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Intake and Digestive Processes in the Rumen of Rams Fed with *Digitaria decumbens* Harvested at Four Stages of Grass Regrowth Age

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ABSTRACT : This study was designed to measure the effect of regrowth age of *Digitaria decumbens (D. decumbens)* on the intake and dynamics of digesta in the rumen of rams. Six Black-belly rams (mean liveweight: 51.6 (s.d. 0.68) kg) fitted with rumen cannulae were fed twice daily a 14-, 28-, 42- and 56-day old fresh *D. decumbens* successively for 4 experimental periods. The daily dry matter intake decreased curvilineary from 75.2 to 48.5 (s.e. 2.0) g/kg $BW^{0.75}$ as the age of the *D. decumbens* grass increased from 14 to 56 days. Dry matter intake for the first 3 h after the morning meal was 863.6, 598.3, 576.4 and 401.5 (s.e. 55.6) g for the 14-, 28-, 42- and 56-day old grasses respectively. The pool of NDF in the rumen at the end of the 3-h feeding period did not vary significantly among the four diets. Twelve hours after the beginning of the morning meal, the pool of NDF increased with the forage regrowth age. Within the total pool of NDF, the pool of large particles tended to increase with the regrowth age. It was concluded that high intake was associated with fast evacuation of NDF from the rumen. Moreover, digestion (cellulolysis) rate and degree of particle reduction by rumination are highly correlated, though speed of physical degradation of forage seems to be the driving force behind intake. (**Key Words** : *Digitaria decumbens*, Intake, Rumen Digestion)

INTRODUCTION

Fresh forage is often the sole component of the diet of many ruminants in the humid tropics. Minson (1990) and Aumont et al. (1995) recognised however, that voluntary intake is a major factor limiting the nutritional value of tropical forage. Voluntary intake of a low quality forage is limited by rumen fill and the fractional disappearance rate of dry matter (DM) from the reticulo rumen (Bowman et al., 1991). The forage particles therefore need to be reduced in size but denser in order to flow out of the rumen. Previous studies (McLeod and Minson, 1988; McLeod et al., 1990) demonstrate that the breaking down of large forage particles to small particles is usually achieved by chewing during eating and rumination whereas only a small part of the particle breakdown (17%) can be attributed to microbial degradation.

Because of the very high level of fibre and the thick-walled bundle sheath of tropical grasses. Wilson (1994) and Archimède et al. (2000) have hypothesized that in intensive systems, in tropical areas, where the forage is irrigated and fertilised, the low rate of reduction in size of large forage particles by chewing is the first limiting factor on intake, even with young forage. This experiment was designed (i) to evaluate variations in tropical forage grass intake according to regrowth age, (ii) to study the digestion kinetics of fiber fraction in the rumen of rams, (iii) to study the impact of cellulolysis and physical breakdown of grass particles on intake. To take into account the fast growth of tropical forages, this study has been performed with grass with state of regrowth age within bounds larger than those classically studied.

MATERIALS AND METHODS

Experimental design, animals, diets and feeding

The harvest of the perennial grass *D. decumbens* (pangola grass) pasture was planned to obtain forage at 14, 28, 42 and 56 days of regrowth for four successive 42-day experimental periods (Archimède et al., 2000). Six Black-belly rams (mean liveweight: 51.6 (s.d. 0.68) kg) were fed

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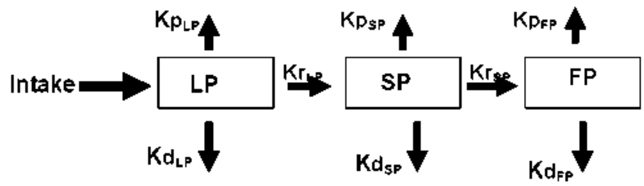

Figure 1. Flow diagram of size reduction, digestion and passage rate of digesta in the rumen. Kr_{LP}, Kr_{SP}, are particle size reduction rate of large and small particles respectively. Kd_{LP}, Kd_{SP}, KdV_{VP}, are the digestion rate of large, small and Fine Particles respectively. Kp_{LP}, Kp_{SP}, Kp_{VP}, are the passage rate of large and small and fine particles respectively.

fresh 14-, 28-, 42- and 56-day old regrowth successively for the experimental periods. Each experimental period consisted of 19 days of adaptation to the diet, 7 days of intake measurement, 7 days of nylon bag incubation and 3 days of rumen sampling. The grass was cut early every morning and chopped (5 cm-length) before being offered. The rams were fed twice at 12-h intervals at morning and evening. The quantity offered was 1.15 times more than the animals' estimated voluntary intake during periods of adaptation. The rams used in this trial were fitted with rumen cannulae and kept in metabolism cages.

Chemical analyses

The DM content of the fresh forage and refusals was obtained daily by drying it to a constant weight at 60°C in a forced-draught oven. Samples were then ground to 1 mm prior to chemical analysis. Organic matter (OM) content was measured after a 10 h pyrolysis at 550°C. Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) were estimated using the methods of Van Soest et al. (1991). The nitrogen content was determined from a representative sample of dry forage using the Kjeldahl method.

Measurements and calculation

Intake was measured daily by weighing the amount of forage offered as well as refusals.

The kinetic degradation rate of forage and the rumen contents were estimated using the nylon bag method. The nylon bags measured 10 cm×5 cm, with a pore size of 50×50 μm, and were filled with 3 g of raw freeze-dried Small Particle (SP) or Large Particle (LP). With respect to forage, 15 g of green matter were introduced in the bag. SP and LP came from the rumen of 3 rams fed with the experimental diet and emptied manually 3 h after the start of their morning meal. The rumen contents were not ground. The incubation time of the nylon bags in the rumen was 96 h.

During the rumen sampling period, two rumen empties (one per day) were carried out on each animal, 3 and 12 h after a 3-h morning meal. The times were chosen because the duration of the main morning meal of rams was 2.30 to 3 h. Moreover, previous observations (unpublished results) have indicated (i) that the times of 3 and 12 h represented the maximum and the minimum rumen filling respectively, (ii) the mean of the two values is equivalent to the weighted mean of times 3, 6 and 12 h (unpublished results). There were 3 days between the emptying of the rumen. The total rumen content was weighed and mixed by hand. Four sub-samples were taken, two for dry matter determination, one preserved (-20°C) until freeze-dried for chemical analysis determination, while the last was used to determine digesta particle size. Rumen particles were separated into Large Particles (LP) and Small Particles (SP), by wet sieving using gradual sieves of 4 mm, 2 mm, 1 mm, 0.75 mm, 0.5 mm and 0.16 mm in size. LP were defined as particles retained in the sieves ranging from 4 mm to 1 mm and SP as those in the sieves between 1 mm and 0.160 mm. Particles that filtered through the 160 μm were considered as Fine Particles (FP).

The granulometry of the forage particles and the duodenal content (expressed in NDF) were measured in concurrently-run experiments (Archimède et al., 2000) using similar diet: all particles of the forage were Large particles, whereas for the duodenal content, large, small and Fine Particles represented 1.33, 54.8 and 43.8% of the pool of NDF with no difference between diets.

The total rumen content of NDF (TRC-NDF) was estimated by multiplying the total rumen content of DM by the NDF content in the rumen.

To calculate for reduction size, passage and digestion rate we used the same model for digestion in the rumen illustrated by Ichinohe et al. (1995) in Figure 1.

The fractional rates (% per h) of total disappearance, passage and digestion of total NDF, Large Particle of NDF (LP), Small Particle (SP) of NDF and Fine Particles (FP) particle of NDF were calculated according to Rinne et al. (2002) as follows:

NDF rate of disappearance from the rumen (kiWR)
= (1/24)×(intake NDF, g/d)
/(mean rumen pool size of NDF, g)

NDF rate of passage from the rumen (kpWR)
= (1/24)×(ruminal outflow of ADL, g/d)
/(mean rumen pool size of total ADL, g)

NDF rate of digestion (kdWR) = kiWR-kpWR

Ruminal outflow was calculated using the mean coefficients of stomach digestibility recorded with similar forage (Archimède et al., 2000).

LP entrance rate in the rumen (kiLP)
= (1/24)×(intake NDF, g/d)
/(rumen pool size of LP-NDF, g)

Table 1. Chemical composition (g/kg) of the 14, 28, 42 and 56-day old *Digitaria decumbens* grass consumed by six Black-belly rams

	Regrowth age (days)			
Constituents (g/kg)	14	28	42	56
Organic matter	840	887	896	879
Crude protein	130	79	72	57
Neutral detergent fibre	740	777	790	790
Acid detergent fibre	380	429	442	441
Acid detergent lignin	71	74	78	78

LP reduction size rate in the rumen (krLP)
= (1/24)×intake of indigestible NDF, g/d)
/(mean rumen pool size of indigestible LP-NDF, g)

LP passage rate (kpLP)
= (1/24)×ruminal out flow of LP-NDF. g/d)
/(mean rumen pool size of indigestible LP-NDF, g)

LP-NDF digestion rate in the rumen (kdLP)
= KiLP-krLP-kpLP

SP-NDF entrance rate in the rumen (kiSP) = krLP

SP-NDF reduction rate in the rumen (krSP)
= ((1/24)×(indigestible NDF intake, g/d)×krLP)
/(mean rumen pool size of indigestible NDF-SP, g)

SP-NDF passage rate from the rumen (kpSP)
= (1/24)×(ruminal outflow of SP-NDF. g/d)
/(mean rumen pool size of indigestible SP-NDF, g)

SP-NDF digestion rate (KdSP) = kiSP-krSP-kpSP

FP-NDF entrance rate in the rumen (kiFP) = krSP

FP-NDF passage rate (kpFP) is calculated as the weighed mean of kpLP, kpSP and kpFP.

FP-NDF digestion rate (KdFP) = kiFP-kpFP

Indigestible NDF intake was determined using the mean coefficient of total tract indigestible NDF of each forage measured in a parallel trial, conducted under the same conditions, with the same forage harvested from the same pasture (Archimède et al., 2000). Ruminal outflow of NDF, LP-NDF and SP-NDF were calculated using the mean coefficient of stomach indigestible NDF of each forage and the proportion of each particle in the duodenal sample (Archimède et al., 2000). Indigestible LP-NDF and SP-NDF were determined using the coefficient of indigestible NDF obtained with the nylon bag method.

Statistical analyses

Data (intake, digestive parameters) were analysed using the General Linear Model procedure of SAS (1987) including forage (d.f. 3) and animal (d.f. 5) effects. The effect of periods was tested on the residues of the precedent model and was not significant. Moreover, similarities among all measurement parameters were first shown by calculating correlation coefficients using the COR procedure of SAS. Regressions between intake and the

Table 2. Effect of the regrowth age of a *Digitaria decumbens* grass (14-, 28-, 42- and 56-day old) on intake in the rumen of Black-belly rams

	Age of regrowth (days)				
	14	28	42	56	sem
Intake (g/BW$^{0.75}$/day)					
Dry matter intake	75.2^a	62.9^b	52.6^b	48.5^c	2.0
NDF intake	55.6^a	48.7^b	41.5^c	38.3^c	1.6
Intake (g/day)					
Dry matter	1,454.0^a	1,234.0^b	1,022.0^c	915.0^d	38.0
Organic matter	1,221.0^a	1,095.0^b	916.0^c	803.0^d	33.0
Crude protein	189.0^a	97.0^b	73.6^c	52.1^d	4.1
NDF	1,076.0^a	959.0^b	808.0^c	723.0^d	30.0
ADF	552.0^a	530.0^b	452.0^c	403.0^d	16.0
Intake (g/3 h)					
Dry matter	863.7^a	598.3^b	576.4^b	401.5^c	55.6
NDF	639.1^a	464.9^b	455.3^b	317.2^c	41.8

Table 3. Nylon degradation of NDF fraction of forage, large particle (LP) and small particle (SP) of a 14-, 28-, 42- and 56-day old *Digitaria decumbens* grass fed to six Black-belly rams

	Age of regrowth (days)				
	14	28	42	56	s.e.
Degradability 96 h of forage	78.93^a	73.70^b	67.40^c	60.30^d	1.20
Degradability 96 h of LP	51.60^a	45.38^b	36.96^c	34.50^d	0.97
Degradability 96 h of SP	23.60^a	22.90^a	21.60^a	22.87^a	0.72

Table 4. Effect of the regrowth age of a *Digitaria decumbens* grass (14-, 28-, 42- and 56-day old) on the particle size distribution of NDF (g) in the rumen of Black-belly rams, 3 and 12 h after the morning meal

	Age of regrowth (days)				
	14	28	42	56	s.e.
NDF pool in total rumen content (g)					
3 h	809.8	881.5	863.1	816.5	61.2
12 h	491.5[a]	527.5[a]	662.0[b]	742.0[b]	40.5
NDF pool in large particle (g)					
3 h	346.5	462.0	451.2	469.2	38.5
12 h	209.5[a]	242.3[ab]	297.7[bc]	334.7[c]	28.4
NDF pool in small particle (g)					
3 h	159.7[a]	173.8[a]	223.8[b]	211.2[b]	15.3
12 h	104.0[a]	163.2[b]	189.7[b]	245.2[c]	13.9
NDF pool in fine particle (g)					
3 h	303.7[a]	245.7[a]	188.2[b]	136.3[b]	26.5
12 h	178.0	122.0	174.7	162.2	22.3

Table 5. Effect of the regrowth age of a *Digitaria decumbens* grass (14-, 28-, 42- and 56-day old) on the particle size distribution of NDF (g/1,000 g of NDF intake) in the rumen of Black-belly rams, 3 and 12 h after the morning meal

	Age of regrowth (days)				
	14	28	42	56	Se
NDF pool in total rumen content (g/kg NDFI)					
3 h	712.6[a]	911.7[b]	1,079.7[c]	1,147.3[c]	45.3
12 h	428.2[a]	554.2[a]	814.8[b]	1,037.8[c]	51.5
NDF pool in large particle (g/kg NDFI)					
3 h	304.7[a]	473.4[b]	563.7[bc]	631.0[c]	36.9
12 h	184.4[a]	255.9[a]	366.7[c]	459.3[c]	34.3
NDF pool in small particle (g/kg NDFI)					
3 h	141.1[a]	179.8[b]	280.0[c]	297.5[c]	13.2
12 h	89.7[a]	170.3[b]	232.6[c]	337.8[d]	15.4
NDF pool in fine particle (g/kg NDFI)					
3 h	266.7[a]	258.3[a]	236.0[a]	218.8[a]	30.7
12 h	154.2[a]	128.0[a]	215.6[b]	240.6[c]	29.6

digestive parameters were then calculated based on the REG procedure and using the MAXR (Maximum r^2 improvement).

RESULTS

Diet composition and intake

The composition and intake of *D. decumbens* are reported in Table 1 and 2. DM (g/$BW^{0.75}$) intake was found to be significantly higher for the 14-day old forage than for the 28-, 42- and 56-day old grasses. The daily intake decreased curvilineary with regrowth age according to the following equation:

$$DMI = 82.4 - 1{\cdot}379\ days + 0.0104\ days^2$$
$(r^2 = 0.82,\ SE = 5.2,\ n = 24,\ p<0.0001)$

The mean daily DM intake on the days of rumen emptying did not vary from ram to ram. Similar trend was observed for the NDF intake.

The DM intake of 14-day grass for the first 3 hours after the morning meal (Table 2) was found to be significantly higher than the 28-, 42- or 56-day old pangola grass.

In situ nylon bag degradation

In situ 96-h degradability of the NDF fraction of forage and LP decreased as the regrowth age of the pangola increased (Table 3). No significant difference was registered for the SP fraction.

Rumen digestion

Digesta pool : The regrowth age of the pangola grass induced no significant differences in rumen NDF pool (TRC-NDF) estimated 3 hours after the beginning of the morning meal (Table 4). Twelve hours after the beginning of the morning meal, significant differences appear between diets. The amount of NDF increased steadily with the regrowth ranging from the 14 to 56 day old grasses, the differences being largest between the 28- and 42-day old grasses.

Regarding intake level (Table 5), there was an increase in NDF (g/kg NDF intake) with the regrowth age irrespective of the time after the meal. The difference was again highest for regrowth between the 28 and 42 days old

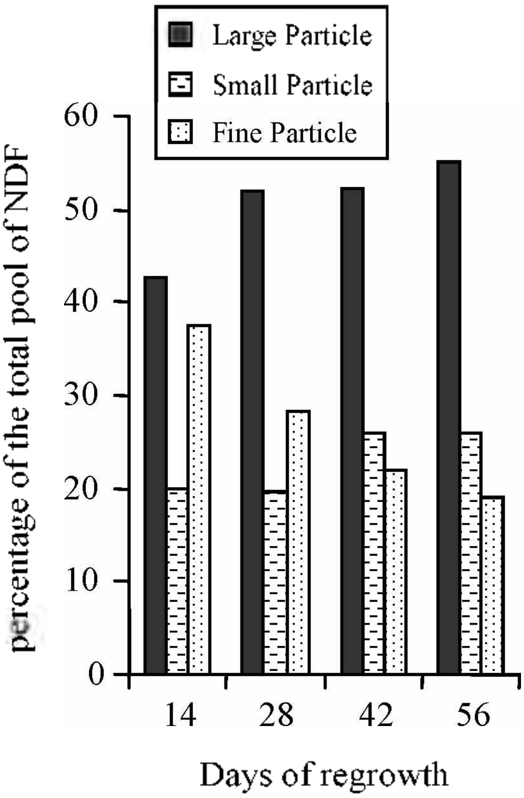

Figure 2. Effect of the pangola grass maturity (14, 28, 42 and 56 days regrowth) on the granulometry of the pool of NDF in the rumen at the end of the morning meal.

grasses.

In general, 3 h after the morning meal, in TRC, the proportion of LP and FP increased and decreased respectively with the maturity of the forage (Figure 2). As was observed with the TRC-NDF (g), 3 h after the beginning of the meal, the LP-NDF pool did not increase significantly with the regrowth age of the forage (Table 4). Nevertheless the LP-NDF pool registered with the 14-day grass tended ($0.06<p<0.09$) to be lower than those of the other grasses. Twelve hours after the meal, there was an increase in the pool of LP-NDF (g) with the maturity of the forage.

Three hours after the meal, the pool of LP-NDF (g/kg NDF intake) increased significantly with the forage regrowth age and this general increase was maintained 12 hours after (Table 5).

Overall, results concerning the pool of SP-NDF were similar to those registered with LP (Tables 4 and 5).

Variations in the pool of FP-NDF in the rumen after the morning meal (Tables 4 and 5) were generally inversely related to those registered for LP and SP. After the morning meal, the amount of FP-NDF (g) levels decreased with forage regrowth age. These differences disappeared 12 hours later. FP-NDF pools (g/kg NDF intake), at 3 h after the meal were not altered by forage maturity, whereas at twelve hours after the meal, FP-NDF pools generally increased with the maturity of the forage.

Fractional rate of disappearance, reduction, passage and digestion

The effects of grass regrowth age on digestion kinetics are presented in Table 6. The rates of disappearance, passage and digestion of TRC-NDF generally decreased with forage regrowth age.

For LP-NDF, it was observed that the rate of particle size reduction decreased significantly as regrowth age increased (Table 6). The same tendency was also observed for the digestion rate. Basically, a negligible rate of passage was recorded for forage regrowth age. Decreasing reduction rate and passage rate were recorded for SP-NDF with increasing forage regrowth age, whereas little or no significant difference was noted for digestion rate. Also, no

Table 6. Effect of the regrowth age of a *Digitaria decumbens* grass (14-, 28-, 42- and 56-day old) on : disappearance rate, reduction rate, passage rate, digestion rate of whole rumen NDF, large particle of NDF, small particle of NDF (SP-NDF) and NDF as fine particle fraction; in the rumen of Black-belly rams, 3 and 12 hours after the morning meal

	Age of regrowth (days)				
	14	28	42	56	s.e.
Whole rumen NDF (%/h)					
Disappearance rate	7.47[a]	5.72[b]	4.47[c]	3.89[c]	0.25
Passage rate	4.49[a]	3.36[b]	2.63[c]	2.42[c]	0.14
Digestion rate	2.98[a]	2.36[b]	1.18[c]	1.47[c]	0.16
Large particle NDF (%/h)					
Reduction rate	9.78[a]	7.60[b]	5.10[c]	4.98[c]	0.32
Passage rate	0.13[a]	0.10[b]	0.07[c]	0.07[c]	0.00
Digestion rate	7.65[a]	3.87[b]	4.13[bc]	3.38[c]	0.25
Small particle NDF (%/h)					
Reduction rate	1.27[a]	0.91[b]	0.38[c]	0.33[c]	0.06
Passage rate	7.10[a]	6.59[a]	4.10[b]	3.65[b]	0.29
Digestion rate	1.41[a]	0.10[b]	0.62[b]	0.99[a]	0.28
Fine particle NDF (%/h)					
Passage rate	4.35	4.03	2.55	3.11	0.68

significant difference was observed for the rate of passage of the FP-NDF.

Intake and digestive parameters

Multivariate predictive regressions of Dry matter intake from digestive parameters showed that total passage rate of NDF from the rumen was the main determining parameter for intake (r^2 = 0.66). Moreover, passage rate is in close correlation with the TRC-NDF disappearance rate (r = 0.97), the digestion rate of TRC-NDF (r = 0.95), the reduction rate of SP-NDF (r = 0.92), the reduction rate of LP (r = 0.83), the digestion rate of LP-NDF (r = 0.83). No significant correlation between passage of NDF and digestion rate of SP was recorded.

Simple predictive regression of intake from digestive parameters showed high and positive correlations between intake of Dry matter (or NDF) with TRC-NDF passage rate (r = 0.81), TRC-NDF disappearance rate (r = 0.77), SP-NDF reduction rate (r = 0.76), SP-NDF passage rate (r = 0.72), LP-NDF passage rate (r = 0.68), LP-NDF reduction size rate (r = 0.68), LP-NDF digestion rate (r = 0.68) and Total NDF digestion rate (r = 0.64). The correlations were not significant between intake, FP-NDF passage rate (0.18) and SP-NDF digestion rate (0.05).

DISCUSSION

Intake

Intake results for this experiment confirm those previously recorded by several authors: Chenost (1975), Aumont et al. (1995), Archimède et al. (2000). Large variations in the range of dry matter intake existed according to the regrowth age of the tropical grass. Intake decreased with older regrowth. Moreover, the high intake of the 14-day old pangola grass was similar to the intake of young temperate forage (Jarrige, 1988). Nevertheless this high level of intake registered with this immature tropical grass is also observed with mature temperate grasses. This phenomenon is a consequence of the particular physiology associated with the C4 pathway of tropical grasses whose cell components mature rapidly in comparison to C3 grasses (Wilson, 1994). Hence, a 6-week tropical grass is an old forage when compared with a temperate grass forage, and for this latter reason, it must be valorised at a younger stage of regrowth, once the main objective is to increase the dry matter intake as well as the digestible dry matter intake (Mahr-un-Nisa et al., 2006). Therefore, in this experiment, the 14-day old grass can be considered as a reference, i.e. a grass with some of the characteristics of a temperate one.

Rumen digestion kinetic and intake

Estimates of the rate of passage and digestion of NDF, reduction rate of Large Particles and Small particles and passage rate of Small particles are all closely related to those reported by Poppi et al. (1981a,b) and McLeod et al. (1990) for tropical grass and Ichinohe et al. (1995) and Mc Leod and Minson (1988) for temperate forage.

In our experiment, dry matter intake of grasses appeared to be regulated by rumen fill and by problems in the evacuation processes of the content through digestion and passage rate (Forbes, 1994). NDF intake actually decreased with grass regrowth age, whereas the pool of NDF in the rumen at the end of the morning meal was similar. This shows that there is a limit to the amount of NDF that can accumulate in the rumen. Consequently, the faster the NDF disappears from the rumen, the higher the intake as illustrated by the positive correlation between intake and the disappearance rate of NDF. In addition, the increase in the amount of NDF in the rumen per unit of NDF intake illustrates an accumulation of NDF in the rumen with older regrowth resulting from the decrease in the disappearance rate of the rumen pool of NDF. The disappearance rate of the NDF pool depends on the physical breakdown of particles and cellulolysis (microbial digestion). However, the faster evacuation of NDF content in younger grass cannot be explained by cellulolysis. Microbial enzymatic digestion needs time to be efficient (Wilson et al., 1989) and the duration of the meal was only 3 h. Hence, this is not sufficient to explain the reduction and then the evacuation of NDF outside the rumen.

Data concerning chewing behaviour should be useful to explain our result. McLeod and Minson (1988) reported that ingestive mastication and rumination accounted for 25 and 50% respectively, for LP broken down to SP and FP. McLeod et al. (1990) hypothesised that voluntary intake of tropical forage was associated with the resistance of LP to be breakdown to SP by chewing during both eating and rumination. Our data concerning the rumen pool of NDF (corrected by intake) 3 h after the beginning of the meal underscores the importance of the process of chewing during eating. First, the mean amount of NDF in the rumen per unit of NDF intake is lower for the 14 day grass. This may be an indication that during ingestive mastication an important part of NDF has been made soluble and evacuated outside the rumen with the younger forage. Moreover, the higher granulometry fineness of the particle pool in the rumen with the 14-day regrowth forage, compared with the others grasses, results mainly from a more efficient physical particle breakdown by chewing during eating. Recent studies in our laboratory (unpublished results) reported chewing values of 40 to 60 seconds per gramme of dry matter intake with similar pangola grass maturing from 14 to 56 days. The more efficient ingestive mastication of young forage compared with those of older forage is illustrated by the values registered for the rate of size reduction. However, this also takes into account chewing during rumination. The increase in the LP-NDF pool (corrected with intake) with older regrowth also illustrates an increase in the resistance of the grass to physical breakdown. This result is closely related to the evolution of the reduction rate of LP-NDF which decreases with the grass regrowth age. Wilson et al. (1989) and Kennedy (1995) indicated that tropical grasses have an inherent disadvantage with respect to particle breakdown that may be difficult to overcome. Our results illustrated a large variation in the resistance of the grasses to physical breakdown. Moreover, values for the reduction rate of LP-NDF remain relatively important in comparison to the rate of digestion which is relatively low and decreases dramatically. Our estimates of LP reduction rate are similar to those reported for temperate grass (Bernard, 1992; Ichinohe et al., 1995).

Digestion helps to elevate the density of particles to a level (Bernard, 1992) necessary (1.1-1.2) for them to be evacuated from the rumen. In our experiment, the low digestion rates for the old forage can partially explain its decrease in intake. Indeed, SP-NDF tends to accumulate in the rumen as the grass matures, although these particles theoretically, have the critical size to leave the rumen. It can be assumed that their density limits their evacuation from the rumen.

Our results suggest a high correlation between parameters which estimate physical (size reduction) and chemical (enzymatic) degradation in the rumen except for Small particle. This can be explained by the fact that the breaking down of the grass increases particle surface which is necessary to maximise microbial cellulolytic activity. Some of the biochemical characteristics of cell-walls (bond lignin-cellulose) probably limit enzymatic activity as well.

Because of the link between physical breakdown and enzymatic digestion of grass in the rumen our results do not allow for any conclusion concerning the driving force behind intake.

CONCLUSIONS

Improved intake is a major objective in ruminant nutrition. A general analysis of the results indicates large variations in intake correlated with large variations in parameters of cellulolysis and physical breakdown. This experiment also indicates that grass management is an important tool to pilot intake. It demonstrates the management of tropical forage at young state of regrowth age (<one month) for which high level of intake is the objective.

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