Relationship between grazing jaw movements and time per bite in cattle: effect of sward structure and grazing methods

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Introduction

The time per bite is the result of the interaction between mouth morphology, animal behaviour and sward structure (Laca *et al.* 1994). The time per bite increases with bite mass (Laca *et al.* 1994), but it has a constant component that is the time required to open and close the jaws, namely, the time required for one jaw movement (Hirata *et al.* 2010, Newman *et al.* 1994). In this experiment we tested the hypothesis that the time per jaw movement will remain constant independently of sward structure and grazing method.

Methods

We performed four experiments, two with *Cynodon* sp. cv. Tifton 85 (Jan- March 2011) and two with *Avena strigosa* cv. IAPAR 61 (July - Sept 2011) in southern Brazil. The experimental area for *Cynodon* sp. consisted of 1.3 ha divided into 18 paddocks of 500 m^2 each. For *A. strigosa*, we sowed an area of 2.6 ha (seed density: 80 kg/ha) on four occasions in order to obtain different sward heights. The two first experiments (one with *Cynodon* sp. and the other with *A. strigosa*) aimed to simulate continuous grazing. During 45 min heifers grazed pastures of different sward height (six height treatments from 10 to 35 cm with *Cynodon* sp. and from 15 to 50 cm with *A. strigosa*). Paddock areas were adjusted to limit sward height depletion to values lower than 5% during the 45 min grazing trials. The other two experiments aimed to simulate rotational grazing and consisted of 45 min grazing down trials. Treatments consisted in 0, 20, 40, 60 and 80% grazing down levels for both *Cynodon* sp. and *A. strigosa*. Initial sward heights were 20 cm for *Cynodon* sp. and 30 cm for *A. Strigosa* because these were the sward heights that allowed the maximum instantaneous intake rates during the two first experiments. Each treatment in all four experiments was replicated four times. The total herbage mass was estimated by cutting five samples per experimental unit using a quadrat of 0.153 m2. Six Jersey heifers (initial age of 20 ± 2 months, average live weight of 318 ± 13 kg) were used in experiments with *Cynodon* sp. and three Angus x Brahman cows (initial age of 45 ± 2 months, average live weight of 349 ± 20 kg) in experiments with *A. strigosa*. All animals were previously trained to the experimental procedure and kept in an adjacent area similar to the experimental paddocks. We recorded grazing jaw movements (GJM) using IGER Behaviour Recorders. GJM were subsequently analysed with the software Graze (Rutter, 2000). The time per bite was compared to the equation of Laca *et al.* 1994. We used covariance analysis to test the effect of forage species and grazing method on the relationship between the number of GJM per bite and the time per bite. Residuals respected homogeneity and normality. To remove the effect of bite mass on time per bite in our last analysis, we used a transformed variable obtained by adding the residuals of the relationship between bite mass and time per bite to the time per bite predicted value of the average bite mass. All statistical analyses were conducted in R 2.12.0 GUI software (R Development Core Team 2010).

Results and Discussion

The forage species did not affect the relationship between the number of GJM per bite and the time per bite neither in the experiments simulating continuous grazing (Figure 1a; equation: $y = 0.44 + 0.68x$; $R^2 = 0.68$, SEM = 0.14, $P<0.001$) nor in those simulating rotational grazing (Figure 1b; equation: $y = 0.31 + 0.67x$; $R^2 = 0.83$, SEM = 0.15, $P<0.001$).The grazing method did not affect the slope of the relationship ($P>0.001$) but the intercept was significantly lower with rotational grazing ($P>0.001$). This means for the same number GJM per bite there was less grazing time required for rotational than continuous grazing.. However, when removing the effect of bite mass on time per bite (see methods), neither the forage species nor the grazing method, affected the relationship between the number of GJM per bite and the time per bite ($y = 0.677$, $R^2 = 0.77$, SEM = 0.14, $P<0.001$).

In both forage species, smaller bite masses resulted in lower time per bite, confirming that if bite mass decreases, the animal needs a smaller number of jaw movements for ingestion (Allden and Whittaker 1970). As a result, the animal can dedicate more grazing jaw movements to taking bites, decreasing the time per bite (Benvenutti *et al.* 2008, Fonseca *et al.* 2013). However, this compensation partially

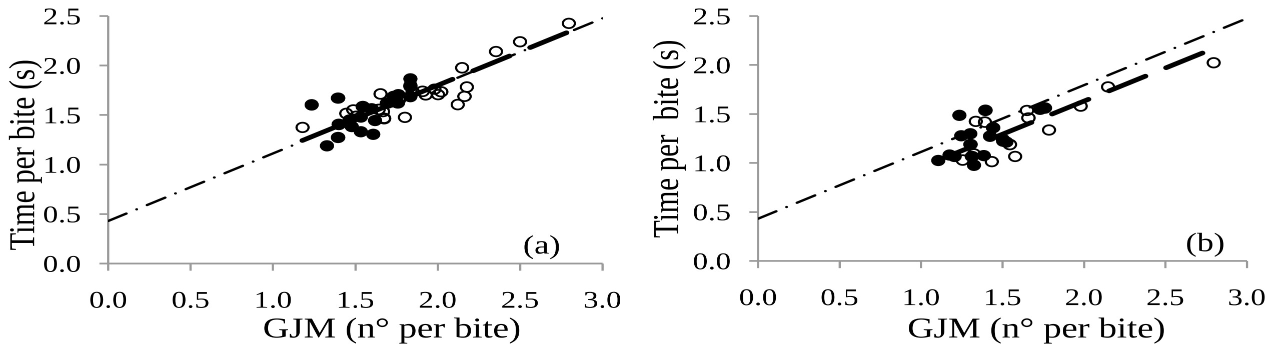

Figure1. Relationship between the number of grazing jaw movements per bite and the time per bite under continuous grazing (a) and rotational grazing (b) conditions with both *Cynodon* sp. (○) and *A. strigosa*(●) forage species. Regression equations (— —) and reference equation from Laca *et al.* 1994 (− · −).

results from the fact for each bite taken, the animal spends a fixed time to open and close the jaws (Hirata *et al.* 2010, Newman *et al.* 1994). This time is independent of the quantity of forage consumed (Fig. 1a, b) and refers to a fixed cost per bite that includes head movements to take new bites and an exclusive time that might be required for swallowing (Laca *et al.* 1994). Considering the same bite mass, we found that fixed costs were similar in continuous (Fig. 1a) and rotational grazing (Fig. 1b). However, for each GJM per bite, animals spent 0.133 s less in rotational grazing than in continuous grazing. Therefore, most of the time spent per bite (0.677 s) is due to this fixed time required for the animal to take a jaw movement and the remaining time per bite is associated with the bite mass harvested (Illius *et al.* 1995).

Conclusion

Regardless of the forage species and grazing method studied, the animals spent 0.677 s for each jaw movement.

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