Adding chopped straw to concentrate feed: The effect of inclusion rate and particle length on intake behaviour of horses

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Introduction

Physiologically horses have evolved to consume structural herbage, which takes a considerable amount longer to chew than cereals or processed feeds. Previous research has highlighted a significant reduction in chewing rates for concentrate feed As the principal stimulus to saliva production in the horse is mastication, the amount of saliva produced therefore can also be compromised when feeding concentrates, which may influence subsequent digestion as well as buffering within the stomach. *Dulphy* et al. (1997) observed that the intake rates (dry matter per minute = DM/min) almost halved when comparing hay and straw (14 g and 7.9 g DM/min, respectively), highlighting the effect of physico-chemical composition on chewing efficiency in horses. for buffering stomach contents is also compromised. The inclusion of dried chopped forages or chaff has become popular but there are few published reports on the effects of chaff length or inclusion rate on concentrate feed intake behaviour. The purpose of this experiment study was to investigate the effects of increasing the amount of straw chaff to concentrate pelletswithin a meal on such behaviour of horses.

Materials and Methods

Feed intake behaviour (chews/minute, intake time/kg Wet Matter [WM]) was measured in 6 mature horses (3 large horses: 670±19kg; 3 small horses: 508±12 kg) morning and evening for the following feeds, fed in approximately 1kg meals: their normal diet mix evening feed (NDM: pellets 50%, Lucerne-straw chaff 15%, and soaked sugarbeet pulp 35%), this feed's normal diet pellets alone (NDP), a trial pellet (PP), a trial pellet-fibre mix (80% pellets, 10% molasses and 10% short chopped lucerne) core pellet mixed with short chopped lucerne and (PF); PF the trial PF mix with added chopped straw (at two lengths – short [S] ~2.5 cm; long [L] ~4 cm) so that the added straw was present in the final mixture at three inclusion rates (PF10%, 20% and 30% both for L or S).

Both morning and evening (7.00 am and 17.00 pm) horses had not received any other feed for at least 3 hours prior to feeding times. Horses were offered 1-1.2 kg of each feed and feed was replaced after approximately 90% of feed had been eaten. Chews per minute were measured by direct observation technique and removed feed was weighed. Intake rate (g/minute) and chewing rate (chews/kg) were calculated from measurements. Feed volume was measured according to cm^3 occupied by a set level of each feed using volumetric flasks and a feed particle size index was calculated according to mean particle size of individual ingredients and by allowing for sieve mesh size used during pelleting procedure.

Trial feeds were fed according to a Latin Square design and the results analysed using analysis of variance after testing for normal distribution of data. The Spearman rank correlation test was used to test for associations. A p-value of less than 0.05 was taken as the lowest significance level.

Results

Mean intake behaviour results are given in Table 1. Multivariate analysis showed no effect of time of feeding on chews/minute, chews/kg WM or intake rate g/min. There was also no effect of horse group (according to size) on chews per minute. There was a significantly increased feed intake time and chews/kg WM for small horses ($p<0.01$, Figure 1).

Table 1 Mean intake behaviour of six horses (± standard deviation).

		Chews/min[b]	Chews/kg WM[c]	Intake time/kg WM (seconds)[c]	Intake rate (g/minute)[c]
Feed[a]	n	Mean s.d.	Mean s.d.	Mean s.d.	Mean s.d.
NDM	23	77 ± 12.8	556 ± 174.8	429 ± 108.8	147 ± 36.8
NDP	24	65 ± 11.6	472 ± 113.8	435 ± 60.1	140 ± 19.4
PP	27	69 ± 9.3	446 ± 99.0	388 ± 76.6	161 ± 32.1
PF	28	67 ± 11.3	609 ± 185.7	552 ± 170.2	113 ± 29.8
PF10L	24	68 ± 9.2	735 ± 149.8	652 ± 93.7	94 ± 15.7
PF10S	24	71 ± 8.6	735 ± 120.1	626 ± 114.6	99 ± 19.4
PF20L	24	66 ± 10.0	896 ± 189.8	822 ± 146.8	75 ± 13.1
PF20S	24	68 ± 10.0	918 ± 205.4	822 ± 227.4	77 ± 15.6
PF30L	22	68 ± 9.1	1074 ± 261.8	950 ± 183.5	64 ± 15.2
PF30S	24	69 ± 9.7	1103 ± 269.2	954 ± 201.4	66 ± 15.4

[a] NDM = normal diet mix, NDP = normal diet pellets, PP = trial mix pellets, PF = PP and 10% chopped Lucerne, PF 10,20,30 = refers to % of chopped straw inclusion rate in PF; L = long straw (~4 cm) and S = short straw (~2.5 cm)
[b] measured
[c] calculated

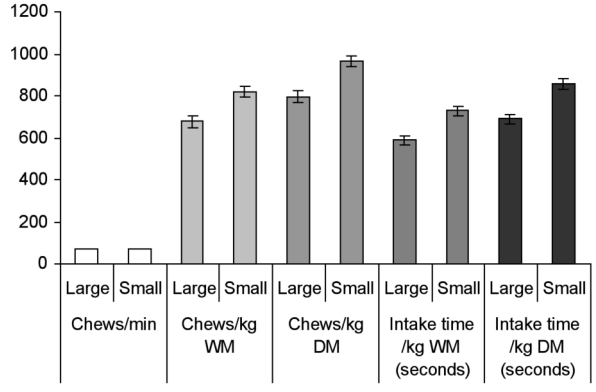

Fig 1 Mean feed intake behaviour for all feed according to horses size (Large or Small) (WM = wet matter; DM = dry matter).

There was a significant effect of type of feed on intake rates and chews/kg WM but no effect on chews/minute. Intake

times ranged from 429±108 (NDM) to 954±201 (PF30L) seconds per kg feed as fed (WM). NDM, NDP, and PP were eaten much more quickly with fewer chews/kg WM than the diets with added straw ($p<0.001$).

However, there was no significant difference between PF and PF10% (609±185 vs 735±149 chews/kg WM). In addition, there was no significant effect of adding more than 20% additional straw although the number of chews/kg increased (20L 896±190 vs 30L 1074±262).

There was no significant effect from straw chop length (see Figure 2). There was a significant correlation between feed volume and chews/kg WM and between feed particle index and chews/kg WM (Spearman Rank Correlation, $p<0.01$; see Figure 3.a & b).

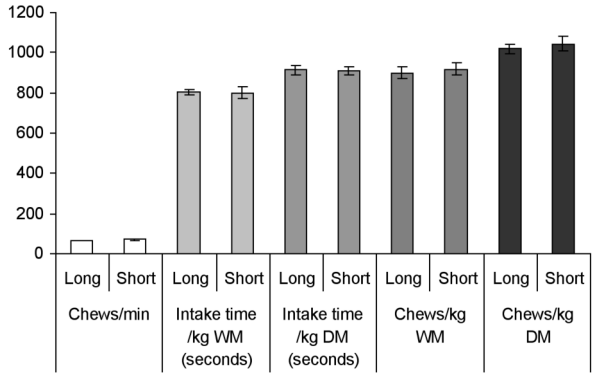

Fig 2 Mean Feed Intake behaviour (for PF10, PF20 and PF30, s.e.) according to straw chop length (Long ~ 4 cm or Short ~2.5 cm).

Discussion

Results show an increase in feed intake time and chews/minute relative to level of chaff inclusion for treatment feed (PF+). This indicates that adding chaff at an inclusion rate of 20 % to a pellet-fibre mix will lead to significantly longer eating periods and increased chews/kg WM ($p<0.01$). This is also likely to lead to an increased saliva production, thus increasing the buffering capacity against acid in the stomach. *Meyer* et al. (1986) reported that despite similar DM content of feed, hay boluses contain a much greater amount of wet matter (827g/kg WM) than boluses retrieved from horses fed a mixed cereal feed (685 g/kg WM) and this effect was directly related to chewing time.

The correlation between feed volume and particle index further confirms these results with one exception. For the normal diet mix it is likely that the much greater wet matter content due to inclusion of soaked sugar beet has contributed to a faster intake rate and formation of bolus, although NDM consisted of a similar level of chaff inclusion and particle size index to the PF10S mix (see also NDM, Figure 3b). Interestingly due to the density and weight of sugarbeet NDM does not stand out in Figure 3a, where volume/weight ratio is measured. This is in accordance with previous observations (*Ellis* and *Hill* 2002). Therefore the beneficial effect of including chopped forages in concentrate feed may only be true for high dry matter feed. Further research in this area is necessary.

Horse size (3 Warmblood/Irish Draught type horses: 670 ± 19kg; 3 small TB type horses: 508±12 kg) in this study showed no effect on chews per minute, although previous studies report a direct relationship between occlusal surface area and chewing rates (*Janis* and *Ehrhardt* 1988, *Meyer* et al. 1975). The lower intake rates observed in the small horse group were therefore likely to be due to the smaller oral capacity of those animals (*Meyer* et al. 1975).

There was no effect on intake behaviour from particle length of chaff. It would therefore be recommended to investigate the effect of increased chaff length on passage rates and on faecal particle size, as efficiency of feed particle reduction has been directly linked to chewing behaviour in the past (*Ellis* and *Hill* 2002, *Dulphy* et al. 1997, *Meyer* et al. 1986).

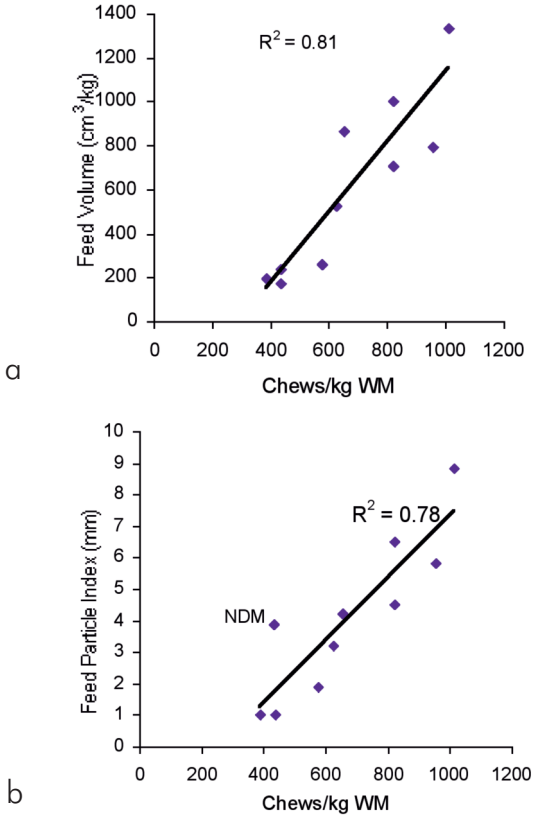

Fig 3 Correlation between chews/kg WM and Feed Volume (a) or Feed Particle Index (b) (NDM = normal diet mix).

Conclusion

A clear 120% increase in feed intake time and chews/kg was observed as straw chaff was added to a high DM concentrate feed. Such an increase, at this level of intake, is likely to lead to a beneficial increase in saliva production without adversely affecting passage rate although further work is needed to confirm this.

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