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In Vitro Digestibility of Hay Mangrove with Native Grass

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Abstract: Forage is the main component of feed given to ruminants. Local feed ingredients that can be used are mangroves and native grass. This study used the Randomized Block Design (RBD) experimental method with 4 = four treatments and 5-five replications. The treatments composed of Hay Mangrove Leaves and Native grass as follows: A (60 + 40%), B (50 + 50%), C (40 + 60%) and D (30 + 70%). Data were analyzed using General Liner Model and continued with Duncan's Multiple Range Tests (DMRT). The results showed that the treatment had a highly significant effect ($P<0.01$) on the digestibility of crude fiber, crude fat, and NFE. The best ratio of the combination of mangrove leaf hay and field grass based on the *in-vitro* digestibility was C treatment (40% mangrove hay + 60% field grass). The digestibility value of each crude fiber was 61.24%, crude fat was 61.43% and NFE was 62.30%. This study aims to evaluate the *in-vitro* digestibility of crude fiber, crude fat, and Nitrogen-Free Extract (NFE) of hay mangrove leave and native grass.

Keywords: Hay Mangrove Leaves, Native Grass, *In Vitro*, Crude Fiber, Crude Fat, NFE, Digestibility

Introduction

In Indonesia, forage is the main component of feed given to ruminants. Forage plays a crucial role because it contains substances needed by livestock for energy metabolism and to support reproduction. Forage must be available continuously to serve its purposes.

Currently, minimal land poses a problem to support forage production. This is due to the conversion of land used for industry, settlements, and plantations. Farmers will prefer to grow food crops and horticulture because it is more profitable than crops for animal feed. For farmers in coastal areas, competition in land use is also a problem because the land is used for the tourism sector which is profitable in the short term. So that land for forage is limited, it is necessary to look for alternative feeds that are available in a sustainable manner (Sari *et al*., 2022).

One of the local feed ingredients that can be used is mangrove. Mangrove leaves had the potential to feed livestock, especially ruminants (Sari *et al*., 2021); (Yanti, 2021). Mangroves are plants that grow in coastal forest areas and other areas that are affected by tides in the tropics and subtropics.

Indonesia is one of the countries with the largest mangrove population in the world. Indonesia has a mangrove forest area of about 22.6% (3.1 million ha) of the total mangrove area in the world (Giri *et al*., 2011). While the area of West Sumatra's mangrove forest is 39,832 Ha, with the largest density found in the Mentawai Islands Regency (Noegroho, 2013). Some types of mangroves that are commonly found in Indonesia are Rhizophora, Avicennia, Sonneratia, Bruguiera, and Xylocarpus. According to Bengen (2000), the composition of mangrove species is influenced by several environmental factors, especially soil type, tidal inundation, and salinity. One of the vegetation that makes up mangrove forests is mangroves (*Rhizophora spp*). Rhizophora apiculata has tap roots, up to 20 m high, the leaves are spiral in shape with a blunt base and a pointed tip, small cylindrical fruit, and reddish cotyledons, this happens because the fruit found is a fruit that has undergone a germination process called propagules (Sidik *et al*., 2018).

Rhizophora apiculata is a widely distributed mangrove in the coastal areas of Indonesia. The population of mangroves in Indonesia reaches 75% of the total mangrove population in the world. The abundance of mangroves in Indonesia has not been used optimally. This shows that the mangrove species *Rhizophora apiculata* needs to be processed and utilized (Duke *et al*., 2010). Areas around the Red Sea, India, and Australia have used mangrove leaves to feed camels. This shows that mangrove leaves have the potential to be used as animal feed. Mangrove leaves can be used as alternative feed ingredients for ruminant animals with 13.37% crude protein, and 7.34% lignin, rich in macro and micro minerals and contain phytochemical compounds such as tannins, steroids, and triterpenoids (Jamarun *et al*., 2020).

One of the most suitable and widely used methods for preserving fodder forage is to make it into hay, which is drying the forage either in direct sunlight or in an oven. Hay can be stored for a long time so it is very suitable as a guarantor for providing feed throughout the year, especially during the dry season (Ali, 2006).

Another forage plant found in coastal areas is native grass. Native grass is a weed that grows without cultivation and is easy to obtain but has low nutritional quality. Nawangsari and Hendrarti (2021) stated that the results of the proximate analysis of native grass produced dry matter ranged from 22.99-44.13%, crude protein up to 9.22-13.56%, fat up to 0.41-3.11%, ash contents up to 9.41-16.22%.

The combination of hay mangrove leave and native grass will be very useful as ruminant feed because has their respective roles as a source of protein and fiber, it is suspected that the combination of hay mangrove leave and native grass will be fiber and protein as an N source for microbes so that they can digest fiber when given in a balanced dose. *Rhizophora apiculata* contain tannins, phenols, alkaloids, flavonoids, saponins, and steroids. Tannins are compounds that can be used to protect proteins from rumen microbial degradation It is known that hay mangrove leave has the potential as animal feed, so it is necessary to research the effect of a combination of hay mangrove leave (*Rhizophora apiculata*) with native grass on the digestibility of crude fiber, crude fat and FEN *in-vitro* using different proportions as follows: A (60 + 40%), B (50 + 50%), C (40 + 60%) and D (30 + 70%) of Hay Mangrove Leaves and Native grass respectively.

Materials and Methods

Materials

Analysis of *in vitro* digestibility was conducted in the Laboratory of Ruminant Nutrition of Andalas University. The material used in this research was a mangrove (*Rhizophora apiculata*) from Nagari Sasak, West Sumatra. Native grass carried out from Limau Manis, Pauh, Padang City used a plot method of 1×1 m^2 size. The composition of treatments is given in Table 1.

Table 1: Composition of experimental treatments

	Feed	
Treatments	HML	NG
A	60%	40%
B	50%	50%
C	40%	60%
D	30%	70%

Note: HML = Hay Mangrove Leaves
NG = Native Grass

In Vitro

An *in vitro* experiment was performed using Tilley and Terry method to determine the nutritional content of feed ingredients and feed digestibility.

Parameters

The sample was analyzed to determine the contents of dry matter, organic matter, protein, fat, and crude fiber using proximate analysis Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), cellulose, hemicellulose and lignin contents using Van Soest analysis.

Data Analysis

This study used a Randomized Block Design (RBD) method which consisted of 4-four treatments with 5-five replications. All data was observed using General Linear Model (GLM) and continued with Duncan's Multiple Range Tests (DMRT) using IBM SPSS Statistics 26.

Results and Discussion

Nutritional Contents of Feed Ingredients

Crude protein values in all treatments ranged from 9.66-9.00% (Table 2). The value of crude protein is suitable for being a forage source for ruminant feed, based Jamarun and Zain (2013) said that forage contains crude protein 5-10% classified as a medium forage source. The protein feed value affected the NH3 production. The contribution of N to ruminants is very important considering that the precursor microbial protein is ammonia and carbon source compounds, the higher the levels of NH3 in the rumen, the more likely the microbial protein formed as a source of body protein (Arora, 1995).

These rations containing high crude protein will also increase the dry matter because dry matter contains protein. Table 2 shows the organic matter contents of the leaves are also relatively high (91.71-94.31%). The ash will decrease when the organic matter is high. The ash content is not essential, the higher value makes the feed quality lower and ash content is only for measuring NFE content (Suparjo, 2010).

The value of crude fat was low (2.57-2.26%), which is advantageous for feed. Fat ingredients in ruminant feed mixtures can cause side effects negative to the physical form of the feed (become sticky) and to microbe's rumen digests fiber, therefore it is necessary to know how fat is metabolized in the body of ruminants, a form of fat that can increase the production or reproduction of livestock or can affect production efficiency (Wina and Susana, 2013).

Crude fiber is one of the important ingredients in the animal fee. The crude fiber on all treatments ranged from 16.75-20.54%. The crude fiber result was good for ruminants because the minimum crude fiber requirement was 13% (Sudarmono and Sugeng, 2008). ADF was an indicator of the digestibility of forage and consisted of cellulose, lignin, and silica. Lignin was an indigestible component (Pazla *et al*., 2020). Then NDF contained hemicellulose, this component was easy to digest (Tibin *et al*., 2021).

Crude Fiber Digestibility

The average digestibility of crude fiber of hay mangrove leave and native grass *in vitro* can be seen in Table 3 below. In the table, it can be seen that each treatment resulted in a highly significantly different effect (P<0.01) on crude fiber digestibility. The digestibility value of crude fiber obtained in the study ranged from 58.67 to 61.28%.

Crude fiber digestibility in C Treatment (40% HDM + 60% RL) showed the highest value compared to treatments A, B, and D. This can happen because the mangroves used contain tannins which can reduce the digestibility of crude fiber. This is following the opinion of Cieslak *et al*. (2014) who states that basic components such as crude protein and crude fiber can interact with phytochemicals such as tannins and cause their availability to decrease. The reduced availability of crude fiber can increase the digestibility of a feed ingredient. This is also influenced by the use of mangroves in combination, where the more use of mangroves the digestibility of crude fiber will also decrease because the levels of lignin and tannins increase so that digestibility decreases.

While the lowest crude fiber digestibility was obtained in the D treatment with a value of 58.67%. This can happen because it has tiger native grass used in the combination, which causes its crude fiber content to be higher than other treatments. When the crude fiber is high, it will reduce the digestibility value because it is difficult to degrade in the rumen. This is following the opinion of Maynard *et al*. (2005) stated that the digestibility of crude fiber is influenced by several factors, including fiber in the feed, the composition of the crude fiber, and the activity of microorganisms.

Crude Fat Digestibility

The average fat digestibility can be seen in Table 4. It can be seen that each treatment resulted in no significantly different in crude fat digestibility. The average crude fat digestibility ranges from 58.00 to 60.85% with the highest percentage of digestibility in treatment C, while the lowest digestibility is found in D treatment.

The combination of hay mangrove leaves and native grass did not have a significant effect on crude fat digestibility. This is caused by the crude fat content of the combination which is almost the same between each treatment. Fat content in feed above 5% will affect the ability of livestock to utilize the nutrients in the feed consumed, disrupting the digestive causes diarrhea (Wina, 1992). Following the opinion of Wiseman (2002), the high digestibility of crude fat is caused by the chemical structure of fat which is easily digested. With the combination of mangrove and native grass at different ratios, each treatment did not affect the fat content of the feed ingredients.

Factors that affect the digestibility of feed ingredients include feed composition, feed treatment, frequency of feeding and drinking, and microbial digestibility in the rumen. The low digestibility of crude fat may be caused by the low number of fat-digesting microbes in the rumen.

Nitrogen Free Extract (NFE) Digestibility

In Table 5 it can be seen that in each treatment the combination of hay mangrove leaves and native grass at different ratios gave a highly significant effect (P<0.01) on the digestibility of Nitrogen Free Extract (NFE) digestibility. NFE is the largest component of organic matter, The high digestibility of organic matter will increase the digestibility of NFE. In Table 4, the highest digestibility was in the C treatment. Syahrir *et al*. (2012) stated that the higher the digestibility of feed organic matter, the higher the nutrients that can be used to meet the nutritional needs of livestock.

NFE is soluble carbohydrates including Monosaccharides, disaccharides, and polysaccharides which is easily soluble and made highly digestible (Aling *et al*., 2020). The increase in NFE content was caused by the breakdown of structural carbohydrates, especially hemicellulose into soluble materials, followed by the conversion of hemicellulose into sugar monomers and acetic acid. Sanchez (2009) the decrease in crude fiber content due to microbial activity causes an increase in the NFE content, resulting in more monosaccharides.

Table 2: Nutritional content of feed ingredients

	Perlakuan			
Nutritional composition (%)	A	B	C	D
Dry Matter	93.49^{a}	93.69^{a}	94.31^{a}	91.71^{b}
Organic Matter	90.45^{a}	91.11^{a}	90.22^{a}	90.00^{a}
Ash	9.55^{a}	8.89^{a}	9.78^{a}	10.00^{a}
Crude Protein	9.66^{a}	9.51^{a}	9.05^{a}	9.00^{a}
Crude Fat	2.83^{a}	2.64^{a}	2.57^{a}	2.26^{a}
Crude Fiber	16.75^{d}	17.61^{c}	19.47^{b}	20.54^{a}
NDF	42.39^{c}	43.52^{b}	44.83^{a}	45.16^{a}
ADF	30.26^{c}	31.81^{b}	33.25^{a}	33.71^{a}
Hemicellulose	11.45^{a}	11.58^{a}	11.72^{a}	12.14^{a}
Cellulose	22.39^{c}	23.61^{b}	24.27^{ab}	24.88^{a}
Lignin	6.51^{c}	6.82^{b}	7.03^{b}	7.39^{a}

Note*:* ^{abc}: Different superscripts on the same row show significant differences (P<0.05)

Table 3: Crude fiber digestibility

Treatments	A	B	C	D
Crude fiber digestibility (%)	58.76^{b}	59.38^{b}	61.28^{a}	58.67^{b}

Note: Different superscripts on the same row show highly significant differences (P<0.05)

Table 4: Crude fat digestibility

Treatments	A	B	C	D
Crude fat digestibility (%)	58.97^{a}	59.72^{a}	60.85^{a}	58.00^{a}

Note: Same superscripts on the same row show, no significant differences (P>0.05)

Table 5: Nitrogen Free Extract (NFE) digestibility

Treatments	A	B	C	D
Crude nitrogen free extract digestibility (%)	54.76^{b}	55.63^{b}	57.89^{a}	54.56^{b}

Note: Same superscripts on the same row show, no significant differences (P<0.05)

The decrease in crude fiber from the feed component will increase the NFE content. NFE is more easily digested by microbes and tends to be used first (Anwar, 2008). Another opinion according to Sutardi (2006) states that the NFE content of a feed ingredient is highly dependent on other components, such as water, ash, crude protein, crude fiber, and crude fat.

Conclusion

The best ratio of the combination of hay mangrove leaves and native grass based on the digestibility of crude fiber, crude fat and NFE *in-vitro* was C treatment (40% hay mangrove leaves +60% native grass). The digestibility value of each parameter was crude fiber up to 59.52%, crude fat up to 59.38%, and NFE up to 55.71%.

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Author’s Contributions

Rani Winardi Wulan Sari: Drafted the manuscript, did experimental work at the laboratory and data analysis. All the authors read and approved the final version of the manuscript.

Novirman Jamarun, Suyitman and Khasrad: Formulated the experimental design and experimental work at the laboratory. All the authors read and approved the final version of the manuscript.

Gusri Yanti: Drafted the manuscript, did experimental work at the laboratory and data analysis. All the authors read and approved the final version of the manuscript.

Ethics

This article is original and has not been published before. The corresponding author has confirmed to all authors to read and agree to the contents of this article and that no ethical issues were involved.

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