In vitro digestibility and gas production of pellet made from oil palm frond and Indigofera zollingeriana silage with different composition

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In vitro digestibility and gas production of pellet made from oil palm frond and *Indigofera zollingeriana* silage with different composition

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Abstract

This study aimed to determine the effect of the use of Indigofera foliage to enhance the feed value of oil palm fronds (OPF). In formulation on gas production and rumen fermentation characteristics were obtained in an in vitro rumen fermentation with increasing levels of Indigofera foliage mixed with OPF in the form of pellets.

Gas production and dry matter (DM) digestibility were increased with linear trends as Indigofera foliage replaced OPF over the range of zero to 100% as DM There were related improvements in ammonia and volatile fatty acid production with increasing levels of Indigofera replacing OPF.

Keywords: *in vitro digestibility, Indigofera zollingeriana, oil palm frond*

Introduction

Based on the availability of oil palm fronds (OPF) in Riau Province which is available throughout the year, it is very potential to be used as animal feed. The area of oil palm plantations in Riau Province in 2020 was 2,862,132 h (BPS 2021) and it is predicted that solid waste from fronds will be 3,623,201 tonnes (Yanti and Lestari 2020). However, the limiting factor for its use as feed is the high content of fiber fractions in the cell wall. Palm fronds contain 73% neutral detergent fiber (Puastuti et al 2015), 59% acid detergent fiber (Dahlan et al 2000), and an average lignin content of 19% (Arpinaini et al 2017). For this reason, there needs to be physical, chemical, and biological treatment to improve the nutritional quality of OPF. The main objective of the physical, chemical and biological treatment is to loosen the complex structure of lignin and disrupt the crystal structure of cellulose but minimize cellulose degradation and the formation of inhibitory compounds such as phenolics that cross-bind with hemicellulose (Rusli et al 2021). The results of the research of Dahlan et al (2000) found that physical treatment through *peletting* can increase the intake and digestibility of crude protein (CP) OPF from 41.9% to 66.4% in goats. Puastuti et al (2015) reported that chemical treatment (ammoniation) with the use of 2.5% urea can increase the *in vitro* DM digestibility of OPF from 25 to 39%.

Improving the quality of nutrients and digestibility of high-fiber feed ingredients such as OPF can also mix it with forage protein sources such as fooder trees and leguminous plants. A leguminous plant that has the potential to be used as a forage animal feed source of protein is *Indigofera sp.* Tarigan and Ginting (2011) reported that the content of CP of *Indigofera sp* was 26%. In addition, Ali et al (2014) reportred CP of *Indigofera zollingeriana* was 23.1%. Furthermore, Tarigan and Ginting (2011) reported that the increasing percentage of administration of Indigofera *sp.* from 15% to 45% in mixed forage (*B. ruziziensis* and *Indigofera sp*) for goats can increase the digestibility of DM from 50.1% to 60.1%, the digestibility of organic matter (OM) from 53.1% to 62.5% and the digestibility of CP from 61.7% to 69.9%.

Based on the results of previous studies related to physical and biological treatment (pretreatment) and the addition of legumes as a source of protein, it is expected to increase the digestibility of high-fiber feed ingredients such as OPF.

This study aims to determine the effect of the use of Indigofera biomass with OPF on gas production, in an *in vitro* fermentation of pellets made from palm frond silage and Indigofera biomass.

Materials and method

Silage making and pelleting were carried out at the Nutrition and Feed Technology Laboratory, Faculty of Agriculture and Animal Science, Universitas Islam Negeri Sultan Syarif Kasim Riau. Measurement of *in vitro* digestibility and gas production was carried out at the Dairy Nutrition Science Laboratory, Faculty of Animal Husbandry, Bogor Agricultural University. The forage used was fronds and palm leaves that grow in the city of Pekanbaru and *Indigofera zollingeriana* (Indigofera) (Photo 1) which grows in the experimental field of the Faculty of Agriculture and Animal Science, Universitas Islam Negeri Sultan Syarif Kasim Riau.

This study was designed using a complete randomized design (CRD) consisting of 5 treatments and 3 replications. The forage ingredients used as pellet formulations were oil palm fronds (OPF), and *Indigofera zollingeriana* biomass (IZ), and each treatment was added with 1.3 ml of probiotic/kg substrate. The treatment was the percentage of IZ foliage in the formulation of the pellets. The treatments were: IZ0 (100% OPF), IZ15 (85% OPF + 15% IZ30 (70% OPF + 30% IZ), IZ45+ (55% OPF + 45% IZ) and IZ100 (100% IZ foliage).

Photo 1. Oil palm frond and *Indigofera zollingeriana* foliage

Research Procedure

Preparation of research materials

The oil palm fronds (OPF) used were 2/3 of the tip of the frond tip and the *Indigofera zollingeriana* biomass (IZ) used were edible stems and leaves. OPF and IZ were chopped using a chopping machine and then dried for 1 day in direct sunlight until the moisture content reaches 50-60%.

Silage making process

Silage-making begins with weighing each ingredient according to the treatment or formulation. The two ingredients (OPF and IZ) were mixed thoroughly by flipping and stirring, then probiotics were added as a source of lactic acid bacteria at a dose of 1.3 ml for 1 kg of substrate dissolved in 1 liter of aquades. The silo used for the fermentation process (*ensilage*) in each treatment was a black plastic bag with a capacity of 10 kg. The fermentation process was carried out for 21 days.

Pellet making process

After 21 days of ensilage, the silage of each treatment was dried in the sun until the weight was constant, then ground until it was in the form of flour, then added 10% tapioca flour of the total weight of each silage flour treatment as a binder (*filler*) and The dough was made by adding enough water and molded with a *pelleting machine* (Photo 2), then dried in the sun until the weight was constant. Pellet made from OPF and IB in this research is showed in Photo 2

Photo 2. The machine for making pellets from oil palm frond and Indigofera foliage

Measurements of in vitro digestibility

The *in vitro* digestibility measurements in this study included gas production, dry matter digestibility (DMD, organic matter digestibility (OMD), pH, total volatile fatty acid (VFA), and ammonia-nitrogen (NH_3-N).

In vitro gas production was measured using 100 ml syringes equipped with pistons according to the method described by Menke and Steingass (1988). The rumen fluid was was obtained from 3 adult male goats using a stomach tube. The syringes were incubated in a *water bath* for 48 hours at a temperature of 39ºC. Gas production was recorded/read at incubation times of 0, 2, 4, 6, 8, 10, 12, 24, and 48 hours. Gas production was measured based on the Close and Menke (1986) method. DMD and OMD each pellet treatment measured based on the method of Tilley and Terry (1963). Supernatants from *in vitro* testing by the Tilley and Terry (1963) method were collected for NH_3-N and VFA total analysis. NH_3-N was measured by the Conway micro diffusion method based on the Obrink directives (1954) and the total VFA was measured by the steam distillation method.

Statistical analyses

Data from the results of the experiment were analyzed by ANOVA. If there were significant difference between treatments, they were compared using Duncan's multiple range test at a level of 5%. Response trends according to levels of Indigofera were analyzed by fitting polynomial equations to the data using Microsoft Excel software.

Results and discussion

Gas production and DM and OM digestibility increased with linnear trends as the proportion of Indigofera in the pellets was increased (Table 1; Figures 1 and 2). The increases in ammonia and in VFA reflect the associated benefits as a result of increasing the proportion of Indigofera foliage in the pellets diets (Table 2 ; Figure 3).

Table 1. Gas production total, in vitro digestibility of dry matter and organic matter of pellet made from oil palm frond and indigofera biomass silage with different composition

Treatments	GPT (ml/200 mg DM	DMDIV (%)	OMDIV (%)
IZ0	$39{,}0^{a}\pm 0{,}70$	$47{,}7^{a}\pm 0{,}30$	$46{,}9^{a}\pm 0{,}25$
IZ15	$41{,}5^{b}\pm 1{,}07$	$50{,}5^{b}\pm 0{,}46$	$50{,}0^{b}\pm 0{,}35$
IZ30	$45{,}7^{c}\pm 1{,}39$	$54{,}4^{c}\pm 0{,}49$	$53{,}5^{c}\pm 0{,}73$
IZ45	$50{,}7^{d}\pm 1{,}33$	$57{,}4^{d}\pm 0{,}88$	$56{,}4^{d}\pm 0{,}29$
IZ100	$63{,}1^{e}\pm 2{,}02$	$70{,}9^{e}\pm 2{,}31$	$70{,}2^{e}\pm 2{,}37$

Note: Means in the same column with different superscripts differ significantly (P<0.05) OPF = Pelepah kelapa sawit; IB = Biomasa Indigofera zollingeriana; GPT = Gas Production Total; DMDIV = Dry Matter Digestibility In Vitro; OMDIV = Organic Matter Digestibility In Vitro.

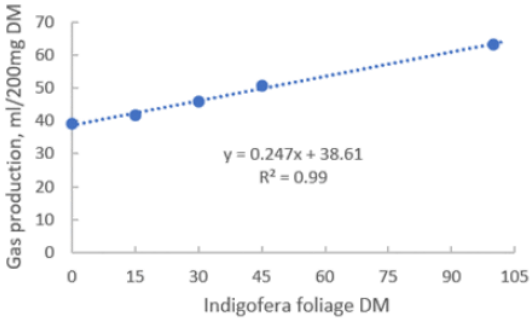

Figure 1. Effect gas production of replacing OPF whit Indigofera foliages

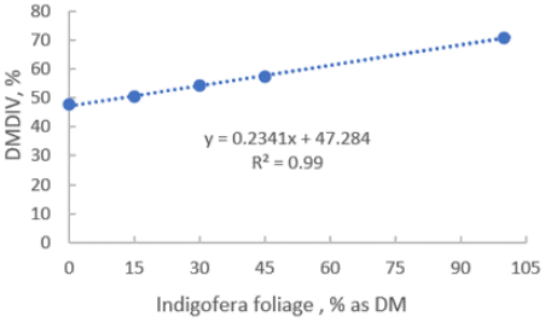

Figure 2. Effect DM digestibility, % of replacing OPF whit Indigofera foliages

Table 2. pH, ammonia-nitrogen (NH_3-N) and volatile fatty acid (VFA) of pellet made from oil palm frond and indigofera biomass silage with different composition

Treatments	pH	NH_3-N	VFA Total
IZ0	6,67	$10{,}81^{a}\pm 0{,}82$	$103{,}54^{a}\pm 7{,}43$
IZ15	6,70	$12{,}48^{b}\pm 0{,}81$	$121{,}73^{b}\pm 1{,}59$
IZ30	6,70	$14{,}21^{c}\pm 0{,}41$	$141{,}58^{c}\pm 7{,}47$
IZ45	6,53	$15{,}70^{d}\pm 0{,}22$	$147{,}50^{c}\pm 5{,}29$
IZ100	6,63	$17{,}83^{e}\pm 0{,}38$	$167{,}50^{d}\pm 6{,}68$

Note: Means in the same column with different superscripts differ significantly (P<0.05) OPF = Pelepah kelapa sawit; IB = Biomasa Indigofera zollingeriana; VFA = volatile fatty acid

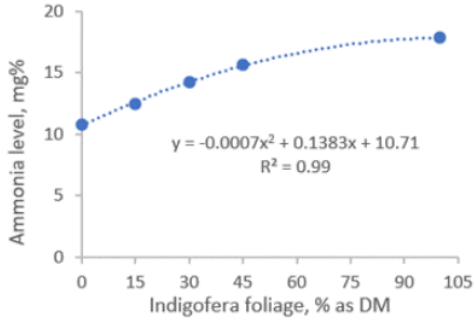

Figure 3. Effect ammonia level of replacing OPF whit Indigofera foliages

Conclusion

- Based on the data from the study, it was concluded that the use and increase of Indigofera biomass percentage in the formulation can increase the digestibility value and fermentation characteristics of pellets made from palm frond silage and Indigofera biomass.

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