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The Digestibility, Degradation and Index Value of Four Local Feeds for Goat

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Abstract: The objective of this paper was to examine the feed digestibility, rumen degradation and the index value of four types of local feed for goat. The feeds studied were T1 = elephant grass, T2 = field grass, T3 = kolonjono grass and T4 = mango leaves. The rumen degradation were measured using *in sacco* technique while the consumption and digestibility were measured using *in vivo* methods. The index value of the feed was determined using the Ørskov and Ryle method. Results from *in sacco* indicated that rumen degradation characteristics of elephant grass and kolonjono grasses were higher ($P < 0.05$) than that of field grass and mango leaves. The results of *in vivo* study showed that kolonjono grasses had a higher ($P<0.05$) feed consumption compared to that of three other feeds. The feed digestibility of mango leaves was lowest compared to the other grasses. The calculated index values of elephant, field and kolonjono grasses and mango leaves were 27.4, 48.13, 69.92 and 39.07, respectively. The overall result of this study confirmed that kolonjono grass tend to have a higher value of rumen degradation, feed digestibility and feed index value. It is concluded that the kolonjono grass was the most readily degradable feed in the rumen of goat compared to the other three types of local feeds.

Key words: Local feed · Consumption · Digestibility · Degradation characteristics · Index value · *Iin sacco* · *In vivo*

INTRODUCTION

The main problems in the local feed for ruminant are their relatively low nutrition with varying physical properties due to the different structural carbohydrate content in the plant cell wall. As a result, there is a different set of responses particularly in the form of livestock consumption, digestibility and rumen degradation on each type of feed. Physical properties of feed are intimately associated with plant cell wall components, which in turn will affect the level of consumption and feed digestibility [1]. The other factors that greatly affect the digestibility and rumen degradation are pH, type and amount of rumen microbial populations [2].

Therefore, the knowledge of degradation in the rumen is very important because the rate of degradation level can give an idea of ??how the quality of individual feed is reflected. This can be indicated through the rapid soluble feed fraction, potential degradable fraction of feed and the rate of feed degradation. Information of rumen degradation can be a good prediction of intake and digestibility *in vivo* [3]. Based on consumption, digestibility and rumen degradation information, the basis to determine the index value of feeds can be easily obtained [4]. The Index value describes a single value of each type of feed based on the rate of consumption, digestibility and rumen degradation. Index value of feed research have been carried out by Orskov and Ryle method in London, England but the application of the

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value of the index does not provide the precise information. This is due to the differences in the prevailing conditions, type of feed and livestock to Indonesia [4, 5]. In order to obtain reliable data and information on the quality of local feeds, the prevailing natural conditions and the type of feed must be taken into consideration. Thus, objective of this study was to examine the feed digestibility, rumen degradation and the index value of local feeds for goat.

MATERIALS AND METHODS

Materials: This research was divided in two stages: (1) observation of the feed digestibility and characteristics degradation in the rumen by *in sacco* method and (2) observation of feed consumption and feed digestibility by *in vivo* method. Local feed were used in this study namely elephant, field and kolonjono grasses and mango leaves. The four goats weighed about 24 kg each and were reared in individual cages. Nutrient content and fractions of forage fiber used in the study can be seen in Table 1.

Methods: The *in sacco* technique used a randomized block design where a long period of incubation in the rumen fistula as a group was performed with four local feed treatments and four replications. Examining digestibility *in sacco* is a method that describes the digestibility of a feed material according to residual dry matter in the bag after incubated in rumen. While *in vivo* observations used a Latin Square Design [6] which consists of four observation periods using four goats and four local feed treatments. Feed samples were placed in nylon bags made of polyester fabric of size 6.5 x 5.5 cm^2 with a porosity of 40 µm. Each feed type were coded respectively, namely elephant grass (T1), field grass (T2), kolonjono grass (T3) and mango leaves (T4). The samples in bags were then soaked with warm water at a temperature of 39°C for one minute. After, the nylon bags containing feed samples were inserted into the rumen fistula and each were incubated for 8, 12, 24, 48, 72 and 96 hours. After the incubation period, the sample bags were removed from the rumen fistula and then washed with running water for five minutes up to translucent. They were later washed and cleaned to eliminate wood particles and the rumen fluid with microbes attached to the sample bags. The samples were dried in an oven at a temperature of 105°C for 24 hours and then weighed to obtain the dry matters missing values. Based on the data, rumen degradation using a *Neway* Program was then determined using the curve exponential equation approach described as follows [4, 7]:

$$Y = a + b\,(1 - e^{(-ct)})$$

Where,

Y = Feed degradation by rumen microbes at time t (incubation time)
a = Fraction of soluble
b = Potentially degradable fraction
c = Rate of degradation of feed
a + b = Potential degradation, including material that escaped from the bag without degradation.

Table 1: Nutrient composition and fiber fractions of local feeds

	Local feeds			
Nutrient composition	Elephant grass	Field grass	Kolonjono grass	Mango leaves
Dry matter	20.55	25.84	37.27	18.41
Crude protein	14.66	7.32	9.44	9.39
Crude fibre	31.94	31.96	34.33	30.16
Fat	4.02	2.25	2.70	2.86
Ash	13.38	8.33	11.27	7.01
BETN	36.00	50.14	42.27	50.13
NDF	69.88	74.63	78.81	48.63
ADF	37.47	44.37	45.31	37.88
Hemicelluloses	33.42	30.26	30.51	10.76
Cellulose	38.72	35.88	32.13	25.98
Lignin	5.74	7.06	5.20	11.31

Description: BETN: material extracts non nitrogen
NDF: neutral detergent fibre
ADF: acid detergent fibre

In the *in Vivo* method, the feed diet for the goats was given as much as 2% of dry matter [8] with drinking water added as *libitum*. Feed sample collection was done every day by taking 10% of the amount given to the cattle. The feed samples taken from the feed stock during the observation period were randomized and subsequently mixed with 10% dry matter for further analysis. As much as 10% of the remaining feed was collected during the observation period. Subsequently, the collected residual feed was mixed and drawn at 10% random for dry matter analysis. Level of consumption (g dry matter/day) was calculated based on the difference of total dry matter feed given 24 hours to residual dry matter feeds.

All the goats' feces were weighed for 24 hours but only 10% of the feces were collected during the observation period. At the end of observation the collected feces were mixed and drawn at random by 10% to analyze the amount of dry feces. Feed digestibility in vivo is examined using the following formula:

$$\text{Digestibility} = \frac{\text{S NK-SNF}}{\text{SNK}}\% \times 100\%$$

Where,
ΣNK is the number of feed dry matter consumed
ΣNF is the amount of fecal dry matter issued

The data obtained in the form of feed consumption and digestibility was analyzed statistically using variance analysis [9].

RESULTS AND DISCUSSION

Feed Digestibility *in Sacco*: The kinetics of feed loss during the incubation period is assumed to the level of feed digestibility. The mean dry feed digestibility *in sacco* after an incubation period of 8 to 96 hours ranges from 20% - 56%. Feed digestibility *in sacco* was found to be highest in elephant grass (56%), followed by kolonjono grass (55%), field grass (53%) and mango leaves (52%).

Figure 1 showed that an incubation period of 72 hours in the rumen gave a 56% rate of feed digestibility of elephant grass and slowly decreases after a 96-hour stretch of incubation. The results obtained are equivalent to a native Australian shrubs where an optimal time to feed degradation in the rumen took a long 72-hour incubation period [10]. This result contradicted with another report where the incubation period of 23 hours showed the highest dry matter loss and decreased as the incubation period increased. Decrease in feed digestibility with increasing incubation time was probably due to the feed substrate which was reduced as a result of rumen microbial activity. According to [12], incubation interval 12, 24, 48 and 72 hours is the most suitable time interval for fibrous feed. Similarly, it has been suggested that the

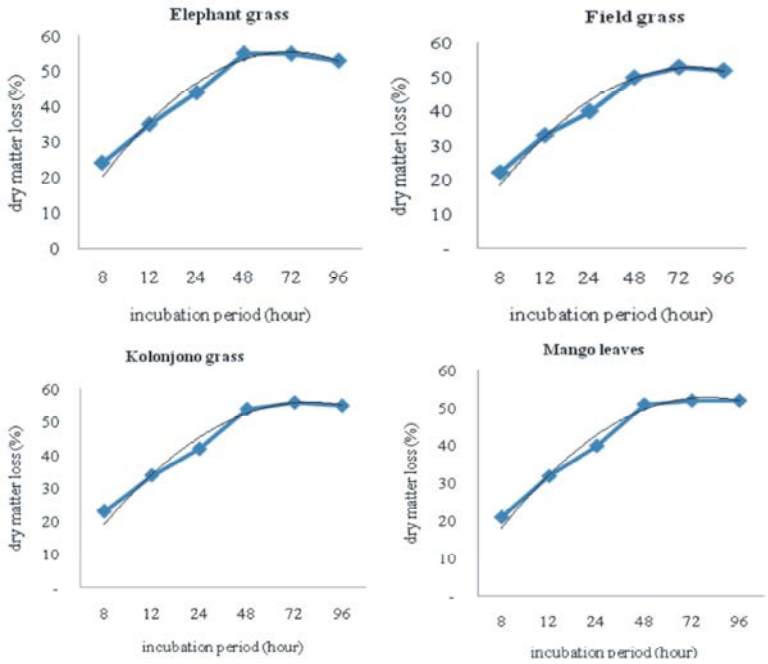

Fig. 1: Kinetics of dry matter digestibility levels in each type of local feed

Table 2: Characteristics degradation in the rumen of local feed

	Characteristics Degradation					
Types of Local Feed	a (%)	b (%)	c (%)	a+b (%)	Lag time (hr)	So (%)
Elephant grass	15.44	41.19	0.06	56.65	2.79	15.44
Field grass	12.79	40.28	0.07	53.07	4.05	12.79
Kolonjono grass	14.09	40.49	0.06	54.50	3.70	14.01
Mango leaves	12.96	38.82	0.07	52.78	4.10	13.96

period of incubation in the rumen for fibrous feed was 48-72 hours [13]. This is quite reasonable that the time span may provide an opportunity for rumen microbes to make contact between the substrate feeds and rumen microbial enzymes [14].

Based on statistical analysis of the incubation period, there was no significant difference (P> 0.05), between the old 48 and 96 hours of incubation period on feed digestibility, but highly significant (P <0.01) in the incubation period of 72 hours. It is confirmed that the incubation period of 72 hours is optimal for rumen microbes to make contact and the substrate were incubated in goat's rumen [15]. The fourth type of local feeds gave similar patterns in terms of feed digestibility, despite the different speed digestibility. Statistical analysis of the types of local feed shows that there was no significant difference (P> 0.05) between elephant grass and kolonjono grass to feed digestibility, however, it shows a highly significant difference (P <0.01) in the field grass and mango leaves. The level of feed digestibility was influenced by the nutritional composition of each raw species feed mainly crude protein content [16].

Rumen Degradation Characteristics: Rumen degradation characteristics of feed which is reflected through the feed can be easily in the form of a degraded fraction. The rate of degradation and fraction of feed loss from the rumen is the amount of feed material degraded by microbes and particles soluble material in the rumen [17].

The rumen degradation characteristics of local feed vary from one to another. Table 2 shows that the value of feed-soluble fraction is highest in the elephant grasses (15.44%), followed by kolonjono grass (14:09%), mango leaves (12.96) and field grass (12.79%). This is due to the content of the feed's nutritional composition such as starch, protein, fat and minerals which are easily digested and readily soluble. The soluble fraction is usually determined by the washing process which greatly affects the loss of particles due to the feed components which is easily soluble in water as a result of the washing and the presence of microbes in the bag during incubation. The presence of microbes in the rumen during the incubation process will affect the level of feed digestibility *in sacco* [18]. The soluble fraction of feed tends to increase when the porosity of the nylon bag is greater than 40 µm [19].

The soluble fractions that might be degraded, namely "b" and "a + b" follow similar pattern of soluble fraction in "a" with the rate of degradation on elephant and kolonjono grass is 0.06/hour while field grass and mango leaves is 0.07/hour. The rate of degradation on elephant and kolonjono grasses illustrated that both types of local feeds are more easily degraded by rumen microbes. The rate of degradation is strongly influenced by the composition of cell contents [20, 21]. It was easily digested and quickly dissolved as starch and protein. Quality diets of different protein showed that a high protein feed degraded faster than low protein feed [22]. On the other hand, the high lag time was evident in mango leaves (4.1 hours) followed by field grass (4:05 hours), elephant grass (2.79 hours) and kolonjono grass (2.6 hours). The higher lag time in mango leaves and field grass indicated the longer time for the rumen microbial activities to feed adaptation. The low lag time on elephant grass and kolonjono grass reflect that the time needed by the rumen microbes to adapt toward the presence of both feed types is shorter and able to degrade and ferment the feed in the rumen. This implied that the elephant grass and kolonjono grasses are more quickly degraded by rumen microbes. There are similarities between the values of easily degradable feed fraction "a" and the value of the water solubility "So". When a feed material is degraded at 0 hour, the feed material has not been affected by the rumen microbes. In essence, the value of water solubility (So) may reflect the rate of feed degradation in the rumen. The more soluble fraction of feed, the faster the feed is degraded by rumen microbes [23].

Feed Consumption and Digestibility Levels *in vivo*: Feed consumption can be used as an indicator of the diet's palatability. The level of feed intake and digestibility illustrates the animal's interest to a certain type of feed. The consumption of feed can be defined as

Table 3: The average feed consumption and feed digestibility *in vivo*

	Type of Local Feed			
Parameter	Elephant grass	Field grass	Kolonjono grass	Mango leaves
Feed consumption (g /day)	282[a]	291[a]	469[b]	238[c]
Feed digestibility (%)	57[a]	55[a]	55[a]	51[b]

Note: [a,b]Means followed by different superscript at similar row were significant difference (P <0.05).

Table 4: Correlation of consumption, digestibility, characteristics degradation and index value

Parameter	Regression Equation	Index Value
	Feed consumption	
Elephant grass	Y = 129.43 + 9.89a + 0.11b - 124.87c	27.14
Field grass	Y = 236.43 + 15.66a + 5.61b + 1300 c	48.13
Kolonjono grass	Y = 414.71 - 9.57a + 3.59b + 665.79c	69.92
Mango leaves	Y = 201.28 + 1.44a + 0.361b + 34.806c	39.07
	Feed digestibility	
Elephant grass	Y = 40.53 + 1.02a + 0.076b – 38.75	55.98
Field grass	Y = 30.05 + 1.28a + 0.032b + 104.60c	42.95
Kolonjono grass	Y = 34.18 + 1.05a – 0.017b + 104.43c	57.91
Mango leaves	Y = 48.15 – 0.71a + 0.277 + 24.12455.98	51.60

the amount of mass that is taken by the animal feed as a result of the palatable taste of the feed. Palatable taste itself gives an indication of the nutritional quality of a food where the higher protein content of nutrients will increase feed palatability. Table 3 shows that the rate of feed consumption on each different types of feed. The average consumption in these experiments ranged from 238 g/day (mango leaves) to 469 g/day (kolonjono grass). Feed consumption was lower than the reported feed consumption of 500 – 550 g/day [24]. The difference level of feed consumption is highly influenced by the location, species and the structure of the xylem cells in each feed. There is a significant difference (P> 0.05) between the levels of feed consumption in kolonjono grass than the other three types of forage grasses. The high levels of kolonjono grass consumption are probably due to the higher protein content which was positively related to dry matter intake of feed [25]. High crude protein content can affect palatability sensation so as to improve the feed consumption of goats. In fact, kolonjono grass is a type of forage that is highly palatable to goat due to its softer texture with smaller size of stems and leaves to fit the size and capacity of the digestive organs of goats [26].

Feed digestibility describes the ability of livestock in digesting and absorbing nutrients contained in the feed material. The average level of feed digestibility in this study was 51-57%. The digestibility level of crude fiber for the proper maintenance of ruminants was 55-65% [27]. Statistic analysis showed that there were no significant differences (P> 0.05) in the level of feed digestibility among the elephant grass, field grass and kolonjono grass. However, the three types of feed grasses differ significantly (P <0.05) to mango leaves. The low level digestibility of mango leaves was suspected to be strongly influenced by the composition of nutrients and fiber content of the fraction of each type of forage. Mango leaves have a high lignin content compared with the other three types of feed. Lignin is a compound that is difficult to be penetrated by a microbial enzyme that would inhibit the digestibility of the cell xylem membrane and subsequent cell contents with low organic matter digestibility. Lignin is a component that is not digested, thus affecting the digestibility of crude fiber [28].

Index Value of Feed: The feed index value was based on the regression equation between feed value intake and digestibility of rumen degradation characteristics. The feed index is a single value of each type of forage in soluble fraction “a”, degradable feed fraction “b” and speed degradation rate “c” as shown in Table 4.

Kolonjono grass shows the highest index compared to the other three types of feeds implying that the quality of the kolonjono grass allows goats to consume better and sufficient feed for their basic consumption maintenance. The index value for the kolonjono grass was higher compared to the reported index of 4.06 [29]. In order to consume a sufficient feed, a minimum index of 35.5 is required to by young cattle [30]. Based on the different genetic potential, an index value is very useful in formulating optimal nutritional feed ratios for goats and other animals.

CONCLUSION

Based on the level of feed consumption, digestibility and rumen degradation and feed index, Kolonjono grass is the best feed for goats. This is due to its faster degradation rate by the rumen microbes. Future studies should focus on the rumen degradability of dry matter and crude protein in other potential nutritious tree leaves and crop residues available in Sulawesi.

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