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Nutrient Value and Invitro Digestibility of Silage from Corn Forage and Indigofera Legume in Different Proportions as Nutrient Rich Feed

Dewi Ananda Mucra, Bakhendri Solfan, Anwar Efendi Harahap*, Jepri Juliantoni, Triani Adelina, Muhamad Rodiallah, Arsyadi Ali, Evi Irawati & Mestia Mulianti
Animal Science Study Program, Faculty of Agriculture and Animal Science,
State Islamic University of Sultan Syarif Kasim Riau
* Email Correspondence: harahapa258@gmail.com

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ABSTRACT. *The provision of ruminant feed is always influenced by the quality and quantity of forage because it is based on field grass, even though there are cultivated forages in the form of corn and indigofera legumes which are rich in nutrients and long-lasting. This research aims to assess the nutritional value, WSC and invitro digestibility of silage made from corn forage and indigofera legume in different proportions as ruminant feed. The research method used a completely randomized design with 5 treatments with 4 replications. The treatments are P1 = 100% corn forage silage (CFS); P2 = 100% indigofera legume silage (ILS); P3 = 75% CFS + 25% ILS; P4 = 50% CFS + 50% ILS and P5 = 75% CFS + 25% ILS. The results showed that the 100% ILS treatment produced the highest crude protein value (P<0.05), namely 18.77%. The highest NDF value (P<0.05) was in the 100% CFS treatment and the lowest was in the 100% ILS treatment (59.47% vs 42.07%). The highest IVDMD value was found in the 100% ILS treatment, 51.23%, and the lowest was in the 100% CFS treatment, 42.63%. The conclusion of this research is that 100% indigofera legume silage produces the highest crude protein, IVDMD and IVOMD values and produces the lowest crude fiber, NDF and ADF values compared to other treatments.*

Keywords: Nutrient, corn forage, legume indigofera, invitro digestibility

INTRODUCTION

Forage generally has high crude fiber and low protein so that when given to ruminants it results in production rates, especially basic living needs, and production not being met optimally. This condition means that it is not uncommon for breeders to always stimulate forage by adding various commercial concentrates from energy and protein sources, which has an impact on increasing feed production costs. Furthermore, in terms of quantity, the need for forage has not been met optimally due to poor management arrangements, especially climate management. Tropical climate conditions in Indonesia mean that forage is abundantly available in the rainy season and vice versa in the dry season. Therefore, strategies are needed to overcome these various problems, one of which is through the use of high-nutrition forage, namely corn forage (energy source) and indigofera legume (protein source). Corn forage have high energy, non-structural carbohydrates, and sufficient soluble sugar (Mandic et al., 2013; Amodu et al., 2014). Weerakkody et al., (2018) stated that corn kernels produce nutritional value, namely dry matter 36.95% - 42.345%, crude protein 7.21-7.67%, crude fiber 23.71%-25.41%, and energy 3168.75 kcal/kg - 3715.67 kcal/kg. Tantalo et al., (2019) said that the NDF and ADF content of indigofera legumes in the dry season at 55 days pruning resulted in values of 81.61% and 56.68%. Furthermore, Abdullah, (2010) said that indigofera zollingeriana contain crude protein 29.16%, crude fiber 14.02%, NFE 35.1% and TDN 75%. Ahmed et al. (2023) said that the use of high-protein legume forage is able to manipulate the rumen well so that it produces NH3 to the maximum.

It is hoped that this combination of potential forage biomass can be used as feed that is cheap, easy to obtain and able to meet the nutritional needs of livestock. However, this forage product which is a source of energy and protein apparently cannot be stored for long because it has a high air content (80-90%) so that farmers are required to always provide forage continuously which results in time inefficiency. Therefore, there is a need for sustainable breakthroughs through fermentation (silage) models for energy and protein sources so that long-lasting and highly nutritious feed is produced. Corn forage are an alternative raw material for fermentation in the form of a substrate (non-structural carbohydrate) which is considered suitable for maintaining silage stability (Hao et al., 2021).

The silage process is anaerobic fermentation which involves the work of lactic acid bacteria by reducing the pH to produce feed that lasts longer. Indicators of silage success are influenced by air content and the adequacy of water-soluble carbohydrates. The dry matter content of a material before it is silaged is a factor that plays a role in influencing the quality of silage (Balo et al. 2022). Furthermore, based on the sufficiency of water soluble carbohydrates (WSC), it is usually associated with non-structural carbohydrate components that are easily utilized as materials. Silage is an anaroeb fermentation used to conserve forage with high moisture content (Wilkinson and Muck, 2019). The novelty of the research is that the right proportion of forage between corn forage and indigofera legume sources of carbohydrates and protein as ruminant feed was found. This research aims to assess the nutritional value, WSC and invitro digestibility of silage made from corn forage and indigofera legume in different proportions as ruminant feed.

MATERIALS AND METHODS

The materials used in making silage are corn kernels, indigofera legumes, molasses (5% of the total ingredients) and corn flour (10% of the total ingredients) (Juliantoni et al., 2024). The production of corn and indigofera legume silage is carried out at the Nutrition and Feed Technology Laboratory of UIN Sultan Syarif Kasim Riau. Testing of nutrients and silage fiber components was carried out at the Animal Logistics Laboratory, Faculty of Animal Science, IPB, using Near Infrared Reflectance Spectroscopy (NIRS) analysis. Furthermore, measurements of WSC, dry matter digestibility, and organic matter were carried out at the Dairy Animal Nutrition Laboratory, Faculty of Animal Science, IPB.

Research Procedure

Stage I. Making corn and Indigofera legume silage

The process of chopping the ingredients uses a chopper with an estimated size of 3-5 cm followed by withering for 6-8 hours to reduce the moisture content of the ingredients. Next, a combination of treatments for the materials used as silage was designed with the addition of 5% molasses additives and 10% corn flour from the total ingredients as a source of sugar for the growth of lactic acid bacteria. Each corn crop silage is then mixed with indigofera legumes according to the treatment, stirred until evenly distributed, put into a vat, compacted and fermented anaerobically for 21 days.

Stage II Nutrient Testing, WSC and Invitro Silage Digestibility

The silage process takes 21 days, after the silage is cooked, the samples are dried in the sun for 2 days and then placed in an oven at 60^0C for 48 hours to determine the dry material. The samples were then ground into flour with a size of 1 mm and the nutrients, fiber fraction composition, WCS and Invitro digestibility of the silage were explained. NIRS measurements use a Buchi NIRFlex N500 Fourier Transform near infrared (FR-NIR) connected to a computer, petri dish, transflactance cover, NIRWare software. WSC measurements use the Phenol method (Singleton & Rossi, 1965). The sample was dried and ground, then 2 grams of the sample was taken and 20 mL of heated distilled water (100˚C) was added, and left for ±10 minutes. The mixture is then filtered to separate the liquid and solids. 2 ml of sample fluid was taken then put into a test tube and 0.5 mL of phenol solution was added, then homogenized using a vortex. 2.5 mL of sulfuric acid solution was added to the liquid and then vortexed, then the absorption of the sample was measured using a spectrophotometer with a wavelength of 490 mm.

In vitro digestibility Refers to the method of Tilley & Terry (1963). This method consists of two main stages, namely fermentative digestion with rumen fluid and enzymatic digestion with pepsin-HCl. A total of 0.5 g of feed sample was weighed and incubated in an environment created to resemble the rumen environment. Each stage requires an incubation time of 48 hours. At the end of the enzymatic digestion, the sample was filtered using Whatman No. filter paper 41 and stored in a porcelain cup. The filter paper and porcelain cup were then heated in an oven at 105° C for 24 hours to measure dry matter and burned in a furnace at 600° C for 4 hours for measuring organic matter.

Research Parameters

Test parameters include nutritional measurements, namely dry matter, crude protein, ether extract, crude fiber, ash, NDF and ADF, WSC, IVDMD and IVOMD

Research methods

The research used a completely randomized design with 5 treatments with 4 replications. The treatments are P1 = 100% corn forage silage (CFS); P2 = 100% indigofera legume silage (ILS); P3 = 75% CFS + 25% ILS; P4 = 50% CFS + 50% ILS and P5 = 75% CFS + 25% ILS.

Data analysis

Analyze the research data obtained using the SPSS version 20 program. If the results of the analysis vary, showing a real effect, carry out a further Duncan test.

RESULT AND DISCUSSION

Corn forage and indigofera legume are contributors of energy and protein components in feed so that the nutritional value of the silage produced is more complete. The nutritional value of silage is presented in Table 1.

Table 1. Nutrient Value of Corn Forage Silage and Indigofera Legumes (%DM)

Paramaters	Treament				
	100% CFS	100% ILS	75 % CFS + 25 % ILS	50 % CFS + 50 % ILS	25 % CFS + 75 % ILS
DM (%)	91,3 ^{a} ± 0,16	87,47 ^{d} ±0,71	90,47 ^{bc} ± 0,39	90,96 ^{ab}± 0,23	90,35 ^{c} ±0,41
CP (%)	9,01 ^{d} ± 0,26	18,77 ^{a} ± 0,42	10,89 ^{c} ± 0,27	13,25 ^{b} ± 0,11	14,53 ^{b} ±2,52
CF (%)	30,56 ^{ab} ± 0,65	25,83 ^{c} ± 0,98	29,78 ^{ab} ± 1,35	31,55 ^{a}± 0,75	28,23 ^{b} ± 1,01
EE((%)	1,44 ^{d} ± 0,08	4,29 ^{a} ± 0,29	2,58 ^{c} ± 0,24	2,71 ^{bc}± 0,24	3,02 ^{b} ± 0,28
NDF (%)	59,47 ^{a}± 0,92	42,07 ^{a} ± 1,25	52,97 ^{b} ± 2,05	49,30 ^{c}± 0,66	43,97 ^{d} ± 2,28
ADF (%)	33,54 ^{a}± 0,47	31,51 ^{b}± 1,04	33,05 ^{a} ± 1,16	33,22 ^{a} ± 0,32	30,55 ^{b} ± 1,20
Ash (%)	4,74 ^{a}± 0,53	7,93 ^{a} ± 0,36	5,92 ^{bc} ± 1,26	5,51 ^{c}± 0,48	6,72 ^{b} ± 0,67

CFS = corn forage silage ; ILS = *legume* i*ndigofera silage; CP (crude protein); CF (crude fiber)* NDF (*neutral detergen fiber*); ADF (*acid detergen fiber*); EE (*ether extract*); Different superscripts in the same column and row indicate significant differences (*p <0.05).*

The 100% CFS treatment produced the highest dry matter value (P<0.05) and the lowest was found in the 100% ILS treatment (91.3% vs 87.47%). Furthermore, the 100% ILS treatment produced the highest crude protein value (P<0.05), namely 18.77% and the lowest was found in the 100% CFS treatment, namely 9.01%. The high crude protein in ILS is caused by indigofera legumes being able to fix nitrogen from the air so that they are rich in nutrients, especially crude protein in forage. This is different from corn plantations which contain high crude fiber and low crude protein. The different nutritional conditions of forage corn and indigofera beans have a significant effect on the nutritional value of the silage produced. Adequate protein in legumes causes lactic acid bacteria to make optimal use of the material sources available in the silage process. This research's corn crop silage is higher than research by Mirsani et al. (2020) using corn crop silage with the addition of various bran, namely 11.06% crude protein and research using corn crop silage with the addition of various additives, namely 8.8% crude protein. The highest crude fiber content (P<0.05) was found in the 50% CFS + 50% ILS treatment and the same in the 100% CFS treatment, namely 31.55% and 30.56%. The next lowest treatment was the 100% ILS treatment, namely 25.83%. The dominance of the increase in crude fiber in CFS is due to the fact that corn forage have cell walls that are rich in cellulose which results in an increase in structural fiber and an increase in silage crude fiber. The crude fiber value of this research is higher than the research of Laksono & Karyono, (2020) on corn straw silage with indigofera legumes using a different starter with an average value of 20.23%-27.20%.

Crude fat measurements produced the highest value in the 100% ILS treatment and the lowest in the 75% CFS + 25% ILS treatment (4.29% vs 2.58%). The high level of crude fat in indigofera legumes is because the plant uses it to store energy. Ali et al. (2021) reported that the crude fat content of indigofera zolengeriana nuts at the pruning age of 4 months was 2.85%. This high crude fat value still has an effect on increasing the crude fat value after disilage. Furthermore, based on the ash content assessment, the highest value was found in the 100% ILS treatment and the lowest was in the 100% CFS treatment (7.93% compared to 4.74%). The high level of ash in legumes during the silage process indicates that more organic components are decomposed due to the sufficient substrate of lactic acid bacteria. This has an impact on increasing inorganic components, namely ash. The ash content of the study was lower than Rodiallah et al. (2023) using sugarcane bagasse silage and indigofera legumes producing a maximum ash content of 9.24%.

In Table 1, the results show that the highest NDF value ($P<0.05$) was found in the 100% CFS treatment and the lowest was in the 100% ILS treatment (59.47% vs 42.07%). The high NDF content in corn forage is because the stem and leaf components contain a lot of cellulose, hemicellulose and even lignin. This component is part of the NDF fraction. The NDF component of this research is lower than the research of Saidil & Fitriani (2019) using corn straw silage with the addition of a combination of mulberry with a maximum NDF value of 61.13%. This condition makes it difficult for the silage process to run optimally because lactic acid bacteria have difficulty digesting the high-fiber component. Furthermore, the highest ADF value was also found in the 100% CFS treatment, namely 33.54%. This is because during the silage process on corn plantations, lactic acid bacteria have not been effective in breaking down complex fiber components into substrates that are easily digested by livestock due to the lack of availability of energy and protein for microbial growth. The WSC components are utilized by rumen microbes in the fermentation process so that they influence the digestibility value of dry matter and organic matter. The WSC values and digestibility of corn and indigofera legume silage are presented in Table 2.

Table 2. WSC Value and Invitro Digestibility of Corn Forage Silage and Indigofera Legumes

Parameters	Treatmens				
	100% CFS	100% ILS	75 % CFS + 25 % ILS	50 % CFS + 50 % ILS	25 % CFS + 75 % ILS
WSC (%)	2,64 [a] ± 0,27	1,51[c] ± 0,01	2,17 [b] ± 0,07	2,40[ab] ± 0,11	2,35 [ab] ± 0,27
IVDMD (%)	42,63 [c] ± 1,72	51,23[a] ± 1,14	47,00[b] ± 2,69	49,48 [ab] ± 2,18	46,77 [b] ± 21,28
IVOMD (%)	40,33 [c] ± 1,81	48,81[a] ± 2,91	44,68[b] ± 3,03	48,18 [ab] ± 1,98	44,73[b] ± 1,23

CFS = corn forage silage ; ILS = *legume indigofera silage;* WSC (water soluble carbohydrat); IVDMD (*In vitro* dry matter digestibility); IVOMD (*In vitro* organic matter digestibility).

The results showed that the highest WSC value was in the 100% CFS treatment and the lowest was in the 100% ILS treatment (2.64% vs 1.51%). The high WSC in CFS is caused by corn shoots being able to store energy components, especially for vegetative growth. Usually energy stores are in the form of non-structural carbohydrates in the form of starch and WSC. This has an impact on increasing the WSC content in the CFS treatment. The high WSC in corn plantation silage is also due to the addition of corn bran and molasses. Ni et al. (2017) reported that WSC can improve silage quality due to the addition of molasses and forage rich in sugar. This WSC value turned out to be lower compared to research by Despal et al. (2017) using corn silage with a cutting age of 90 days which produced a WSC of 4.98%. Furthermore, the highest IVDMD value was in the 100% ILS treatment, namely 51.23%, and the lowest was in the 100% CFS treatment, namely 42.63%.

The high IVDMD in ILS is due to the fact that indigofera legumes have high crude protein and low crude fiber resulting in an increasing digestibility value. The availability of crude fiber is an important component to maintain rumen fermentative balance with the support of adequate protein, thus increasing digestibility, in contrast to corn plantation silage which has relatively high NDF and ADF components so this has an effect on decreasing the overall digestibility value of the feed. Rahmawati et al. (2021) reported that different IVDMD values in forage are influenced by the nutrient content and type of forage used. Likewise, with the IVOMD parameter value, it was found that the highest treatment was in the 100% SLI treatment, namely 48.81% and the lowest was in the 100% CFS treatment, namely 40.33%. The IVDMD value of this study is lower than the results of research by Antari et al. (2023) using indigofera legume which produced a rumen dry matter digestibility value of 72.6%. The IVDMD value in this study was lower than research using a combination of shorgum and indigofera legume proportions of up to 20%, namely IVDMD 57.66% (AHolik et al., 2019). The IVOMD value in this study was lower than the research of Despal et al. (2017) which used corn plant silage harvested at 90 days of cutting age to produce IVOMD value of 69.80%. The difference in the IVDMD and IVOMD may be due to the older age of the corn forage in this study compared to previous studies

CONCLUSION

100% Indigofera Legume Silage (ILS) produces higher values of crude protein, IVDMD, and IVOMD and produces the lowest values of crude fiber, NDF, and ADF compared to other treatments, so it can be recommended as superior feed for ruminants.

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