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Research Article

Exploration of the Potential of Gambir Leaf Extract (*Uncaria gambir Roxb.*) from Sutera, Pesisir Selatan as a Feed Additive to Improve Fiber Digestibility and Suppress Methane Emissions of Ruminants

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ABSTRACT

This study explored the potential of gambir leaf extract (*Uncaria gambir Roxb.*) from Sutera, South Pesisir Regency, West Sumatra, as a natural feed additive to improve fiber digestibility and suppress methane emissions in rumen fermentation. The study was conducted in vitro using fiber-based rations added with gambir extract at 0%, 0.5%, 1%, and 2%. Parameters observed included digestibility of NDF, ADF, cellulose, hemicellulose, and methane gas production. Results showed that adding gambir extract up to 2% significantly increased fiber digestibility and decreased methane production compared to the control. This study proves that local gambir extract has the potential as an environmentally friendly feed additive to support the efficiency and sustainability of ruminant farming.

Keywords: feed additives, fiber digestibility, gambir, methane, ruminants

INTRODUCTION

The productivity of ruminants in Indonesia, especially in the West Sumatra region, is highly dependent on providing quality, affordable, and sustainable feed. Feed costs account for more than 60% of total production costs, most of which still rely on conventional raw materials such as soybean meal and fishmeal. This dependence on imported feed ingredients not only suppresses the economic efficiency of farmers but also makes the national livestock industry vulnerable to global price fluctuations and supply uncertainty. Therefore, utilizing abundant and underexplored local resources is one of the important strategies in supporting national feed security.

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One of the interesting local potentials to be developed is gambir (*Uncaria gambir Roxb*.), a typical West Sumatran plant that has been better known as a raw material for the leather tanning and pharmaceutical industries (Isnawati et al., 2012; Yunarto et al., 2017). Gambir leaves produced from the Sutera area, Pesisir Selatan Regency, West Sumatra, contain high levels of bioactive compounds such as catechins, tannins, and saponins. These compounds have the potential to act as natural feed additives that can increase the efficiency of rumen fermentation, suppress the production of methane gas, which is detrimental to the environment, and increase the utilization of fiber in feed (Laura et al., 2024; Elihasridas et al. 2024; Pazla et al., 2024a). Previous studies have shown that adding gambier leaves to rations can increase fiber digestibility and reduce ruminant methane emissions (Ardani et al., 2024; Pazla et al., 2025). However, most existing studies are still limited to gambir from the main producing areas, such as Limapuluh Kota. In contrast, the potential of gambir from Sutera, which has different bioactive content characteristics, has not been widely studied scientifically.

In addition, previous studies have generally focused on gambir in the context of non-food industrial uses. At the same time, the application of its extracts in ruminant nutrition as bioactive agents for improving feed efficiency and mitigating methane emissions has not been widely explored. The absence of scientific data examining the effectiveness of gambir Sutera extract, both in terms of phytochemical characteristics and its impact on rumen fermentation performance, indicates an important research gap to be filled. This study offers novelty by addressing the potential of local gambier extract from Sutera as an environmentally friendly natural feed additive. The evaluation was conducted to increase digestibility and feed efficiency and reduce methane production, which is a strategic issue in greenhouse gas mitigation efforts in the livestock sector. Thus, this research is expected to make a real contribution to optimizing the utilization of local resources and supporting the development of a more sustainable and competitive livestock system.

MATERIAL AND METHODS

Materials

This study used gambier leaf extract (*Uncaria gambir Roxb*.) obtained from gambier production centers in Sutera District, Pesisir Selatan Regency, West Sumatra, Indonesia. The basic feed ingredients used in this study consisted of rice straw, elephant grass, rice bran, ground corn, palm kernel meal, and tofu dregs, arranged into a fiber-based ration according to the formulation of Tables 1 and 2.

Table 1. Ration composition

Feed Ingredient	Treatment (%)
Rice Straw	20
Elephant Grass	40
Bran	2
Corn	6
Palm kernel Meal	15
Tofu Dregs	16
Minerals	0.5
Salt	0.5
Total	100

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Table 2. Ration nutrient content

Nutrient content	Value of content (%)
Dry matter	90.01
Crude protein	12.59
Crude Fiber	25.79
TDN	62.59
NDF	61.56
ADF	47.55
Cellulose	25.34
Hemicellulose	14.01
Lignin	6.39

TDN = Total Digestibility Nitrogen; NDF = Neutral Detergent Fiber; ADF = Acid Detergent Fiber

Methods

This study used a completely randomized design with four treatments and four replicates. The treatments given were the level of addition of gambier silk extract into the ration as follows:
T0: Control ration (without gambier extract)
T1: Ration + 0.5% gambier extract
T2: Ration + 1% gambier extract
T3: Ration + 2% gambier extract

Research Implementation

The study was conducted in vitro using Tilley and Terry's (1963) method to simulate the rumen fermentation. Rumen fluid was obtained from an abattoir. Rumen fluid was filtered and mixed with McDougall buffer solution in a ratio of 1:4 (v/v) under anaerobic conditions. The ration and rumen fluid mixture were put into a fermentation tube and incubated at 39oC for 48 hours. Parameters observed included fiber digestibility, namely NDF, ADF, cellulose, and hemicellulose—determination of fiber fraction content based on the Van Soest et al. (1991) method. Methane gas production was measured using the method of Fieves et al. (2005). Bioactive catechins, tannins, and saponins were analyzed using spectrophotometry.

Data Analysis

The data obtained were analyzed using analysis of variance (ANOVA). If there was a significant difference between treatments, the Duncans Multiple Range Test (DMRT) at the 5% level was followed to determine the difference between treatments. All analyses were conducted using SPSS statistical software.

RESULTS AND DISCUSSION

Bioactive Compound Content of Silk Gambir Leaf Extract

The results of the phytochemical analysis showed that gambier leaf extract from Sutera District, Pesisir Selatan Regency, contained catechins of 30.22 g/100 g, tannins of 32.99 g/100 g, and saponins of 1.05 g/100 g (Table 3). This high content shows the potential of using gambir as a source of bioactive compounds in ruminant feed. Compared to gambir from other regions, such as Talang Maur, which has a higher catechin and tannin content (Pazla et al., 2025), Sutera

gambier still provides strategic value given its abundant availability in coastal areas. It has not been widely utilized in the animal feed industry.

Tabel 3. Nutrient tannin, catechin, and saponin

Parameters (%)	Gambier Leaf Extract Sutera
Catechin	30.22
Tannin	32.99
Saponin	1.05

Catechin compounds, a class of flavonoids, act as antioxidants and antimicrobials that can modulate rumen microbial activity, especially bacteria and protozoa involved in fiber fermentation and methane gas formation (Bhatta et al., 2009). Tannins, on the other hand, can form complex bonds with microbial proteins and enzymes, which, in the right concentration, can increase nitrogen use efficiency in the rumen without significantly inhibiting fiber fermentation (Jayanegara et al., 2015; Pazla et al., 2015; Putri et al., 2015). 2024b; Putri et al. 2024; Jamarun et al. 2025). Saponins also play a role in reducing the population of rumen protozoa, which are known to be symbiotic with methanogens in producing methane (Patra & Saxena, 2010).

Although the bioactive content of gambir Sutera is relatively lower than in some other regions, an approach based on utilizing local potential remains economically and ecologically relevant. In addition, this moderate bioactive content can reduce the risk of adverse effects often reported in high doses of tannin, such as decreased palatability and digestibility of other nutrients (Min et al., 2003).

Impact of Gambir Extract Addition on Fiber Digestibility

The increase in fiber digestibility (NDF, ADF, cellulose, and hemicellulose) observed in treatment T3 (addition of 2% gambir extract) indicates that Silk gambir extract can increase cellulolytic microbial activity in the rumen. Tannin at the correct dose is thought to reduce excessive protein degradation by proteolytic microbes so that available nitrogen can be utilized more optimally by cellulolytic microbes to support enzymatic activity in fiber degradation (Makkar, 2003; Pazla et al., 2024b).

Table 4. Digestibility of NDF, ADF, cellulose, and hemicellulose

Treatment	Digestibility of NDF	Digestibility of ADF	Digestibility of Cellulose	Digestibility of Hemicellulose
T0	61.68^{c}±0.28	61.59^{c}±0.62	64.6^{c}±0.51	64.84^{c}±0.43
T1	62.59^{b}±0.60	62.09^{b}±0.53	64.99^{c}±0.53	65.39^{b}±0.29
T2	62.82^{b}±0.54	62.34^{b}±0.44	65.3^{b}±0.47	65.62^{b}±0.38
T3	63.73^{a}±0.45	63.15^{a}±0.39	65.98^{a}±0.41	66.38^{a}±0.22

Description: T0 (Ransum control), T1 (Ransum + 0.5% Gambier Sutera), T2 (Ransum + 1% Gambier Sutera), T3 (Ransum + 2% Gambier Sutera), NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber

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In addition, antioxidant catechins can protect cellulolytic microbes from oxidative stress during the fermentation process, thereby increasing the stability of the microbial community responsible for fiber breakdown (Goel & Makkar, 2012). This increase in fiber digestibility has positive implications for increasing energy and nutrient utilization of high-fiber feed ingredients, which generally have limited digestibility.

This study supports the results of Jayanegara et al. (2015), who reported that adding polyphenols to the diet can increase fiber digestibility if given in concentrations that do not excessively suppress microbial activity. Therefore, gambier extract at the 2% level can be categorized as still within optimal limits to increase efficiency without causing adverse side effects.

Impact of Gambir Extract Addition on Methane Gas Production

The significant reduction in methane gas production in the T3 treatment indicated that the Silk Gambier extract effectively suppresses methanogen activity in the rumen (Figure 1). This effect is most likely due to the combined activities of tannins, catechins, and saponins synergistically inhibiting the microbial population of mana-producing Archaea and the protozoa symbiotic (Patra & Saxena, 2010).

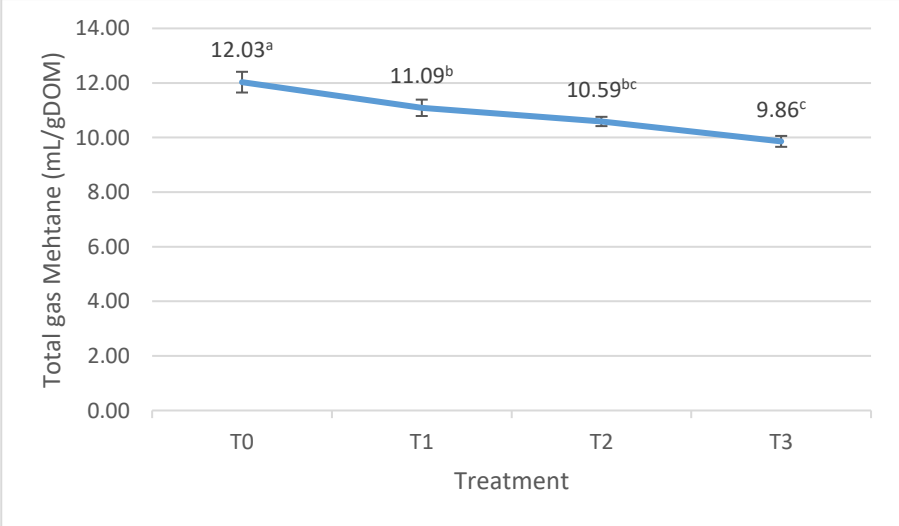


Figure 1. Gas Methane total (mL/g DOM). Description: T0 (control ration), T1 (T0+ 0.5% gambier Sutera), T2 (T0 + 1% gambier Sutera), T3 (T0 + 2% Gambier Sutera), DOM: an organic matter of digestibility

Tannins and catechins work by inhibiting metabolic pathways used by methanogens to produce methane, while saponins reduce the number of protozoa that provide an ideal environment for methanogens to thrive (Makkar et al., 2007). The observed reduction in methane not only impacts mitigating greenhouse gas emissions but also has the potential to improve energy efficiency, as methane is an end product that is not utilized by livestock and only represents energy loss from feed.

This finding is in line with the studies of Goal and Makkar (2012), Antonius et al. (2023), and Antonius et al. (2024), which state that polyphenolic compounds from plants can be used as a natural strategy to suppress methane production in the rumen. The use of local gambier such as from Sutera provides its advantages because it supports the development of feed technology based on local resources that are environmentally friendly.

CONCLUSION

This study showed that gambir leaf extract (*Uncaria gambir Roxb*.) from the Sutera area, Pesisir Selatan Regency, West Sumatera, which contains catechins, tannins, and saponin, has the potential to be utilized as a feed additive for ruminants. The Addition of Gambir extracts up to 2% level in rations increased fiber digestibility, including NDF, ADF, cellulose, and hemicellulose, and significantly reduced methane gas production during in vitro fermentation.

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