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The effect of the order of feeding oats and chopped alfalfa to horses on the rate of feed intake and chewing activity

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Introduction

The speed of intake varies between ~10 min/kg for concentrates and ~45 min/kg for roughage. Associated with the rapid ingestion of concentrates per unit of time is the limited production of saliva (<3kg/kg feed) whilst the consumption of roughage encourages a profuse production of saliva (~5kg/kg feed, *Meyer* et al. 1975 1986). Food consumption accounts for the major part of the time budget of equids kept under natural conditions (*Frentzen* 1994). Concentrate feeding reduces the time spent feeding enabling other activities such as work. However, for the majority of horses this 'free' time is not used in useful activities. The consequent risk is that abnormal behaviours such as coprophagia or crib biting are performed and these present areas of concern for animal welfare (*McGreevy* et al. 1995; *Waters* et al. 2002). Another critical aspect of using concentrates is that of low saliva production. Obviously, there is no mechanical problem for the transport of the rather dry, ensalivated concentrate through the oesophagus, but problems may arise in the stomach (Vervuert and Coenen 2004) and may influence the function of the entire gut (*Willard* et al. 1977). Differences in saliva production per unit of feed affect the dry matter concentration of the gastric digesta. This interferes with digestive processes in the stomach, in particular, the acidification of the ingesta necessary to reduce microbial activity and to condition the material for digestion in the small intestine.

In order to offset the problems associated with the rapid consumption of concentrate it is common practice to recommend that chopped roughage is mixed with the concentrate or, that roughage be fed before providing the concentrate. However, the precise effects of these recommendations in terms of reducing the speed of intake are unknown. The objectives of the present study were to elucidate the effects of feeding oats alone before or after feeding chopped alfalfa or, in admixture with the alfalfa on feed intake and the chewing activity of healthy horses.

Material and methods

Four horses (560±36 kg M) were used in a changeover experiment. The animals were individually kept on wood shavings in boxes with free access to water. The diets (2 meals/d) consisted of chopped alfalfa (0.5 g crude fibre=1.6 g alfalfa/kg M x meal-1) and unprocessed oats (2 g starch=4.5 g oats/kg M x meal-1). The diets were offered alternatively in three ways; a) first alfalfa and immediately thereafter oats (A/O), b) first oats followed by alfalfa (O/A) or c), a mixture of alfalfa and oats (A-O-mix). Each diet was fed for 21 days. The time taken to consume the feed was recorded for each horse from 9 to up to 14 days depending on the type of feed. Parallel special halters were used which were equipped with a tube (fixed on the inner side of the strap which passes under the lower jaws), a pressure transducer and a data logger. Any jaw movement produced a signal via an increase in pressure in the tube (the indirect method). The signals were recorded by a Gemini Data Logger®. Myography measurements were performed on two days for each horse per feeding session. Three electrodes were mounted superficially, one on the withers, the other two on the rising and the horizontal branch of the mandibles. The signals were amplified by an electronic amplifier (EMG Signalverstärker, IED®). The software package DasyLab® was used as an interface for recording and reading of data. The data were analysed using an analysis of variance (Statistica®) and the results are presented as mean ± standard deviation (SD).

Results

The quickest intake was recorded with the alfalfa-oats mixture. The rate of intake of both oats and alfalfa was not influenced by the feeding order (Table 1). The chewing activity (chews/100 g) was similar for the A-O-Mix and oats at about

Table 1 The mean (n=4) rate of intake (g/min) and chewing activity (chews/100g and chews/min) of horses fed oats or alfalfa separately and together 1) duration of one activity cycle 2) difference between min and max within a chewing cycle a. different superscript indicate significant differences, $p<0.05$.

Indirect recording of jaw movement				
diet		g/min	chews/100 g	chews/min
A-O-Mix	--	101 ±25.7^{a}	83 ±15.3^{a}	81 ± 8.3
A/O	alfalfa 1st	64 ±10.2^{bc}	132 ±27.8^{bc}	82 ± 8.1
	oats 2nd	89 ±15.8^{ad}	87 ±13.0^{ad}	76 ±13.6
O/A	oats 1st	104 ±16.8^{ad}	81 ±7.9^{ad}	84 ±13.0
	alfalfa 2nd	59 ±13.7^{bc}	147 ±25.2^{bc}	80 ±12.1
Myographical recording of jaw movement				
diet		chews/min	cycle, sec[1)]	amplitude[2)], mV
A-O-Mix	--	87 ±9.0	0.21 ±0.019	11.7 ±3.99
A/O	alfalfa 1st	82 ±10.6	0.20 ±0.027	8.9 ±3.33
	oats 2nd	82 ±10.0	0.21 ±0.027	10.5 ±3.01
O/A	oats 1st	81 ±9.7	0.21 ±0.019	10.0 ±3.85
	alfalfa 2nd	80 ±9.6	0.21 ±0.043	10.3 ±4.92

[1)] duration of one activity cycle [2)] difference between min and max within a chewing cycle

[a..] different superscript indicate significant differences, $p<0.05$

90. More chewing was required during alfalfa ingestion independent of the order of feeding.

No differences exist between chews/min between the A-O-Mix or the roughage and oats. The indirect method and myography yielded comparable results for chewing activity. The mean duration of a chewing cycle was 0.2 sec with no influence of feeds or feeding order; .there was a trend towards shorter cycles towards the end of a meal (Figure 1). Further time-associated changes were, an increase in the interval between chewing episodes and a reduction in the amplitude. Chews/min were unaffected by type of feed and feeding order.

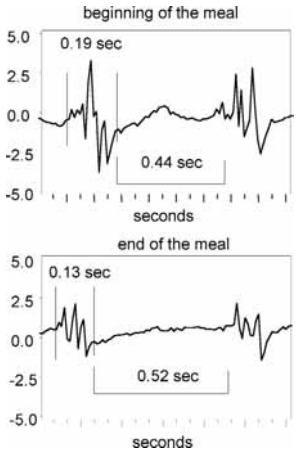

Fig 1 Examples of two chewing cycles measured by myography in one horse at the beginning and end of a meal (A-O-Mix); one chewing cycle is defined as the 0.13-0.19 s lasting sequence of spikes.

Discussion

There is a close interaction between nutrition and behaviour. Negative effects may be seen amongst stabled horses (*Vervuert* and *Coenen* 2001). Stereotypic behaviour is a common problem in horses that are isolated and inactive. Therefore, any feeding regime that could increase the time spent feed intake would be beneficial. The hypothesis that, by simply mixing roughage with concentrate the rate of food consumption will be reduced, is flawed. About 60 g alfalfa are consumed per min whilst oats are ingested at 90-100 g per min; mixing both components together seems to speed up intake. Since both feeds are highly palatable any confounding effects of feed preference can be ignored. A lower rate of intake was expected when forage was fed first but this was not confirmed by the results of the current study. The order in which the feeds were supplied was insufficient to influence the rate of intake (g/min). The chewing frequency (chews/min) showed little variation between the diets and in the order of feeding. As saliva production is associated with chewing activity, it can be concluded that saliva production per min was comparable. Consequently the chews/g of feed determines salivation during ingestion and alfalfa stimulates more chewing and thus more salivation than oats.

Conclusion

Horses have fairly uniform chewing frequencies of 80-85 chews/min. Variations in feed intake are thus not related to changes in chewing frequency but rather to the need to reduce particle size. Neither feeding oats after forage nor by mixing them with forage reduced the speed of intake or the number of chews per unit of feed increased. The ratio of roughage to oats used in the current study (~1:3) is different from the ratio in common rations. Thus, further experiments are required to discover more about fibre/concentrate interactions. Cereal/fibre mixes of the type used in the current study appear to be of little benefit in ameliorating the rapidity with which concentrates are consumed.

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