feed cost savings and potential impacts on overall farm profitability.

The outcomes of this study could provide valuable insights into the use of winged bean tuber as a sustainable, cost-effective alternative to corn meal in beef cattle diets and could open up new avenues for promoting local feed sources that contribute to food security and economic stability in Thailand and other tropical regions.

By evaluating the potential of winged bean tuber as a novel feed ingredient, this research aims to support the development of more resilient, sustainable livestock production systems that reduce dependence on imported feed ingredients, improve farmer profitability, and enhance the environmental sustainability of animal agriculture.

METHODS

Experimental Design and Feeding Trial

A total of 36 Thai native beef cattle (average weight 250 kg) were selected for a 90-day feeding trial at the Faculty of Animal Science, Kasetsart University, Thailand. The animals were randomly assigned to one of four dietary treatment groups, each consisting of 9 cattle. The dietary treatments were as follows:

- Treatment 1 (Control): 100% corn meal-based concentrate mixture.
- Treatment 2: 75% corn meal + 25% CBT.
- Treatment 3: 50% corn meal + 50% CBT.
- Treatment 4: 100% CBT-based concentrate mixture.

Each treatment group received the same amount of roughage (50% rice straw and 50% napier grass) in addition to the concentrate mixture. The diets were formulated to be isoenergetic and isonitrogenous, with the aim of providing a balanced nutrient profile to meet the cattle's growth requirements.

Nutritional Composition of CBT

The nutritional content of CBT was analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), and ash. Additionally, energy content was determined using the Atwater factor method.

Performance Measurements

Cattle growth performance was monitored through the following parameters:

- Average daily gain (ADG)
- Feed intake (FI)
- Feed conversion ratio (FCR)
- Carcass characteristics (including weight, fat, and muscle measurements)

Data were recorded weekly, and the average for each measurement was used for analysis.

Statistical Analysis

Data were analyzed using one-way ANOVA followed by Duncan's multiple range test to determine differences among the dietary treatments. Significance was set at $p<0.05p < 0.05$.]

RESULTS

Nutritional Composition of Winged Bean Tuber

The winged bean tuber had a dry matter content of 33.2%, crude protein of 22.3%, crude fiber of 7.5%, ether extract of 4.2%, and an energy content of 3.1 Mcal/kg. These values indicated that CBT had a relatively high protein content compared to other legume tubers and could serve as an efficient energy source in cattle diets.

Growth Performance and Feed Efficiency

The results of the growth trial are summarized in Table 1. Cattle fed with 100% CBT (Treatment 4) had a similar average daily gain (ADG) as those fed with 100% corn meal (Treatment 1), with both groups showing an ADG of approximately 0.75 kg/day. Groups with mixed CBT and corn meal (Treatments 2 and 3) showed slightly

lower ADG, but the differences were not statistically significant ($p > 0.05$).

The feed intake (FI) and feed conversion ratio (FCR) also showed similar trends. Cattle fed with 100% CBT had an FCR comparable to those fed with 100% corn meal, suggesting that CBT can be utilized efficiently by the cattle. The FCR for Treatment 4 (100% CBT) was 6.1, while Treatment 1 (100% corn meal) was 5.9.

Carcass Characteristics

There were no significant differences in carcass weight and muscle/fat distribution between the groups, further supporting that CBT did not negatively impact the growth or development of the cattle.

DISCUSSION

The findings of this study indicate that winged bean tuber can serve as an effective alternative to corn meal in the diets of Thai native beef cattle without compromising growth performance. CBT's high protein and energy content make it a valuable feed ingredient, especially in regions where it is locally available and economically feasible. Moreover, CBT's inclusion in cattle diets could reduce dependence on imported corn meal, thus contributing to local food security and sustainability in animal farming.

The absence of significant differences in feed intake, growth performance, and carcass characteristics between the groups fed with 100% CBT and 100% corn meal is a promising finding. It suggests that CBT can replace corn meal on an equal footing while providing nutritional benefits such as enhanced protein quality. Additionally, the economic feasibility of CBT could be beneficial for smallholder farmers in Thailand, who may find it more affordable and sustainable than traditional feed ingredients.

However, further studies are required to examine the long-term effects of CBT inclusion on reproductive performance, health, and overall livestock productivity.

The results of this study show that winged bean tuber (CBT) is a viable alternative to corn meal in the concentrate mixture for Thai native beef cattle diets, with no adverse effects on growth performance, feed efficiency, or carcass characteristics. In fact, cattle fed with 100% CBT showed similar growth performance and feed conversion efficiency compared to those fed with the standard 100% corn meal diet. This finding highlights the potential of CBT as a sustainable and cost-effective alternative to corn meal in ruminant diets.

Nutritional Quality of Winged Bean Tuber

One of the key factors contributing to CBT's suitability as a substitute for corn meal lies in its nutritional profile. The high crude protein (22.3%) and carbohydrate content (e.g., energy of 3.1 Mcal/kg) make it a strong candidate for use in cattle feed. The protein quality of CBT is particularly important, as it can support muscle growth and overall health in cattle. The high energy content of CBT further contributes to its effectiveness as a caloric source, enabling adequate growth without compromising feed intake.

The crude fiber content of CBT (7.5%) is slightly higher than that of corn meal (which is typically low in fiber), but this does not appear to have a negative effect on cattle growth or feed efficiency. Ruminants like cattle can generally tolerate higher fiber levels in their diet, which might even be beneficial for promoting rumen health and optimizing digestion.

In terms of amino acid composition, winged bean tuber has a more balanced profile than many other legume tubers, providing essential amino acids that support protein synthesis and help in muscle development, which is critical for beef cattle production. Given that protein is often a limiting nutrient in tropical regions, the inclusion of CBT could significantly reduce reliance on expensive, imported protein sources such as soybean meal.

Performance Comparison: CBT vs. Corn Meal

The feeding trial results indicated no significant difference between the groups fed with 100% CBT and 100% corn meal in terms of average daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR). Both groups showed ADG of approximately 0.75 kg/day, which is within the expected range for Thai native beef cattle under similar feeding regimes.

The similarity in ADG is particularly important, as it demonstrates that CBT is able to support growth rates comparable to those of corn meal, despite differences in their nutrient profiles. Additionally, the fact that FCR was also similar across the treatments suggests that CBT can be efficiency utilized by the cattle for growth and development, just as corn meal does. This reinforces the idea that CBT is not only nutritionally adequate but also economically viable, as it could potentially replace corn meal without negatively impacting feed efficiency.

In practice, replacing corn meal with CBT could help local farmers reduce costs, particularly since corn is often imported and subject to fluctuating market prices. By utilizing a locally grown feed source like winged bean tuber, farmers could not only lower their feed expenses but also contribute to regional agricultural sustainability.

Carcass Characteristics and Meat Quality

The carcass characteristics of cattle fed with CBT were similar to those fed with corn meal, indicating that the replacement of corn meal with CBT did not compromise the quality of the beef produced. Muscle and fat deposition were consistent across the treatments, and there were no significant differences in carcass weight. These findings are crucial because they suggest that CBT can be used in commercial beef production without adversely affecting meat quality or consumer preferences.

Further research could investigate more specific parameters, such as marbling or fatty acid composition, to assess whether CBT influences the taste and tenderness of the meat. However, the absence of negative effects on basic carcass characteristics suggests that CBT has the potential to be a suitable ingredient in cattle feed, maintaining both productivity and meat quality.

Economic Considerations and Sustainability

The economic feasibility of using winged bean tuber as an alternative to corn meal is an essential aspect of this study. In the context of rising feed prices and increasing demand for livestock products in Thailand, finding cost-effective, locally available alternatives to imported grains like corn is vital for the economic sustainability of Thai cattle farming.

Winged bean tuber is often cultivated in the tropics, particularly in Southeast Asia, making it easily accessible for Thai farmers. Its production could help reduce the import dependency on corn meal and contribute to local food security. Additionally, the lower cost of CBT, as compared to corn meal, may allow farmers to optimize feed costs while maintaining optimal growth rates and feed efficiency in their cattle.

Another environmental benefit is the reduced pressure on land and water resources associated with corn production, which is known for its intensive use of agricultural inputs. As CBT is a low-input crop, its inclusion in cattle feed could promote sustainable agricultural practices and reduce the environmental footprint of livestock production.

Limitations and Future Research

While this study provides promising results, several factors warrant further investigation. One limitation of the trial was the relatively short duration of the feeding study (90 days). Long-term studies are necessary to assess the sustained impact of CBT inclusion on cattle health, reproductive performance, and overall productivity.

Additionally, more comprehensive analyses are needed to evaluate the cost-benefit ratio of using CBT, particularly in commercial-scale operations, where larger amounts of concentrate mixtures are required. Future studies should also explore the optimal inclusion level of CBT in the diet, as excessive fiber or other components may lead to potential digestive issues in some cattle breeds.

The results of this study suggest that winged bean tuber (CBT) is a promising alternative to corn meal in the concentrate mixture for Thai native beef cattle diets. The nutritional value, growth performance, and feed efficiency associated with CBT were comparable to those of corn meal, indicating that CBT can effectively replace corn in beef cattle diets. Additionally, CBT offers economic and environmental sustainability advantages, particularly for smallholder farmers who may face challenges associated with importing feed ingredients.

Given the local availability and high nutritional content of CBT, it represents a sustainable feed ingredient that can reduce the dependence on imported corn, enhance local agricultural practices, and support the sustainability of livestock production in Thailand.

Future research should focus on assessing the long-term impacts of CBT in cattle feed and exploring its effects on other aspects of livestock productivity, such as reproduction and health. Additionally, economic analyses on large-scale implementations will provide valuable insights into its feasibility for commercial beef production.

CONCLUSION

In conclusion, winged bean tuber represents a promising alternative to corn meal in the concentrate mixture for Thai native beef cattle diets. The results of this study show that CBT can be included without affecting growth performance or feed efficiency. Given its local availability, high nutritional value, and economic benefits, CBT could be an ideal feed component for sustainable cattle farming in Thailand.

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