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Research Paper

Effects of Tropical Legume as a Substitution of Concentrate on Nutrient Digestibility and Growth Performance of Ongole Crossbreed Cattle

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ABSTRACT
This study aims to determine the effect of different substitution of concentrate with various tropical legume species (Gliricidia sepium, Indigofera zollingeriana, and Leucaena leucocephala) in ruminant ration based on ammoniated rice straw with addition of gambir leaf waste on nutrient digestibility and growth performance in Ongole crossbred (PO) cattle. The treatments, namely, A (ammoniated rice straw 40%+ gambir leaf waste 5%+ concentrate 55%); B (ammoniated rice straw 40%+ gambir leaf waste 5%+ concentrate 35% + G. sepium 20%); C (ammoniated rice straw 40%+ gambir leaf waste 5%+ concentrate 35% + I. zollingeriana 20%); D (ammoniated rice straw 40%+ gambir leaf waste 5%+ concentrate 35% + L. leucocephala 20%). The parameters measured in this study were digestibility of dry matter (DMD), organic matter (OMD), crude protein (CPD), and average daily gain (ADG). The study design used a randomized block with 4 treatments and 4 groups. Data integration using analysis of variance and followed by Duncan multiple range test. The results showed that substitution of concentrate with legume were able to improved DMD, OMD, CPD, and ADG. The highest significant treatments (P <0.01) was C (20% I. zollingeriana). It showed that DMD (65.29%), OMD (67.17%), CPD (68.34%), and ADG (0.84 kg/day). It can be concluded that inclusion of 20% of level of I. zollingeriana as subsitution of concentrate in diet provided the highest nutrient digestibility and growth performance for PO cattle.
KEYWORDS*: Tropical legume, nutrient digestibility, average daily gain, PO cattle, concentrate substitution*

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I. INTRODUCTION

OC cattle are a type of local cattle that are mostly kept in West Sumatra. OC cattle have the advantage of good adaptation to tropical climates, high temperatures, resistance to parasites, and tolerance to feed with high fiber content (Astuti, 2004). The increase in daily body weight for OC cattle ranges from 0.3 to 0.4 kg/head/day (Astuti, 2003). The genetic potential of OC cattle on daily body weight gain ranges from 0.3 to 0.98 kg/head/day (Astuti, 2003). The availability of good quality feed ingredients is one factor in the low productivity of OC cattle. This is due to the conversion of land into industrial and residential areas. Utilization of agricultural waste is one solution that can be taken in overcoming this problem, one of which is rice straw.

Rice straw has the potential to be used as a ruminant animal feed. According to the Badan Pusat Statistik (2019), West Sumatra has a rice field area of 312,000 hectares with rice production ± 4.76 tons/ha/year and rice straw produced ± 7.14 tons/ha. The use of straw as a feed ingredient has a limiting factor in the form of high lignin and silica content, so ammonia processing is necessary. Ammoniation processing can loosen the lignin bonds with cellulose and hemicellulose. The provision of rice straw as a single one in the ration is not able to meet the needs of cattle (Sarnklong et al., 2010). Efforts that can be made are the addition of supplements and concentrates.

The use of supplements in rations aims to improve the quality of feed ingredients. Gambir leaves (*Uncaria gambir* Roxb.) are plants that have a high tannin content and are one of the export crops of West Sumatra (Daswir and Kusuma, 1993). The waste produced from the processing of gambir leaves is in the form of gambir leaf dregs and gambir leaf cooking water. Gambir leaf waste contains tannins that can potentially be used as animal feed ingredients. The addition of gambir leaf waste in the ration as much as 5% in ration shows optimal results on livestock performance (Ramaiyulis et al., 2019). The content of tannins in the waste of gambir leaves functions as a defaunation agent for rumen protozoa. The use of concentrate in the ration has the advantage of having a high nutritional content, but a decrease in the availability of concentrate leads to higher prices. So that breeders find it difficult to obtain quality concentrate. The solution that can be done is to substitute legume.

Legume has advantage of high nutritional content. Utilization of legume that is too high can interfere with the digestive process and cause health problems in livestock. The use of legume in cow rations is a maximum of 40% in rations (Mayasari et al., 2012). Legumes that have potential as feed for ruminants include *Gliricidia sepium*, *Indigofera zollingeriana*, and *Leucaena leucocephala*. The nutritional content of *G. sepium* is 25.7% crude protein and 91.6% organic matter (Mayasari et al., 2012). According to the Food Security Agency of West Sumatra Province (2015), the potential for *G.sepium* with a production interval of 3 months of cutting is 8-11 tons of DM/ha/year. *I. zollingeriana* is nutritional content is Crude protein, ranging from 23.66 to 31.1% (Suharlina, 2010) and organic matter of 89.12% (Putri et al., 2019). Abdullah and Suharlina (2010) stated that the *I. zollingeriana* plant had a total production of 51 tonnes DM/ha/year. The nutritional content of *L. leucocephala* is 25.9% crude protein (Devi et al., 2013) and 90.11% organic matter (Putri et al., 2019). *L. leucocephala* plants have a total production of 20 tonnes of DM/ha/ year (Dilaga et al., 2016). Concentrate substitution with various types of legume in the basal ration of ammoniated rice straw is expected to improve nutrient digestibility and performance of OC cattle.

II. MATERIALS AND METHODS

Research materials

This study used male OC cattle aged 18-24 months and weighing 137.00 – 157.00 kg. The rations in this study carried out concentrate substitution with legume by 20%. The composition and nutritional content of the concentrate provided consisted of rice bran, palm kernel meal, tofu waste, and minerals can be seen in table 1. The nutritional content of tropical legume can be seen in Table 2. The composition and nutritional content of the ration can be seen in Table 3. The equipment used in the study included individual cow sheds of 1.5 × 1.0 meter/head, cattle scales, feed scales, a set pens, and laboratory equipment for digestibility analysis.

Experimental design

This study used an experimental method with a randomized block design with 4 treatments and 4 groups. Each treatment used ammoniated rice straw (40% DM) and gambir leaf waste (5% DM), then the concentrate was substituted with a legume species. These treatments are as follows:
A = 55% concentrate
B = concentrate 35% + *G. sepium* 20%
C = concentrate 35% + *I. zollingeriana* 20%
D = concentrate 35% + *L. leucocephala* 20%

Animal preparation

The procedure for making ammonia rice straw begins with the preparation of rice straw, urea, and plastic cover. The amount of urea used is 4% of the dry matter of rice straw waste (40 grams of urea are dissolved in 1 liter of water for 1 kg of dry matter of rice straw waste). Furthermore, rice straw waste is piled on top of a plastic tarpaulin measuring 4×5 m^2 with a thickness of ±20 cm, then sprayed with urea solution and followed by the next pile. The straw that has been piled up and sprayed with urea solution is covered with a tarp so that it can reach anaerobic conditions. the ammonia process lasts for ±3 weeks. Then the ammonia rice straw is ready for use. Giving the waste from gambirr leaves and legume dry and then mashed. Feeding is calculated based on needs, 3% dry matter of body weight. The preparation of livestock includes health checks, initial weighing (for the purpose of group randomization), and administration of antiparasitic drugs. The anti-parasitic drug used is Wormectin® (dehydroavermectin B12) at a dose of 1 ml/100 kg bodyweight. The research implementation in the cage was divided into 3 periods, namely, adaptation period, preliminary period, and sample collection period. Weighing the body weight is carried out every week.

Feed consumption, digestibility, and average daily gain

The variables observed in this study were the feed consumption and digestibility of dry matter (%), organic matter (%), crude protein (%), and average daily gain (kg/head/day).

The determination of the value of nutritional consumption is seen from the consumption of dry matter, organic matter, and crude protein. Feed consumption is calculated by reducing the feed provided with leftover feed, with the following equation:

Feed consumption (kg/ head/ day) = (feed - residue)/feed × % DM ×% nutrition

In collection period, feces for one day are collected and homogenized. Furthermore, 10% of the total feces was taken and dried at 60C. Then feces are crushed for laboratory analysis. Dry matter (DM), organic matter (BO), and crude protein (PK) were analyzed using standard methods (AOAC, 1990). Nutritional digestibility is calculated by subtracting nutrients consumed by nutrients in feces, with the following equation:

Feed digestibility = (nutrients consumed - faecal nutrients)/nutrients consumed × 100%

The animal productivity measured in this study is average daily gain (ADG). ADG is calculated by subtracting the final body weight from the initial body weight, with the following formula:

ADG = (final body weight - initial body weight)/maintenance time

Data analysis

The data analysis used was analysis of variance (ANOVA) and was further tested with Duncan Multiple Range Test (DMRT) method to identify the effect between treatments (Steel and Torrie, 1995).

III. RESULTS AND DISCUSSION

Effect of treatment on nutritional consumption, digestibility and performance

The average nutritional digestibility and performance of OC cattle from concentrate substitution with legume can be seen in Table 3. Based on the analysis of variance, it showed that the substitution of the concentrate with legumes in the basal ration of ammoniated rice straw had a very significant effect (P <0.01) on the nutritional digestibility of OC cattle. The average digestibility of dry matter, organic matter, and crude protein can be seen in Table 3. DMRT test results of the nutrient digestibility showed that treatment A was very significantly different (P <0.01) from treatments B, C, and D. Treatment B was significantly different (P <0.05) from treatment C and not significantly different (P >0.05) with treatment D. Treatment C was not significantly different (P >0.05) with treatment D.

Based on ANOVA, it showed that the substitution of concentrate with legumes in the basal ration of ammoniated rice straw had a very significant effect (P <0.01) on the performance of OC cattle. The average daily body weight gain can be seen in Table 3. The average daily body weight gain ranged from 0.46 to 0.84 kg/head/day. DMRT further test results from daily body weight gain showed that treatment A was very significantly different (P <0.01) from treatment B, C, and D. Treatment B was significantly different (P <0.01) from treatment C and D. Treatment C not significantly different (P >0.05) with D.

The different results are not in fact the consumption of dry matter which does not indicate that the ability to consume the ration is relatively the same in each treatment. This is an indicator that the ration treatment given provides the same palatability for OC cattle. In addition, in normal conditions the consumption of dry matter has a positive license to the rate of stomach emptying, the faster the rate of stomach emptying, the better the digestibility. the increase in the dry matter digestibility value of the ration in the digestive tract leads to faster emptying of the digestive tract so that livestock can consume more rations and livestock productivity will be better (Tillman, 2005). Another factor that was thought to cause the treatment ration consumption was not significantly different was that the energy content (TDN) in each treatment was relatively the same, namely in the range of 65.16 - 66.62%. Ration consumption has an interaction with energy fulfillment in livestock. The statement according to Van Soest (2006) states that the energy content of the ration has an effect on feed consumption. Coleman and Moore (2003) states that the regulation is an interaction between feed, digestive tract and livestock.

The different results are not in fact the consumption of organic matter which does not indicate that the ability to consume the ration is relatively the same in each treatment. The average comsumption of organic matter ranged from 3,95 - 4,18 kg/head/day Concentrate substitution with I. zollingeriana showed the highest yield of all treatments. Consumption of organic matter has a correlation with increasing dry matter consumption. This is because organic matter is the material contained in dry matter. The results obtained are in accordance with the research of Febrina et al. (2017) consumption of organic matter will increase if dry matter consumption increases. NRC (1989) states that the ability to consume organic materials for beef cattle ranges from 2.5 - 3.0 % of body weight. Murni et al. (2012) consumption of organic matter in livestock is influenced by several factors, including body weight, age of livestock, quality of feed, level of feed digestibility and level of animal palatability of feed ingredients.

The average dry matter digestibility value of the treatment ration ranged from 61.64 to 65.29%. Concentrate substitution with I. zollingeriana showed the highest digestibility results from all treatments although it was not significantly different from the use of L. leucocephala. This is an indicator that the dry matter digestibility value of the concentrate substitution with I. zollingeriana has a positive effect in increasing the dry matter digestibility. The increase in the dry matter digestibility value of the concentrate substitution with legume was caused by the growth of amylolytic and cellulolytic bacteria so that the feed ingredients could be utilized more optimally. Research conducted by Anantasock et al. (2013) reported that the addition of tannins in the ration was able to increase the population of amylolytic and cellulolytic bacteria in the rumen. In addition, the optimal administration of tannins in the ration functions to defaunation of protozoa so that the digestibility of dry matter will increase. In accordance with the opinion of Ningrat et al. (2017) stated that tannin supplementation in the ration can improve the digestibility of feed nutrients.

The average digestibility value of organic matter from the treatment rations ranged from 62.43 to 67.17%. Concentrate substitution with I. zollingeriana showed the highest yield of all treatments. The results obtained in this study have a correlation with dry matter digestibility, the value of organic matter digestibility increases with increasing dry matter digestibility. This is because the dry matter content in the ration consists mostly of organic matter. The results obtained are in accordance with the research of Tillman et al. (2005) which states that the digestibility of organic matter and dry matter is related to each other, dry matter is composed of two chemicals, namely organic and inorganic materials. The increase in the digestibility value of dry matter has a correlation with the increase in the digestibility value of organic matter (Muhtarudin and Liman, 2006).

The digestibility value of organic matter is an indicator of the digestibility value of feed provided and used by livestock to meet basic living needs and production needs. Harahap et al. (2018) stated that the digestibility of organic matter has a positive correlation with the rate of fermentation that occurs in the digestive tract. The fiber content in plant-derived feed is found in the part of the plant cell wall which consists of structural carbohydrates and lignin. Lignin has glucosic bonds with structural carbohydrates. Lignin is a feed ingredient that is difficult to digest by rumen microbes. Zain et al. (2019) stated that lignin binds to cellulose and hemicellulose which cannot be digested by enzymes produced by rumen microbes. This will have an impact on the low digestibility value of the feed.

The mean value of crude protein digestibility of the treatment rations ranged from 64.50 to 68.34%. Concentrate substitution with I. zollingeriana showed the highest yield of all treatments although it was not significantly different from the use of L. leucocephala. The value of crude protein digestibility obtained shows the correlation between the digestibility of organic matter. The increase in crude protein digestibility is thought to be caused by differences in crude protein content in the treatment rations. This is consistent with Tillamn et al. (2005) stated that the protein content of the ration consumed by livestock will affect the digestibility of crude protein. The content of tannins in the ration will have several phenolic hydroxyl groups which can become complex compounds by binding to proteins (Mueller-harvey, 2006). So this will be a limiting factor of the digestibility value of crude protein by proteolytic bacteria in the rumen and has a positive role in increasing protein bypass for further digestion. The high digestibility value of crude protein in the ration is an indicator of the development of proteolytic bacteria, such as Streptococcus bovis, Butyrivibrio fibrisolvens, and Provetella bryantii (Jayanegara et al., 2014). Tannins are compounds that can protect protein from rumen microbial degradation (Jayanegara, 2015). Frutos et al. (2004) stated that condensed tannins had a positive impact on increasing the digestibility value of the nutritional components of the ration and would have a negative impact if given with levels above 4% DM in the ration.

The average daily body weight gain can be seen in Table 3. The average daily body weight gain ranged from 0.46 to 0.84 kg/head/day Concentrate substitution with I. zollingeriana showed the highest yield of all treatments. Daily body weight gain is in line with the increase in digestibility of feed nutrients. This is an indicator in determining the quality of feed that can be used by livestock for production. The increase in daily body weight of livestock is influenced by the quality and quantity of feed consumed. Pazla et al. (2018) states that the nutritional digestibility of ration shows the quality of the ration, the higher the digestibility value of a ration shows that ration is of better quality for consumption and is used for the body's metabolic processes. The energy source of the ration affects the performance of animals, the main energy source for ruminants is volatile fatty acids.

IV. CONCLUSION

Concentrate substitution using *I. zollingeriana* of 20% in ammoniated rice straw-based rations showed the highest yield of the tested parameters. The dry matter digestibility value was 65.29%, organic matter 67.17%, crude protein 68.34%, and daily body weight gain 0.84 kg/head/day.

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Table 1. Composition and nutritional content of the concentrate (%)

Ingredients	Composition
Rice bran	39,00
Palm kernel meal	50,00
Tofu waste	9,00
Mineral	2,00
Total	100
Nutritional content	
Dry matter	80,96
Organic matter	87,37
Crude protein	16,24
Crude fiber	17,01
Crude fat	7,69

BETN	36,25
TDN	68,36
NDF	63,05
ADF	41,31
Cellulose	22,85
Lignin	11,95

Table 2. The nutritional content of tropical legume

Nutritional content	tropical legume		
	G.sepium	*I.zollingeriana*	*L.leucochepala*
Dry matter	86,71	86,98	87,36
Organic matter	90,93	90,57	91,44
Crude protein	24,20	25,29	25,35
Crude fiber	13,09	9,95	15,24
Crude fat	3,96	3,64	4,80
BETN	36,39	40,51	33,41
TDN	70,00	76,00	75,00
NDF	35,73	21,91	31,63
ADF	22,47	20,78	23,39
Cellulose	6,68	6,09	14,85
Lignin	7,24	4,32	9,14

Table 3. Composition and nutritional content of the ration diet

Ingredients (%)	**Treatment**			
	A	**B**	**C**	**D**
Ammoniated rice straw	40	40	40	40
Concentrate	55	35	35	35
Gambir leaf waste	5	5	5	5
G.sepium	0	20	0	0
I.zollingeriana	0	0	20	0
L.leucochepala	0	0	0	20
Total	100	100	100	100
Nutrional content (% DM)				
Dry matter	73,53	74,68	74,73	74,81
Organic matter	86,92	87,64	87,93	87,74
Crude protein	12,93	14,52	14,74	14,75
Crude fiber	26,58	25,80	25,17	25,63
Crude fat	4,46	3,71	3,65	3,88
BETN	20,91	20,94	21,76	20,94
TDN	65,17	65,42	66,62	66,42
NDF	67,53	62,07	59,30	61,25
ADF	49,49	45,72	42,90	45,90
Cellulose	22,05	18,82	18,70	20,45
Lignin	12,97	12,43	10,90	12,41
Tannin	0,97	1,01	1,24	1,28

Table 3. Average nutritional digestibility and performance of PO cattle from each treatment

Parameter	**Treatment**				**SEM**
	A	**B**	**C**	**D**	
DMI (kg/ head/ day)	4,55	4,65	4,78	4,69	0,01

DMI (kg/ % Body Weight)	2,97	2,97	2,97	2,96	0,01
OMI (kg/ head/ day)	3,95	4,10	4,18	4,14	0,10
OMI (kg/ % Body Weight)	2,74	2,62	2,63	2,62	0,10
CPI (kg/ head/ day)	0,59 [a]	0,68 [b]	0,70 [b]	0,69 [b]	0,02
Dry matter digestibility (%)	61,64[a]	63,98[b]	65,29[c]	64,60[bc]	0,28
Organic matter digestibility (%)	62,43[a]	64,81[b]	67,17[c]	65,93[bc]	0,40
Crude protein digestibility (%)	64,50[a]	66,09[b]	68,34[c]	67,27[bc]	0,52
average daily gain (kg/head/day)	0,46[a]	0,59[b]	0,84[c]	0,75[c]	0,03

A (40% ammonia rice straw + 5% gambier leaf waste + 55% concentrate); B (40% ammoniated rice straw + 5% gambier leaf waste + 35% concentrate + *G. sepium* 20%); C (40% ammoniated rice straw + 5% gambier leaf waste + 35% concentrate + *I. zollingeriana* 20%); D (40% ammonia rice straw + 5% gambier leaf waste + 35% concentrate + *L. leucocephala* 20%). different superscripts in different columns showed a very significant effect (P <0.01).

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