

Degradability of Concentrate in Goats

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Three (3) female rumen-cannulated goats, weighing 27.33 ± 1.53 kg, were housed in individual elevated metabolism stalls, used to evaluate the ruminal degradability of concentrate, using a nylon bag technique with respect to incubation time. The study utilised concentrate composed of rice bran, 35%; corn grits, 14%; copra meal, 34%; soybean oil meal, 5%; molasses, 10%; salt, 1%; and monocalcium phosphate, 1%, with ad libitum feeding of Napier grass. Drinking water was available at all times. Approximately, 3.0 to 5.0 g of feed concentrates was weighed into nylon bags (between 20-40 μ pore size). The nylon bags (total of 48) were labelled accordingly. These were incubated ruminally at 0, 3, 6, 9, 12, 24, 36 and 48 hour exposures to determine the percentage (%) of ruminal degradability of dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) of the formulated concentrate. The results showed that degradability of the dry matter (DM) content of the concentrate was found to be 82.30% at 48 hours of incubation. The 68% potentially degradable fraction has a rate of degradation (disappearance) of 49%. It was also observed that the percentage degradability (% loss) of DM was noticed exponentially on the first twelve hours of incubation and then slowed down until it reached 48 hours. However, the crude protein (CP) degradability resulted at 78.50% of the 15.30% CP content of the concentrate, a 12% breakdown of protein components after 48 hours of incubation. The digestibility of crude fibres based on NDF and ADF were calculated at 75.72% and 70.47%, respectively, i.e. approximately, 31.5% degradability of NDF and 9.5% of ADF (crude fibre contents) after 48 hours. The data gathered have demonstrated significant differences in the rate of degradability of DM, CP, NDF and ADF of the concentrate fed to goats. This simple, easy and basic technique could also be applied to other animal species in pursuit of finding ways to formulate indigenous feedstuff materials that have potential nutritive values. Given the limitations such as the climatic and environmental constraints, this particular study could serve as a benchmark in conducting related research in optimising the conditions with respect to animal nutrition and feedstuff utilisation. Thus, this study was conducted to augment productivity and to provide new opportunities for

achieving enhanced growth performance in a way that alleviates poverty, improves food security and nutrition, and promotes the sustainable use of natural resources.

Key words: *Ruminal degradability of concentrate, rumen-cannulated goat, Napier grass, Los Baños, Laguna, Philippines.*

Introduction

With the increasing cost of commercial feed ingredients in many developing countries, the search for a good source of cheap and readily available materials with potential nutritive values (Preston, T.R., 2001; Wanapat, M., 1999; Lam, V., 2003; Chanjula, P, *et al.*, 2003) is gaining much attention among local farmers who are in the goat, sheep and/ or cattle raising business. The growing interest in making use of materials that are viable and usable as feed materials, such as indigenous plants and crop residues (Moore, C.P. and Cock, J.H., 1985; Preston, T.R., 1986; Pearce, G.R., *et al.*, 1987; Reed, J.D, *et al.*, 1990, Vongsamphanh, P., 2003) abundantly cultivated and produced in a particular locality, is a practical approach to increasing the ruminant production industry in a certain region. Several studies have been conducted on how to improve ruminant nutrition by examining the rumen environment (Church, D.C., 1969; Church, D.C., 1976; Leng, R.A., 1990) and the chemical compositions of the feedstuffs (Demeyer, D., *et al.*, 1982; Cronje, P and Boomker, E.A., 2000; Moss, A.R. and Givens, D.I., 1994), which have led to various experiments on different factors influencing the efficiency of feed utilisation (Adamu, A.M. Russel, J.R., *et al.*, 1988; Preston and Leng, 1987; Miles, J.T., 1951; Kustantinah, Hartadi, H., *et al.*, 1999). The efficiency with which absorbed nutrients are converted to ruminant products (liveweight, milk, etc.) is dependent on meeting the animal's nutritional requirements (Preston, T.R. and Leng, R.A., 1987). Therefore, it is essential to evaluate the ruminant diet composition to improve rumen ecology, dry matter intake and subsequently meat and milk quantity and quality (Wanapat, M., 1999; Moran, J., 2005).

The productivity of animals in developing countries like the Philippines needs to be substantially increased in order to satisfy increasing consumer demand, to efficiently utilise scarce resources and to generate income for a growing agricultural population. This study was therefore conducted to augment productivity and to provide new opportunities for achieving enhanced growth performance, in a way that alleviates poverty, improves food security and nutrition, and promotes the sustainable use of natural resources.

Materials and Methods

Feeding Management

Three (3) mature female rumen-cannulated goats weighing 27.33 ± 1.53 kg were housed in individual elevated metabolism stalls and were provided with 30% concentrate in the morning, based on the feed requirements (3% of their body weight (BW) as dry matter (DM) basis) of the animals. *Ad libitum* feeding of Napier grass will follow thereafter. Clean drinking water was made available at all times in the respective animal watering troughs.

Formulation and Proximate Analysis of Concentrate

The animals were given 30% concentrate from its total feed requirements of 3% of the total live weight (dry matter basis), as presented in Table 1.

Table 1: Formulation and proximate analysis of concentrate in goats.

Particulars	Parts by weight (%)
Rice bran D1	35.00
Corn grits	14.00
Copra meal	34.00
Soybean oil meal	5.00
Molasses	10.00
Salt	1.00
Monocalcium phosphate	1.00
Total	100.00
Proximate Analysis	(%)
Dry matter	82.30
Crude protein	15.30
Acid detergent fibre	13.48
Neutral detergent fibre	41.68

Incubation Times of Nylon Bags in the Rumen

A total of 48 nylon bags measuring 3 x 10 cm each were prepared. Each bag was tacked with polyester thread with a double seam and close stitching. The prepared nylon bag was oven-dried for 24 hours; after oven drying at 105°C, the nylon bag was placed inside the desiccators for 20-30 minutes and kept at room temperature, afterwards the bags were weighed. Three (3.0) g of concentrate was placed in a properly marked net bag before incubating in the rumen.

All bags containing feed samples were incubated or introduced into the rumen following the sequential removal at 0, 3, 6, 9, 12, 24, 36 and 48th hours with 2 bags of sample being pulled out of each animal. This procedure minimised the time of preparation of the samples as well as that for the scheduling for laboratory analysis. After incubation, the bags were immediately cleaned to remove the feed particles adhering to the bags, then rinsed under running water for about 20 minutes or until the water washed clear. A good guide to the sample and bag being clean was when the water from a slowly running tap ran through and entered the bag with ease. The bags were then dried to a constant weight at 105°C (which takes approximately 24 hours). Afterwards, the samples were placed in a desiccator for about 20-30 minutes at room temperature. The bags were weighed after drying.

Chemical Composition Determination

The samples were analysed at the Animal Nutrition Analytical Service Laboratory (ANASL) Animal and Dairy Sciences Cluster, University of the Philippines, Los Baños, for dry matter (DM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to AOAC (1990).

Data Gathered

The following data were gathered from rumen-cannulated goats.

1. Dry matter degradability
2. Crude protein degradability
3. Neutral detergent degradability
4. Acid detergent fibre degradability

The percentage of digestion of feedstuff and the digestion kinetic parameters were then calculated using the exponential equation:

$$D = a + b(1 - e^{-ct})$$

$$e^{-ct} = (a + b - D)/b$$

where: D is the degradation that has taken place

a is the intercept

b is the amount which in time will be degraded

c is the degradation rate constant

e is the natural logarithm

Statistical Analysis

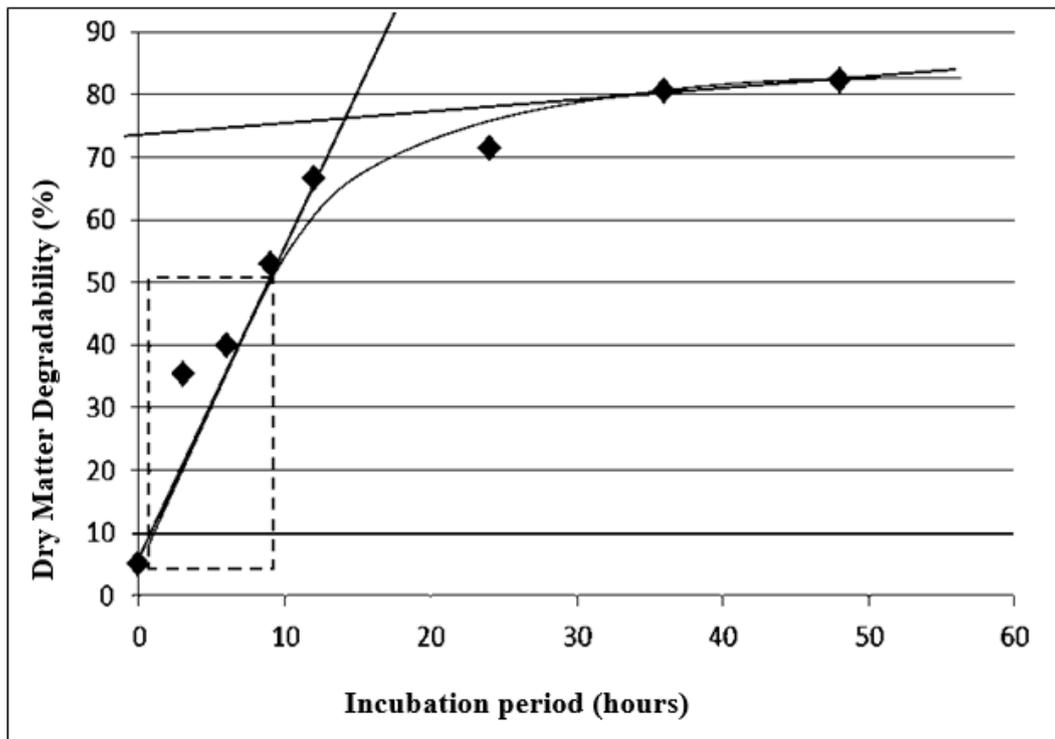
Data for the ruminal disappearance characteristics of dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were fitted to the exponential equation following the procedure described by Ørskov and McDonald (1979) and using the NEWAY program (Chen 1996). $P = a + b(1 - e^{-ct})$ where, D = disappearance rate at time t (%), a = the intercept of the degradation curve at time zero (%), b = the fraction of DM, CP, NDF and ADF which will be degraded when given sufficient time for digestion in the rumen (%), c = a rate constant of disappearance of fraction b (h^{-1}), and t = time of incubation (h). The effective degradability (ED) of DM, CP, NDF and ADF were calculated using the following equation. $EDDM$ or $EDOM = a + \{(bc)/(c+k)\}$ where, k = (assuming the rate of particulate outflow from the rumen), k , is $0.05 h^{-1}$ by the equation of Ørskov and McDonald (1979).

Results and Discussion

Dry Matter Degradability

The dry matter degradability of concentrate after incubation for each incubation period (0, 3, 6, 9, 12, 24, 36 and 48 hours) in upgraded goats fed with 70% Napier grass and 30% concentrate, is presented in Figure 1. It reveals that the percentage degradability (% loss) of the dry matter content of concentrate was noticed exponentially on the first twelve hours of incubation and slowed down during the next few hours until 48 hours. Data also shows that at 48 hours, DM was determined at 82.3% (approximately), as shown in Figure 1 and Table 2. The results may suggest that the population of the rumen microbes (Chiba, 2007) influenced the degradation process of digestible dry matter.

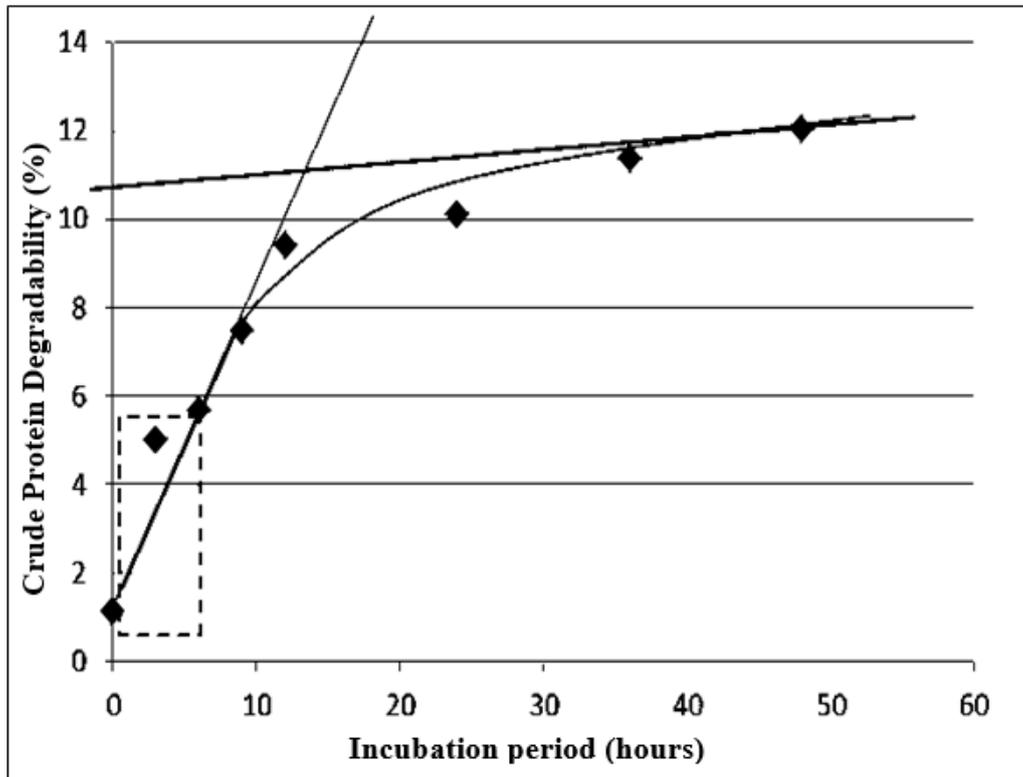
Figure 1. Percentage of DM degradability of concentrate



Crude Protein Degradability

The results show that at 48 hours of rumen incubation, 12% crude protein (CP) was measured, as presented in Figure 2 and Table 2, and, at the sixth hour of the incubation period, the percentage rate of degradation was calculated at 5.5% (Table 3). This may suggest that rumen microorganisms utilised the protein from concentrate efficiently. Results conform to the report of Mehrez, *et al.*, (1977) and Ørskov, *et al.* (1980), that the disappearance or degradability of crude protein from a sample feedstuff was positively correlated with an increasing level of ruminal ammonia nitrogen (NH₃-N). Furthermore, Leng (1990) also emphasises that those higher levels of rumen NH₃-N improved the digestibility of sample feedstuff.

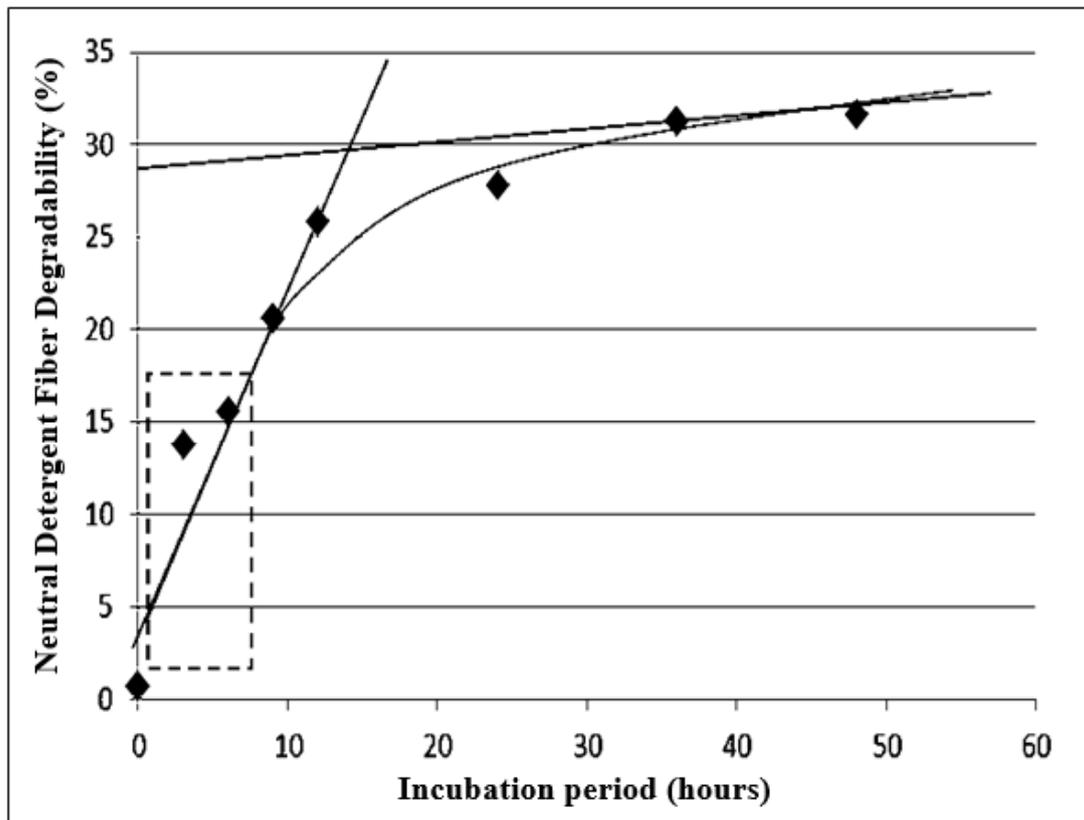
Figure 2. Crude protein degradability of concentrate in goats



Neutral Detergent Fibre Degradability

After 48 hours of incubation, 75.72% from the 41.68% neutral detergent fibre (NDF) content of concentrate was degraded, i.e. 31.56%. The data shows that rumen microorganisms partly utilised the NDF forage content of Napier grass. In relation to NDF, a large potentially degradable fraction (b) was observed, i.e. 26% (Table 3) and the percent of degradability is calculated to be 17% at the seventh hour (Figure 3 and Table 2). The data reveals that high a NDF content would mean less energy was generated, thus supporting the study of Van Soest (2005) on crude fibre degradability, i.e. a high NDF fraction relates to a low intake of feedstuff.

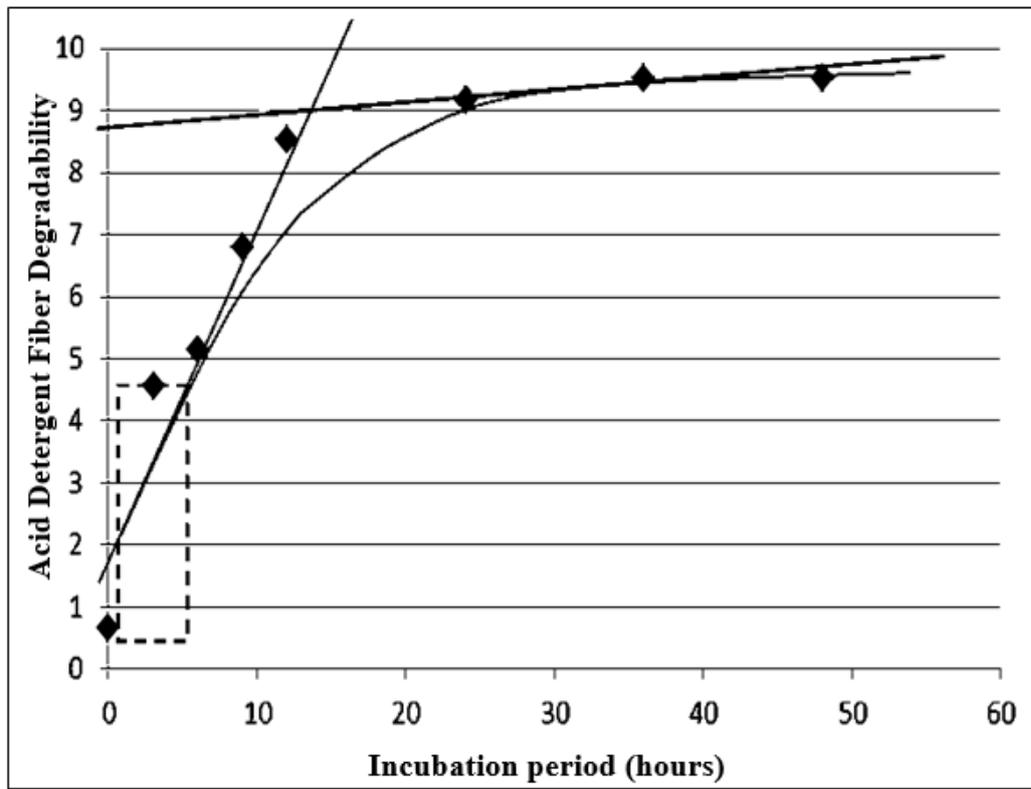
Figure 3. Neutral detergent fibre degradability of concentrate in goats



Acid Detergent Fibre Degradability

As presented in Figure 4, the acid detergent fibre (ADF) degradability of concentrate after incubation for 48 hours demonstrated 9.5% degradability (% loss) of the ADF content.

Figure 4. Acid detergent fibre degradability of concentrate in goats



After 48 hours of incubation, merely 70.47% of the ADF content (13.48%), i.e. 9.5% of the concentrate, was degraded in the rumen (Table 3). The data gathered indicates that rumen microorganisms efficiently utilised the concentrate. As shown in Figure 4, the effective degradability was recorded at 4.5 hours with 4.25% (% loss). In relation to the data gathered, the low value for ADF conforms to the study of Varga (1983), being that a low ADF correlates to a high energy content of the feedstuff.

Nutrient Degradability

The nutrient degradability of concentrate, as summarised in Table 2, shows an increased percent degradability based on DM, CP, NDF and ADF as the incubation period reached 48 hours. Data suggests a direct correlation of digestibility of the concentrate with reference to time.

Table 2: Degradability of concentrate in goats based on DM, CP, NDF and ADF

Incubation Period	Nutrients			
	%DM	%CP	%NDF	%ADF
0	5.00	1.12	0.65	0.65
3	35.50	5.01	13.76	4.55
6	40.00	5.65	15.51	5.13
9	53.00	7.49	20.56	6.80
12	66.50	9.39	25.79	8.53
24	71.50	10.10	27.73	9.17
36	80.50	11.36	31.22	9.50
48	82.30	12.01	31.56	9.50

Data for ruminal disappearance characteristics of dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were calculated based on the exponential equation following the procedure described by Ørskov and McDonald (1979); where, D = the actual degradation after time 't'; a = the intercept of the degradation curve at time zero; b = the potential degradability of the component degraded in time; c = the rate constant for the degradation of 'b'. The total degradability of the sample is given by a + b which cannot exceed 100. Thus, 100 - (a+b) represented the undegradable fraction in the rumen.

Low ADF values show higher energy value and digestibility (Ørskov, 1980). Therefore, low ADF values are desirable. The positive value for “a” suggests that the contents of the concentrate were degraded rapidly and/or components were soluble, or fine enough to escape from the bags. Thus, forages with low NDF have higher intakes than those with high NDF.

Table 3: Degradability values of the various nutrient composition of concentrate.

Degradability Values	Nutrients			
	%DM	%CP	%NDF	%ADF
a	5	1	3	1.5
b	68	9.5	26	7.25
D	49	5.5	17	4.25
e^{-ct}	0.35	0.52	0.46	0.62
c	-3.13	-2.45	-2.72	-1.98
t	8	6	7	4.5

However, for the degradation of cellulosic materials by micro-organisms, which occurred largely in the rumen, and as with proteins, the outflow rate from the rumen determined what the effective degradation would be. The effective degradation may not be the full potential degradation, although with cellulosic materials degradation is probably easier relative to the possible outflow rate of the non-degradable fraction. This is because the non-degradable



fraction normally has to be broken down physically to a size small enough so as to be able to leave the rumen.

As demonstrated in Table 3, the data shows a qualitative indicator of the degradation process using the nylon bag technique with some internal and external limitations.

Conclusions

Little is known of the relative degradability(-ies) of the wide range of feedstuff available or potentially available. Information on the degradability(-ies) of different feedstuffs, and of the variation between sources, would help towards a better understanding of the potential value of the feedstuffs, and their proportion.

It can be concluded that there are several potential opportunities for improving the efficiency of ruminant digestion and possibilities for utilising a wider range of feeds than is currently possible. The study confirms that animal nutrition should not be overlooked. In fact, it is one of the most important factors that must be considered by local farmers in providing quality and healthy livestock, in order to improve and enhance the potential of the animals. Ruminant diets in most developing countries are based on fibrous feeds and crop residues. These feeds are imbalanced and are particularly deficient in protein, minerals and vitamins, and are highly lignified. Efficient supplementation of locally mixed concentrate with grains or other protein sources has been demonstrated to improve rumen ecology, dry matter, crude protein and crude fibre contents. In addition, to be able to evaluate the feedstuffs on their viability and degradability, it is suggested that the so-called nylon bag technique is a practical and useful approach in screening potential ruminant diets and supplementations. This technique provides comparative estimates of degradability of feedstuffs used as supplements or components of the basal diet for ruminants. Hence, it is better to attempt to define some form of degradation curve for the material under test, and to make comparisons in this way. Thus, the importance of a standard method of sample preparation is critical. Accordingly, in this study, what is actually measured is the breakdown of material to a size small enough to leave the bag and not necessarily a complete degradation to simple chemical compounds. The results must therefore be treated with due caution, and, in general, be used as qualitative indicators of general principles.

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