INTAKE OF IMPROVED AND UNIMPROVED PASTURES IN TWO SEASONS BY GRAZING WEANLING HORSES

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SUMMARY

Intake was estimated using the n-alkane technique in 2 groups of 16 grazing weanling horses at Rutherglen during November 1998 (fillies; mean liveweight = 355 kg) and May 1999 (colts; mean liveweight = 266 kg). Weanlings grazed either improved (phalaris, annual ryegrass and subterranean clover; limed and 150 kg/ha superphosphate) or unimproved (annual ryegrass, silver grass, barley grass and subterranean clover; no lime and 125 kg/ha superphosphate) pastures at both high (1.33 horse/ha) and low (0.8 horse/ha) stocking rates. Weanlings were dosed with 500 mg of C_{32} alkane (via a 300 mL liquid suspension) daily for 7 days prior to, and during, the 4 days of faecal collection. The concentrations of individual alkanes were measured in samples of faeces and herbage. Intake (g OM/kg LW) was then calculated for each horse. A good relationship (r^2 = 0.99) was observed between the proportions of herbage and faecal odd-chain alkanes in May 1999. However, in November 1998, the relationship was lower (r^2 = 0.86). Assuming the recovery of odd-chain alkanes does not vary with chain length, this suggests pasture samples collected in November may have been less representative of what the horses were selecting, particularly for horses grazing unimproved pastures at the high stocking rate (r^2 = 0.79). Intake estimates were similar when C_{33} or C_{31} concentrations were used along with the dosed C_{32}, except at the November 1998 sampling for horses grazing unimproved pastures at the high stocking rate. The only significant effect ($P<0.05$) was the interaction between pasture type and stocking rate at the November 1998 sampling when intake was estimated using the C_{31}/C_{32} alkane pair.

Keywords: horses, pasture, intake

INTRODUCTION

Information on the intake of horses at pasture is limited. Early studies in the United Kingdom (Archer 1973, 1978) focussed on pasture selectivity, and identified species preferences on the basis of grazing times. The first study in Australia to measure the intake of grazing horses was conducted in Queensland by Gallagher and McMeniman (1988). This was followed by a study by Martin (1993) in Queensland, both studies using the Cr_2O_3 method to estimate intake. While the Cr_2O_3 method has been widely used to estimate the intake of grazing animals, it has lost favour due to concern over the accuracy of the intake estimates, arising from the fact that digestibility is not estimated for each animal, but rather is estimated for a representative sample of pasture only (Dove and Mayes 1996; Dove *et al.* 2000). A better approach is to use an indigestible marker that occurs naturally in pasture that accommodates herbage digestibility in individual animals. One type of indigestible marker is the n-alkanes, whereby intake is calculated based on the ratios of a naturally occurring odd-chain alkane and even-chain dosed alkane of adjacent chain length.

McMeniman (2000) used the alkane technique to estimate feed intake, digestibility and diet composition with horses in stalls, and found that alkane-based intakes estimated measured intakes with a high level of accuracy. The results of this study have provided valuable information on the potential of tropical pastures to meet the nutrient requirements of broodmares and young horses (McMeniman 2000). As yet, there have been no studies on the intake of horses at pasture in the temperate areas of Australia. The objective of this study was to quantify the intake of weanling horses of improved and unimproved temperate pastures at 2 stocking rates in 2 seasons.

MATERIALS AND METHODS

Experimental design

This intake study was part of a larger study (Avery *et al.* 2000) that investigated the potential of improved and unimproved pastures to meet the nutritional needs of young horses. The design consisted of 2 pasture types, improved (phalaris, annual ryegrass and subterranean clover; limed and

fertilised with 150 kg/ha superphosphate in autumn 1998 and 1999) and unimproved (annual ryegrass, silver grass, barley grass and subterranean clover; no lime and fertilised with 125 kg/ha superphosphate in autumn 1998 and 1999). In addition to pasture type, 2 stocking rates were applied, 0.8 (low) and 1.33 (high) horses/ha. There were 4 replicates of the 4 treatments, providing 16 plots in all. Eight of these plots were randomly selected for this intake study (2 plots for each stocking rate within each pasture type).

Horses and measurements

All methods involving the use of animals were approved by the Charles Sturt University and Agriculture Victoria Animal Care and Ethics Committees. Thirty-two weanling thoroughbreds were randomly allocated on the basis of liveweight to the 16 plots upon arrival in autumn 1998 (fillies; initial liveweight 189 kg) and autumn 1999 (colts; initial liveweight 231 kg). Each plot included 2 weanlings, resulting in 8 weanlings per treatment group. Upon arrival, horses were drenched with Ivomec (MSD Agvet). Horses were subsequently drenched every 3 months, and hooves trimmed as required. Horses were inspected twice daily for the duration of the experiment.

Pasture intake was estimated in all 16 horses grazing the 8 selected plots in November 1998 and May 1999. Intake was estimated using the n-alkane technique (Mayes *et al.* 1986). Weanlings were dosed using a modification of the technique described by Marais *et al.* (1996). Dotriacontane (C_{32} alkane; Sigma-Aldrich, USA) was initially dissolved in petroleum ether in a rotary evaporator flask. Cellulose (10 fold the weight of C_{32}) was added, and the solvent evaporated in a fume cupboard prior to final evaporation in a 60^{o}C oven. The mix was then ground to pass through a 0.5 mm sieve. Prior to each day's dosing, 21.6 g of xanthum gum (Keltrol GM, Merk and Co, USA) was added to 5.4 L of water. Sufficient alkane-coated cellulose was then added to achieve a desired daily dose rate of 500 mg C_{32} per 300 mL of suspension. Each of the 16 horses was then dosed with this volume of suspension per day at 1000 h for 7 days prior to, and during, the 4-day faecal collection period. Faecal grab samples were collected at 1600 h during this period, bulked for each horse, and frozen until later analysis. Twenty pasture grab samples were collected from each of the plots during the faecal collection period, bulked for each plot, and frozen until later analysis. These grab samples were collected by hand, and taken randomly across each plot at 1300 h on each of the 4 days of faecal sampling.

After drying in an oven at 60^{o}C for 48 h, herbage and faecal samples were ground through a 1 mm screen. Alkanes were extracted from herbage and faecal samples using the method described by Friend *et al.* (1995), followed by gas liquid chromatography (Dove 1992) to determine alkane concentrations. Dried herbage and faeces samples were also analysed for dry matter (DM) and organic matter (OM) using AOAC (1980) standard procedures. The concentrations of C_{31} and C_{32}, or C_{33} and C_{32}, in both herbage and faeces samples were used to calculate OM intake per day (Mayes *et al.* 1986). Due to an unusually high concentration of C_{32} in 1 of the unimproved high stocking rate plots in November 1998, the herbage alkane concentrations from the other unimproved high stocking rate plot were used to estimate the intake of the horses on this plot. Liveweights recorded at the commencement of each sampling period (Table 1) were used to express intake on a liveweight basis. Herbage mass and metabolisable energy (ME) values reported are taken from Avery *et al.* (2000).

Regressions were calculated between the concentrations of individual odd-chain alkane (expressed as a proportion of total odd-chain alkane concentration) in herbage and faeces, in order to obtain an indication of how representative sampled herbage was of what the horses were selecting. Intake (g OM/kg LW) and the r^2 values from the regression of alkane proportions in herbage and faeces were analysed by ANOVA for each sampling time, using the General Linear Models procedure (SAS 2000), with pasture type and stocking rate being included as main effects.

RESULTS

Representative pasture samples

The r^2 values for the relationship between the proportion of odd chain alkanes in herbage and faeces were consistently high for samples taken in May 1999, but were lower in November 1998 (Table 1). At the November 1998 sampling, pasture type, stocking rate and the interaction were all not significant in the ANOVA of r^2. At the May 1999 sampling, the r^2 was greater ($P<0.05$) for samples taken from unimproved pastures (1.00 ± 0.00) than improved pastures (0.99 ± 0.00), and greater ($P<0.01$) in

pastures stocked at the low (1.00 ± 0.00) than at the high (0.99 ± 0.00) stocking rate. The interaction between pasture type and stocking rate was significant (P<0.05) at the May 1999 sampling (Table 1).

Intake

Intake, estimated using either the C_{31}/C_{32} or C_{32}/C_{33} alkane pairs, did not differ between pasture types or stocking rates in either November 1998 or May 1999. The interaction between stocking rate and pasture type was significant in November 1998, when intake was estimated using the C_{31}/C_{32} concentrations, but not when the C_{32}/C_{33} concentrations were used (Table 1).

Table 1. Intake (g OM/kg LW; daily intakes, kg OM, in brackets) estimated using the C_{31}/C_{32} or C_{32}/C_{33} alkane pair, r^2 of the relationship between faecal and herbage odd-chain length alkanes, horse liveweight (kg), pasture mass (t DM/ha) and metabolisable energy (MJ ME/kg DM) for each stocking rate in each treatment group in each season.

	November 1998					May 1999				
	IH	IL	UH	UL	s.e.m	IH	IL	UH	UL	s.e.m
Intake (C_{31}/C_{32})	18.0^{a} (6.2^{a})	23.2^{ab} (8.5^{ab})	33.1^{b} (11.1^{b})	18.6^{a} (6.7^{a})	3.5 (1.2)	13.1 (3.6)	12.8 (3.2)	14.2 (3.6)	10.9 (3.1)	2.0 (0.6)
Intake (C_{32}/C_{33})	16.1 (5.5)	22.0 (8.1)	16.9 (5.7)	17.2 (6.2)	2.7 (0.9)	13.6 (3.7)	12.7 (3.2)	12.6 (3.2)	10.5 (3.0)	2.0 (0.6)
r^2	0.86^{ab}	0.87^{ab}	0.79^{a}	0.90^{b}	0.04	0.98^{a}	1.00^{b}	1.00^{b}	1.00^{b}	0.00
Liveweight	346	373	339	364	10	273	254	255	281	22
Pasture mass	5.6	6.5	5.2	5.1	-	3.9	4.4	3.3	3.7	-
ME	5.6	7.8	8.3	8.5	-	10.5	10.5	8.1	6.5	-

Means in the same row and sampling date with different superscripts are significantly different (P<0.05)

DISCUSSION

The accuracy of the alkane technique for estimating intake relies on obtaining herbage samples that represent what the animals have consumed. Calculation of the proportion of individual odd-chain alkanes in herbage and faeces is 1 method of gauging how representative pasture samples have been of what the animals are consuming. However, even if the pasture sampled was identical to that consumed, the r^2 value may not be 1. This is a result of differences in the recovery of faecal alkanes with varying chain length (Dove and Mayes 1991). This may not be an issue with horses, as evidence indicates recovery may not vary with chain length as it does in ruminants (O'Keefe and McMeniman 1998; Ordakowski *et al.* 2001). The high r^2 values obtained for the alkane proportions in herbage and faeces for the May 1999 samples, therefore, indicate that pasture sampling was representative of what the weanlings were consuming, assuming that no correction for faecal recovery is required. In contrast, the lower r^2 values obtained at samplings in November 1998, particularly for the UH group, indicate that sampled herbage may have been less representative of what the weanlings were consuming. The higher herbage mass in November 1998 (Table 1) undoubtedly made it more difficult to obtain samples representative of what horses were consuming.

In general, there was good agreement between intake estimates made using the C_{31}/C_{32} and C_{32}/C_{33} alkane pairs. The exception was the November 1998 estimate for horses grazing unimproved pastures at the high stocking rate. While McMeniman (2000) reported values as high as 52 g DM/kg LW for weanlings grazing south-east Queensland pastures of high (70%) digestibility, we consider our estimate (33.1 g OM/kg LW), based on the C_{31}/C_{32} pair, to be inflated for several reasons. Firstly, the herbage mass and ME of the UH pasture in November was not substantially better than that of the UL pasture (Table 1). Secondly, as discussed above, there is some doubt as to whether herbage samples collected from the UH pasture in November 1998 accurately represented what the horses were consuming.

The generally higher intake estimates in November 1998, compared with those in May 1999, are unusual given the relative ME values of the pastures (Table 1). There are several possible explanations for this anomaly. Firstly, given the poorer relationship between herbage and faecal odd-chain alkanes in November 1998, unrepresentative sampling may have led to an overestimate of intake in November 1998. Secondly, the sampling of pastures for ME estimates is unlikely to represent the ME of the diet consumed. While the proportion of dead and green herbage were similar in both seasons, and in both pasture types and at both stocking rates (Avery *et al.* 2000), the greater mass in November 1998 may have provided the opportunity for horses to be more selective in their grazing habit, selecting a diet of higher ME than indicated in Table 1. Finally, as different horses were used in

the different years, and horses were older at the November 1998 sampling than at the May 1999 sampling, it is possible intake per unit of liveweight may differ.

Disregarding the C_{31}/C_{32} intake estimate in November 1998 for horses grazing unimproved pastures at the high stocking rate (on the basis that it is inflated as argued earlier), we conclude pasture intake was not affected by pasture type or stocking rate at either sampling date. This conclusion must be interpreted in context - the minimum herbage mass of 3.3 t DM/ha is likely to have provided the horses with the opportunity to select a diet of similar digestibility across pasture types and stocking rates.

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REFERENCES

AOAC (1980). 'Official Methods of Analysis of the Association of Official Agricultural Chemists.' 13th Edn. (AOAC: Washington.)

ARCHER, M. (1973). *J. Brit. Grass. Soc.* **28**, 123-128.

ARCHER, M. (1978). *J. Brit. Grass. Soc.* **33**, 239-243.

AVERY, A., NASH, D. and DEMPSEY, W. (2000). 'Rural Industries Research and Development Corporation, Project DAV 118A Final Report.'

DOVE, H. (1992). *Aust. J. Agric. Res*. **43**, 1711-1724.

DOVE, H. and MAYES, R.W. (1991). *Aust. J. Agric. Res.* **42**, 913-952.

DOVE, H. and MAYES, R.W. (1996). *J. Nutr.* **126**, 13-26.

DOVE, H., FREER, M. and FOOT, J.Z. (2000). *Aust. J. Agric. Res.* **51**, 765-777.

FRIEND, M.A., ROBARDS, G.E., LINDSAY, A.R. and CHAMPION, S.C. (1995). *Proc. NZ Soc. Anim. Prod.* **55**, 127-129.

GALLAGHER, J.R. and MCMENIMAN, N.P. (1988). *Equine Vet. J.* **20**, 414.

MARAIS, J.P., FIGENSCOU, D.L., ESCOTT-WATSON, P.L. and WEBBER, L.N. (1996). *J. Agric. Sc., Camb*. **126**, 207-210.

MARTIN, R.G. (1993). PhD thesis, The University of Queensland, Brisbane.

MAYES, R.G., LAMB, C.S. and COLGROVE, P.M. (1986). *J. Agric. Sci.* **107**, 161-170.

MCMENIMAN, N.P. (2000). 'Rural Industries Research and Development Corporation, Project UQ 45A Final Report.'

O'KEEFE, N.M. and MCMENIMAN, N.P. (1998). *Proc. Aust. Soc. Anim. Prod.* **22**, 337.

ORDAKOWSKI, A.L., KRONFELD, D.S., HOLLAND, J.L., HARGREAVES, B.J., GAY, L.S., HARRIS, P.A., DOVE, H. and SKLAN D. (2001). *J. Anim. Sci.* **79**, 1516-1522.

SAS (2000). 'SAS Users Guide.' (SAS Institute Inc.: North Carolina.)

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