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In sacco Degradation Characteristics of Crop Residues and Selected Roughages in Brahman-Thai Native Crossbred Steers

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ABSTRACT

Three crop residues and five roughages were selected to evaluate nutritive value using nylon bag technique. Nylon bag technique was conducted in two rumen fistulae Brahman-Thai native crossbred steers. Steers were fed 0.5% BW of concentrate and rice straw *ad libitum*. The treatments were 1) water hyacinth, 2) kraphanghom, 3) corn stover, 4) cassava hay, 5) sugarcane top, 6) Chinese spinach, 7) rice straw and 8) cavalcade hay. The result indicate that the rapidly soluble fraction (*a*) of DM OM and CP were highest in Chinese spinach (P<0.01). The lowest rapidly soluble fraction (*a*) of DM, OM were observed in sugarcane top (P<0.01). The potential degradable fractions (*b*) of OM and CP were highest (P<0.01) in cassava hay and the lowest potentially degradable fractions (*b*) of DM and OM were found in Chinese spinach. Degradation rate of DM, OM and CP in Chinese spinach was fastest. The slowest degradation rates of DM and OM were observed in water hyacinth, whereas the slowest degradation rate of CP was observed in rice straw. The effective degradability of DM, OM and CP were highest in Chinese spinach. Effective degradability of DM and OM were lowest in sugarcane top. Crop residue and selected roughages having nutritive value for ruminant feed ranked from the highest to the lowest were: Chinese spinach, krapanghom, cassava hay, corn stover, cavalcade hay, water hyacinth, rice straw and sugarcane top, respectively.

Key word: *in sacco*, roughage, rumen degradation

INTRODUCTION

A major constraint to livestock production in tropical areas is the scarcity and fluctuating quantity and quality of the year-round feed supply. Particularly during dry season, the natural pastures drop in quantity and quality, especially in energy and nitrogen content. As a consequence, feed intake declines and animal productivity is curtailed. Moreover, tropical forages have a large proportion of lignified cell walls with low fermentation rates and digestibility, leading to low digestibility rates and limited intake (Ibrahim *et al*., 1995).

Although natural pastures are often not available for ruminants in the dry season, crop residues are present in large amounts and can be useful for ruminant feed, especially sugarcane top

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(Chinh *et al*., 2000), rice straw (Agbagla-Dohnani *et al*., 2001) and corn stover (Hindrichson *et al*., 2001). Crop residues have the advantage of being nutritionally valuable even in the dry season, when feeding of ruminants in tropical countries is most critical (Mgheni *et al*., 2001). However, crop residues have some drawbacks such as high content of cell wall, low protein and low utilization rate (Hindrichson *et al*., 2001). The addition of foliage from tree leaves or supplementation with seed meals or even urea can improve the utilization of low quality roughages, mainly through the supply of nitrogen to the rumen microbes. In addition, Wanapat *et al*. (1997) reported that cassava hay might be a good source of protein supplement for ruminants in dry season, particularly on a small-holder dairy farm. Kraphanghom (*Paederia foetida* Linn) is also available in dry season and has high protein content, making it a useful supplement for ruminants in dry season.

The degree of nutrient degradation occurring in the rumen has major influence on the total utilization of nutrient in feedstuffs. *In sacco* nylon bag technique is often used to characterize rumen fermentation kinetics of nutrient in the rumen. In spite of numerous studies conducted on the used of crop residue as ruminant feed, limited information is available about ruminal degradation. There is also little research that characterizes individual feeds (DePeters *et al*., 1997). Therefore, the aim of this study was to assess the chemical composition and ruminal degradation characteristics of crop residues and selected roughages using the *in sacco* nylon bag technique.

MATERIALS AND METHODS

Crop residues and selected roughages preparation and analysis

The crop residues and selected roughages, 1) water hyacinth (*Eichhorunia crassipes Solms*, WH), 2) kraphanghom (*Paederia foetida Linn*, KH), 3) corn stover (*Zea mays*, CS), 4) cassava hay (*Manihot esculenta Crantz*, CH), 5) sugarcane top (*Saccharum officinarum Linn*, SCT), 6) Chinese spinach (*Amaranthus viridis L*., CP), 7) rice straw (*Oryza sativa*, RS) and 8) cavalcade hay (*Centrosema pascuorum cv. Cavalcade*, CC) were collected from Maha Sarakham province area in the North-East of Thailand. Fresh samples (1 kg.) were harvested by hand from three specimens. Duplicate fresh samples (0.5 kg. /replicate) were dried in a hot, dry air force oven at 65 °C for 72 h and weighed. The samples (Table1) were then ground to pass through a 1 mm screen for nylon bag incubation and chemical analysis. The samples were analyzed for dry matter (DM), crude protein (CP) and ash (AOAC, 1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were assayed using the method proposed by Van Soest *et al*. (1991).

In sacco degradation procedure

Ruminal degradation measurement using the nylon bag technique was carried out in Brahman-Thai native cross bred after a two week adaptation period. The steer with an average body weight of 250±15 kg and fitted with a permanent rumen cannula were offerred rice straw *ad libitum* and received concentrate at 0.5 % BW (concentrate mixture: 49.8% cassava chip, 17.5% rice bran, 14.6% palm meal, 7.0% soybean meal, 1.4% urea, 0.4% salt, 1.0 % mineral mix and 8.3% sugarcane molasses). Approximately 3.0 g (as fed basis) of each test feed was accurately weighed into synthetic bag with a mean pore size of 45. Bag plus the sample were placed into the rumen of the beef steer, 30 min after the morning meal and retrieved after a period of 3, 6, 12, 24, 48 and 72 h (four bags of each feed for each period). After removal from the rumen, bags were rinsed in pipe line fresh water and washed by hand under tap water until the water became clear. After washing, the bags were placed into a hot dry air force oven at 65 °C for 48 h and weighed. To determine the content of water soluble material bags, representing 0 h degradation also underwent the same washing procedure as the incubated bags. Dried residues of each incubation time from each steer were pooled, for DM, OM and CP analyzed, then DM, OM and CP disappearance values were calculated for the difference between nutrient weight before and after incubation of each sample. The degradability data obtained for DM, OM and CP for each feed was fitted to the equation $P = a+b(1-e^{-ct})$ (Ørskov and McDonald, 1979). The effective degradability was calculated as $ED=a+b\{c/(c+k)\}$, where K = fractional passage rate (0.02/h)

Statistical analysis

All data obtained were subjected to the analysis of variance (ANOVA) procedure according to the Complete Randomized Design using the general linear (GLM) of the SAS system (SAS, 1996). Treatment means were compared using Duncan's New Multiple Range test. Probabilities less than 0.05 were considered to be significant.

RESULTS AND DISCUSSION

Chemical composition of crop residue and selected roughage

The chemical compositions of crop residues and selected roughages are presented in Table 1. The crude protein content of the crop residues and selected roughages ranged from 3.0 to 26.42 %. Rice straw had the lowest crude protein content, while the Chinese spinach had the highest crude protein content. Similar crude protein content were observed in krapanghom and cassava hay. When comparing crude protein content of krapanghom and cassava hay with alfalfa hay as reported by Alcaide (2000), it was found that the crude protein content of krapanghom, cassava hay and alfalfa hay were similar. Low protein content was observed in crop residues (corn stover, sugarcane top and rice straw). The result of study agrees with Hindrichson *et al*. (2001) who reported that most crop residues were low in protein and high in fibrous content. The crude protein content of rice straw was lower than that reported by Liu *et al*. (2002). However, the crude protein content of rice straw was similar to that reported by Fonseca *et al*. (1998) and Department of Livestock Development (2004). The crude protein content

Table 1 Chemical composition of crop residues and selected roughages.

Feedstuffs[1]	DM (%)	CP	Ash	NDF	ADF	ADL
		……………..%DM basis……………….				
WH	15.0	12.9	14.3	69.2	42.7	3.7
KP	21.7	16.6	8.6	50.2	45.3	11.8
CS	23.3	6.3	6.3	67.4	38.4	4.1
CH	24.0	15.8	8.7	50.9	51.4	12.6
SC	36.7	5.8	5.3	79.9	54.6	8.9
CN	15.6	26.4	23.3	40.1	19.9	4.9
RS	91.5	3.0	13.6	72.1	53.3	4.9
CC	94.5	10.9	7.6	59.9	41.6	11.5

DM = dry matter, CP = crude protein, NDF = neutral detergent fiber,
ADF = acid detergent fiber and ADL = acid detergent lignin, [1] WH = water hyacinth,
KH = kraphanghom, CS = corn stover, CH = cassava hay, SC = sugar cane top,
CN = Chinese spinach, RS = rice straw, CC = cavalcade hay

of cassava hay was lower than that reported by Promkot and Wanapat (2004) and Wanapat *et al*. (1997). The difference of crude protein content was probably due to maturity level and leaves-stem ratio of cassava hay. Normally, the crude protein content of cassava hay decreased as maturity increased (Wanapat, 2003). The crude protein content of sugarcane top was higher than that reported by Kawashima *et al*. (2002). In addition, crude protein content of corn stover was higher than those reported by Hindrichson *et al*. (2001) and Mgheni *et al*. (2001). There are many factors that affect crude protein content such as stage of growth (Promkot and Wanapat, 2004) maturity and species or variety and soil types (Baloyi *et al*., 1997). These factors may partially explain differences in crude protein content between our study and others.

Ash content of crop residue and selected roughage was ranged from 5.27 to 23.31%. Sugarcane top had the lowest ash content while the Chinese spinach had the highest. The ash content of rice straw was lower than that reported by Department of Livestock Development (2004), but higher than that reported by Liu *et al*. (2001). The difference of ash content was probably due to variety of rice straw (Agbagla-Dohnani *et al*., 2001) and soil type (Thu and Preston, 1999). However, ash content of rice straw was similar to that reported by Fonseca *et al*. (1998). In addition, the ash content of rice straw was similar to ash content of water hyacinth. The ash content of corn stover was lower than that reported by Hindrichson *et al*. (2001) and Magheni *et al*. (2001). Ash content of sugarcane top, water hyacinth and cassava hay were similar to previous reports (Thu and Preston, 1999; Kawashima *et al*., 2002).

Neutral detergent fiber (NDF) content of crop residues and selected roughages ranged from 40.06 to 79.93%. Chinese spinach had the lowest NDF content while sugarcane top had the highest. Similar NDF content was observed in water hyacinth, corn stover and rice straw. The NDF content of rice straw was higher than that reported by Department of Livestock Development (2004) and Fonseca *et al*. (1998). However, NDF content of rice straw was similar to that reported by Liu *et al*. (2002). The NDF content of corn stover was lower than that reported by Hindrichson *et al*. (2001). Neutral detergent fiber contents of sugarcane top, water hyacinth and krapanghom were all similar to previous reports (Thu and Preston, 1999; Kawashima *et al*., 2002; Department of livestock Development, 2004)

Acid detergent fiber (ADF) content of crop residues and selected roughages ranged from 19.96 to 54.61%. Chinese spinach had the lowest ADF content while the sugarcane top had the highest ADF content. Similar ADF content was observed in water hyacinth, krapanghom and cavalcade hay. The ADF content of rice straw was higher than that reported by Department of Livestock Development (2004) and Thu and Preston (1999), but similar to reports by Liu *et al* (2002). The ADF content of corn stover was similar to that reported by Department of Livestock Development (2004). In addition, ADF content of water hyacinth and sugarcane top were higher than those previously reported (Thu and Preston, 1999; Kawashima *et al*., 2002)

There are many factors that may affect fibrous (NDF and ADF) content such as stage of growth (Promkot and Wanapat, 2004), maturity and species or variety (Agbagla-Dohnani *et al*., 2001), dried method and growth environment (Mupangwa *et al*., 1997) and soil types (Thu and Preston, 1999). These factors may partially explain differences in fibrous content between our study and others.

Acid detergent lignin (ADL) content of crop residues and selected roughages ranged from 3.67 to 12.64 %. Water hyacinth had the lowest ADL content while the brown salwood had the highest. Similar ADL content were observed in krapanghom, cassava hay and cavalcade hay. The ADL content of rice straw was lower than that reported by Thu and Preston (1999), but similar to other previous reports (Fonceca *et al*., 1998 and Department of Livestock Development, 2004). The difference of ADL content was probably due to difference in variety of rice straw (Agbagla-Dohnani *et al*., 2001) and soil type (Thu and Preston, 1999).

Degradability characteristics

The rapidly soluble fraction (*a* fraction), potentially degradable fraction (*b* fraction), rate of degradation of *b* fraction (*c*) and potential degradation (*a*+*b*) are presented in Table 2. Dry matter *a* fraction was highest (P<0.01) for Chinese spinach and lowest for rice straw. Dry matter *a* fraction for rice straw was lower than that reported by Keir *et al*. (1997). However, dry matter *a* fraction for rice straw was similar to those reported by Fonseca *et al*. (1998) and Mgheni *et al*. (2001). Similar dry matter *a* fraction was observed in water hyacinth and cassava hay. Dry matter *a* fraction of cassava hay was similar to that reported by Promkot and Wanapat (2004). In this study dry matter *a* fraction for Chinese spinach was highest as compared other feed; possibly because fine dusty particles were OM and CP readily soluble in the rumen.

Chinese spinach had the highest (P<0.01) organic matter *a* fraction and rice straw had the lowest. The organic matter *a* fraction of water hyacinth, krapanghom, corn stover, cassava hay, sugarcane top and cavalcade hay were; 13.62, 24.60, 28.49, 20.85, 15.07 and 26.82 %, respectively. Chinese spinach also had the highest (P<0.01) crude protein *a* fraction and cassava hay had the lowest. The crude protein *a* fraction of water hyacinth, krapanghom, corn stover, cassava hay, rice straw and cavalcade hay were; 33.73, 27.44, 30.24, 32.69, 28.74 and 33.96 %, respectively. Crude protein *a* fraction for cassava hay was lower than that reported by Wanapat *et al*. (1997) and Promkot and Wanapat (2004). Additionally, crude protein *a* fraction for water hyacinth was higher than that reported by Khan *et al*. (2002). Crude protein *a* fraction of rice straw and corn stover were similar to those in previous studies (Mgheni *et al*., 2001). Feedstuffs had high rapid soluble fraction of OM should be matching with feedstuffs had rapid soluble fraction of CP, when feeding ruminants.

Variation in this fraction between studies could be due to differences in feed particle size and processing methods (i.e., degree of heating) or differences in analytical technique. Feed particle size did not affect rate of DM and N degradation in some studies (Nocek, 1995) but others NRC (2001); Promkot and Wanapat (2004) observed large difference in disappearance of substrate with difference particle size. Even if the samples were milled in the same mill the differences in small particle proportion would probably depend on the vegetal structure of forages, *i.e*. degree of lignifications and fragility. It is well know that difference between forages in small particles occur during the milling process, even in the same equipment and screen size (Olivera, 1998). In addition, the small particles produced by grinding dried samples may result in an overestimation of zero time losses (Lopez *et al*., 1995).

The dry matter *b* fraction for all feeds ranged from 48.82 to 68.48 %. Similar dry matter *b* fraction was observed in corn stover, cassava hay and cavalcade hay. Dry matter *b* fraction for rice straw was higher than those reported by Keir *et al*. (1997) and Fonseca *et al*. (1998), but lower than that reported by Mgheni *et al*. (2001). Dry matter *b* fraction corn stover was also lower than those in previous studies (Megheni *et al*., 2001).

The organic matter *b* fraction for all feeds ranged from 56.11 to 75.78%. Organic matter *b* fraction was highest for rice straw and lowest for Chinese spinach, possibly because Chinese spinach had the highest ash content and a high rapidly soluble fraction, which affected the organic matter *b* fraction. Similar organic matter *b* fraction was observed in Chinese spinach, cassava hay and

Table 2 *In sacco* degradation characteristic and effective degradability of crop residues and selected roughages.

Parameters[2]	Treatment[1]								SEM
	WH	KH	CS	CH	SC	CN	RT	CC	
DM degradation									
a, %	20.12^{d}	27.58^{c}	30.94^{b}	20.65^{d}	18.00^{e}	39.10^{a}	13.27^{f}	29.54^{bc}	1.24
b, %	68.68^{a}	61.53^{ab}	53.04^{ab}	67.56^{a}	53.49^{ab}	48.82^{b}	62.49^{ab}	55.39^{ab}	2.01
c, h^{-1}	0.011^{c}	0.025^{b}	0.022^{bc}	0.020^{bc}	0.018^{bc}	0.051^{a}	0.018^{bc}	0.016^{bc}	0.001
a+*b*, %	88.81	89.12	83.98	88.21	71.49	88.92	75.77	84.94	2.05
EDDM, %	44.35^{f}	61.63^{b}	58.49^{c}	54.52^{d}	40.83^{f}	74.48^{a}	41.38^{f}	52.60^{d}	1.95
OM degradation									
a, %	13.62^{e}	24.60^{c}	28.49^{b}	20.85^{d}	15.07^{e}	34.43^{a}	9.33^{f}	26.82^{b}	1.45
b, %	71.86^{ab}	63.33^{ab}	66.81^{ab}	74.80^{a}	56.16^{b}	56.11^{b}	75.78^{a}	57.06^{b}	2.02
c, h^{-1}	0.011^{c}	0.028^{b}	0.017^{bc}	0.0.016^{c}	0.017^{ab}	0.044^{a}	0.014^{bc}	0.016^{bc}	0.001
a+*b*, %	85.49^{abc}	87.93^{abc}	95.30^{a}	95.65^{a}	71.24^{c}	90.55^{ab}	84.0^{abc}	83.88^{abc}	2.30
EDOM, %	38.82^{f}	61.21^{b}	58.07^{c}	53.75^{d}	38.45^{f}	72.07^{a}	40.47^{f}	51.20^{e}	2.05
CP degradation									
a, %	33.73^{c}	27.44^{e}	30.24^{d}	12.48^{g}	32.69^{cd}	43.31^{b}	28.74^{f}	33.96^{a}	1.83
b, %	17.72^{e}	72.56^{a}	54.94^{b}	74.22^{a}	37.97^{d}	45.91^{c}	57.17^{cd}	44.81^{c}	3.21
c, h^{-1}	0.039^{b}	0.025^{cd}	0.017^{d}	0.019^{cd}	0.015^{d}	0.066^{a}	0.004^{e}	0.057^{a}	0.001
a+*b*, %	51.45^{e}	100.0^{a}	85.18^{c}	89.60^{bc}	70.66^{d}	89.22^{b}	85.9^{bc}	78.77^{b}	2.80
EDCP, %	45.44^{f}	67.62^{c}	55.19^{d}	48.90^{e}	49.05^{e}	77.65^{a}	38.87^{e}	67.20^{b}	2.10

$^{a, b, c, d, e}$ Means within a row different superscripts differ ($P<0.01$)

Where: DM= dry matter, OM= organic matter, CP= crude protein, EDDM= effective degradability of dry matter, EDOM= effective degradability of organic matter, EDCP= effective degradability of crude protein,

[1] WH = water hyacinth, KH = kraphanghom, CS = corn stover, CH = cassava hay, SC= sugar cane top, CN = Chinese spinach, RS = rice straw, CC = cavalcade hay

[2] *a, b, c* are constants in the exponential equation, $P= a+b (1-e^{-ct})$ Where a = the rapidly soluble fraction, b = the potentially degradable fraction, c = the rate of degradation of fraction b, a+b= potential degradation

cavalcade hay. The crude protein *b* fraction ranged from 17.72 to 72.56%. Crude protein *b* fraction was highest for krapanghom and lowest for water hyacinth. Similar crude protein *b* fraction was observed in Chinese spinach and cavalcade hay. The crude protein b fraction for water hyacinth was similar to those in previous studies (Khan *et al*., 2002). Crude protein b fraction for cassava hay was higher than those reported by Wanapat *et al*. (1997) and Promkot and Wanapat (2004). In addition, crude protein *b* fraction for rice straw was lower than that reported by Mgheni *et al*. (2001), but for corn stover was higher than that reported by Mgheni *et al*. (2001). Numerous factors may have influenced the differences in *b* fraction in this study.

Degradation rate (*c*) of dry matter was fastest (P<0.01) in Chinese spinach follow by the krapanghom. Similar degradation rates of dry matter were observed in corn stover, cassava hay, sugarcane top, rice straw and cavalcade hay. Degradation rate of dry matter for crop residues and selected roughages in this study were slower than compared concentrate feedstuffs (Woods *et al*. 2003). This is possibly due to the fact that fibrous content and degree of lignifications in crop residues and selected roughages were higher than concentrate feedstuffs. This structure was difficult for attach by microorganism, leading to slow rate of degradation. Degradation rate of dry matter for rice straw was slower than those reported by Fonseca *et al*. (1998) and Mgheni *et al*. (2001), but in close agreement with Keir *et al*. (1997). Degradation rate of dry matter for corn stover was similar to reported by Mgheni *et al*. (2001). Degradation rate of dry matter for cassava hay was also slower than that reported by Promkot and Wanapat (2004).

Degradation rate of organic matter of crop residue and selected roughages are similar to the degradation rate of dry matter. In exception, the degradation rate of organic matter for Chinese spinach was slower than degradation rate of dry matter, possibly because of disturbance by ash content (Table 1).

Degradation rate of crude protein was fastest for Chinese spinach and slowest for rice straw. Similar degradation rates of crude protein were observed in corn stover, cassava hay and sugarcane top. The degradation rates of crude protein for cassava hay and water hyacinth were slower than those in previous studies (Wanapat *et al*., 1997; Promkot and Wanapat, 2004). However, degradation rate of crude protein for corn stover and rice straw were similar to that reported by Mgheni *et al*. (2001)

The potential degradation (*a+b*) of dry matter was not significantly different between treatments (P>0.05). Potential degradation of dry matter for rice straw was lower than that reported by Mghani *et al*. (2001), but higher than that reported by Keir *et al*. (1997). Moreover, potential degradation of dry matter for cassava hay was higher than that reported by Promkot and Wanapat (2004). Potential degradation of organic matter was highest (P<0.01) for cassava hay and sugarcane top had the lowest.

The potential degradation of crude protein was highest (P<0.01) for krapanghom and lowest for water hyacinth. Promkot and Wanapat (2004) reported lower potential degradation of crude protein values for cassava hay than we found. Furthermore, potential degradation of crude protein for rice straw was lower than that reported by Mgheni *et al*. (2001). Potential degradation of crude protein for water hyacinth was similar to that reported by Khan *et al*. (2002). Remarkably, crude protein content of crop residue was found to be very low (Table 1). Such low values of crude protein are known to depress DM and crude protein degradability and result in low intake (Shem *et al*., 1995). Djajanegara and Doyle (1989) indicated that low levels of crude protein decrease microbial activities and that intake of roughages is limited when crude protein content is lower than 6.25 %. Also the high NDF, ADF and ADL values may result into low degradability and induce low intake. The structure and solubility characteristics of protein in feedstuffs influence crude protein degradability in the rumen (Mahadevan *et al*., 1980). Crude protein degradability of crop residue and selected roughages are much lower than in common concentrated feed (Woods *et al*., 2003), leguminous (Khandaker and Tareque, 1996), and aquatic plant (Khan *et al*. 2002).

Numerous factors had effect of *in sacco* degradability, such as bag pore size (Vanzant *et al*., 1998), sample size (Nocek, 1985), washing procedures, grinding, diet of host animal, species of animal, sample preparation, incubation time and washing method (Olivera, 1998). Maturity of perennial forages affected all degradation fractions and degradation rate of dry matter and crude protein (Hoffman *et al*., 1993). Furthermore, chemical composition and processing of feedstuffs affected degradation characteristics (Huntington and Gives, 1997). Vitti *et al*. (1999) reported *in sacco* dry matter disappearance was highly correlated (P<0.001) with NDF (negatively) and with phenolic compounds and reducing sugars (positively).

The results in this study indicated that crop residues and selected roughages have a degradability ranked from the highest to the lowest were; Chinese spinach, krapanghom, cassava hay, corn stover, cavalcade hay, water hyacinth, rice straw and sugarcane top, respectively. Crop residues had low value of crude protein and high fibrous content, but had the advantage that they are still available in the dry season, when feeding of ruminant in tropical countries is most critical. (Sinclair *et al*., 1993) suggested feed with similar ruminal availabilities of CP and OM could be used in synchronizing nutrient supply for maximum microbial protein in ruminants. These data could be the advantageous when used in synchronizing the rate of energy and nitrogen release in the rumen to improve ruminal fermentation and microbial protein synthesis.

Effective degradability

Effective degradability of DM, OM and CP are also presented in Table 2. Rate of passage (k) was assumed at 0.02/h for the calculation of effective degradability (∅rskov and McDonald, 1979). The effective degradability of DM, OM and CP was significantly affected by samples of feed used for all crop residues and selected roughages (P<0.01). Effective degradability was highest for Chinese spinach and lowest for sugarcane top. Effective degradability of dry matter for rice straw was lower than that reported by Mgheni *et al*. (2001), but corn stover was higher than that reported by Mgheni *et al*. (2001). In addition, effective degradability of organic matter of all feeds is similar to that of dry matter. Remarkably, potential dry matter and effective degradability of dry matter of crop residues and selected roughages declined as NDF content in crop residues and selected roughages increased (Table 1 and Table 2). This result is in agreement with Broderick (2003) who found that NDF concentration has a negative relationship with dry matter degradability.

Effective degradability of crude protein was highest for Chinese spinach and rice straw had the lowest. The effective degradability of crude protein for rice straw was lower than that reported by Mgheni *et al*. (2001), but corn stover was higher than that reported by Mgheni *et al*. (2001). In this study the effective degradability of crude protein ranked from the highest to the lowest were; Chinese spinach, krapanghom, cavalcade hay, corn stover, sugarcane top, cassava hay, water hyacinth, and rice straw, respectively. The ruminal availability of crude protein for Chinese spinach, krapanghom, cavalcade hay, corn stover was high. Whereas, ruminal availability of crude protein for sugarcane top, cassava hay, water hyacinth, and rice straw were low. In the other hand low ruminal availability of crude protein could provide high amount of rumen undegradable protein and subsequent enhancement of amino acid absorption and utilization by the ruminant animal.

CONCLUSIONS

Ruminal disappeared characteristic of crop residue and selected roughage differed among feedstuffs. Crop residue and selected roughage showed a great variation in chemical composition and degradability. The result in this study indicated that crop residues and selected roughages have a degradability ranked from the highest to the lowest were; Chinese spinach, krapanghom, cassava hay, corn stover, cavalcade hay water hyacinth, rice straw and sugarcane top, respectively. Importantly, crop residues and selected roughages are abundant and available for feeding ruminants in the dry season.

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