Handling time and bite mass mechanisms in large herbivores: contrasts between sward structure and grazing methods

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Introduction

Grazing is a time-dependent process where jaw movements of prehension, handling and chewing compete with them (Laca *et al.* 1994; Ungar *et al.* 2006). The grazing efficiency is dependent of bite mass and time per bite. Bite mass has been related to sward structure by forage height, structural components (Cangiano *et al.* 2002). In rotational stocking this effect becomes more pronounced, especially under high grazing down levels. Consequently, there is a progressive reduction in short-term intake rate (Fonseca *et al.* in press). New management targets should be proposed based on the predominant influence of sward structure in short-term intake rate by grazing animals (Carvalho *et al.* 2007). We hypothesise that intake potential of animals grazing tropical pastures will be reduced due to higher constraints in bite formation when compared to temperate pastures.

This study aimed to investigate the intake process of heifers under the influence of different sward heights and grazing down levels in two contrasting - tropical and temperate - forage species.

Methods

Two experiments were fulfilled with *Cynodon* sp. cv. Tifton 85, (25 ° 45 '00 " S, 53 ° 03' 25" W) between January and March 2011. Two other experiments were carried out with *Avena strigosa* cv. IAPAR 61, (30 ° 05 '27" S, 51 ° 40' 18" W), between July and September 2011. The experimental area had 1.3 ha and 2.6 ha for *Cynodon* sp. and *A. strigosa*, respectively. Experiment 1 used six pre-grazing sward height treatments (10, 15, 20, 25, 30 and 35 cm) in *Cynodon* sp. Experiment 2 had eight pre-grazing sward heights (15, 20, 25, 30, 35, 40, 45 and 50 cm) in *A. strigosa*. Experiment 3 and 4 used five grazing down levels (0, 20, 40, 60 and 80%), based upon the best sward height set in experiment 1 and 2, respectively (20 cm for *Cynodon* sp. and 30 cm for *A. strigosa*). All experiments were performed with four replicates. The sward height variation between pre- and post-grazing did not exceed 5%. The sward height was measured at 200 points using a sward stick. The total herbage mass was estimated by cutting five samples per experimental unit using a quadrat of 0.153 m^2 of area. For the *Cynodon* sp. trial, we used Jersey dairy heifers with an average live weight of 318 ± 13 kg. In *A. strigosa*, were used cross bred Angus x Brahman beef heifers with an average live weight of 349 ± 20 kg. To compare sward structure effect under different animals we corrected the bite mass and the short-term intake rate (STIR) effect (Yi') by adding the residual effect of bite mass (x) to estimate values for an average bite mass: Yi '= Yi - f (xi) + f (x), where Yi is the original variable, f (xi) is the model that relates Yi to the bite mass and x is the average of bite mass. The animals were fitted with faeces and urine collecting bags and with IGER Behaviour Recorders. This device records the grazing jaw movements (Rutter, 2000). The short-term intake rate (STIR) was fixed by the double weighing technique using a balance with an accuracy of 10 g. STIR was calculated by the equation:

$$STIR = [(W2 – W1) / (t2 – t1)] + [(W3 – W4) / (t4 – t3)] \times [(t2 – t1) / ET]$$

where: STIR = short-term intake rate; W1 and W2 = animal's weight pre- and post-grazing; t1 and t2 = pre- and post-grazing time; W3 and W4 = animal's weight pre- and post-insensible weight losses; t3 and t4 = pre- and post-insensible loss time and ET = effective eating time.

For all variables studied, in the four experiments, analyses of variance were done using a significance level of 5%. All behavioural and sward variables showed a normal distribution (tested by the Kolmogorov–Smirnov test, $P>0.05$). The treatment means were compared by Tukey's HSD test ($P<0.05$). The paddock was considered the experimental unit. To compare the behavioural variables, linear regression analysis (y = a + bx + € ij) was performed for each forage species. All statistical analyses were conducted on R 2.12.0 GUI software (R Development Core Team 2010).

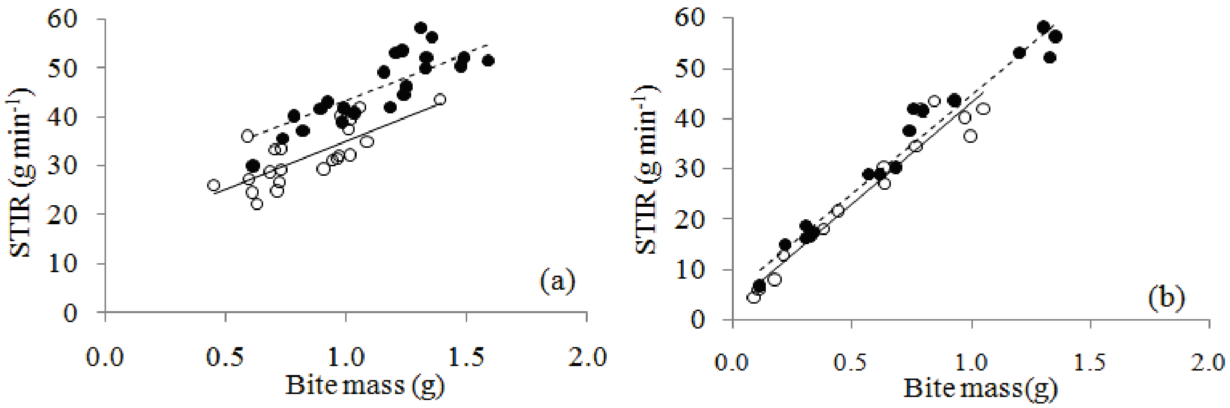

Figure 1. Relationship between bite mass and short-term intake rate in continuous grazing (a) and rotational stocking (b) for *Cynodon* sp. (○, solid line) and *A. strigosa* (●, dashed line) pastures. The models presented for each forage species demonstrate the estimated equations when the tests of equality of slopes were significant.

Results and Discussion

The total herbage mass (THM) in *Cynodon* sp. ranged from 3 to 7 t DM/ha while in *A. strigosa*, the variation was between 0.5 and 3 t DM/ha in experiments 1 and 2. The sward height and THM decreased significantly throughout the grazing down in both forage species with decreases of 1.5 t between pre- and post-grazing for both forage species. The relationship between STIR and bite mass proved there was an effect of forage species on the intercept of models without difference in slopes (Fig. 1). That is, in continuous grazing (Fig.1a), with an equivalent bite mass, the STIR was 9 g higher in *A. strigosa* (y = 24.46 + 18.91x, R^2 = 0.67, *SEM* = 2.5, *P*<0.001) than in *Cynodon* sp. (y = 15.60 + 18.91x, R^2 = 0.60, *SEM* = 2.4, *P*<0.001). In rotational stocking (Fig. 1b), this difference was 2.8 g (*A. strigosa* y = 5.53 + 39.15x, R^2 = 0.97, *SEM* = 4.6, *P*<0.001; *Cynodon* sp. y = 2.68 + 39.15x, R^2 = 0.94, *SEM* = 3.6, *P*<0.001).

Grazing is a time-dependent process where jaw movements of prehension, handling and chewing compete (Ungar *et al.* 2006). The efficiency of forage harvested by animals (high STIR) is directly related to bite mass (Fig. 1a, b). The bite mass can be reduced in low sward heights due to structural components (Laca *et al.* 1992), which constrain the process of bite formation. Bite mass may also be reduced in high sward heights and also in higher grazing down levels (Benvenutti *et al.* 2006, Fonseca *et al.* 2013). For smaller bite mass the animals need fewer times per bite. As a result, the animal can dedicate more grazing jaw movements to take bites, decreasing the time per bite (Benvenutti *et al.* 2008, Fonseca *et al.* 2013). However, this compensation is limited because the fixed time available for each jaw movement (Newman *et al.* 1994). Mean while, this reduction in time per bite is only partly compensated by the reduction in bite mass, decreasing drastically STIR throughout grazing down in both forage species. According to these results, even when the pasture is managed to be an optimal sward structure for grazing, animals, more grazing time will need in *Cynodon* sp. than *A. strigosa* because of the higher time required to harvest an equivalent bite mass. Therefore, regardless of the grazing method and forage species, any management strategy that allows the animal harvest high bite masses is extremely important for improving nutrient acquisition rate and efficiency.

Conclusion

Bite mass is the determinant component of short-term intake rate by heifers, regardless of the forage species and grazing method studied. Management targets should permit animals to graze swards that promote high bite masses.

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