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Original article

Effect of quality of hay given to mares around foaling on their voluntary intake and foal growth

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Summary — Two groups of 7 saddle mares weighing about 550 kg after foaling, received *ad libitum* hay - concentrate diets (90:10) from 4 wk before foaling until 5 wk after foaling. One group received high quality (HQ), the other group low quality hay (LQ).

In late pregnancy, daily intake was slightly higher (1.0 to 1.4 kg DM) for HQ diet than for LQ diet ($P > 0.05$). Intake greatly increased in early lactation (18.6 and 21.1 kg DM for LQ and HQ diets in the 3rd wk) but the difference in intake between diets remained higher than 1.5 kg DM. There was no short-term adaptation of mares to the increase in requirements.

With LQ diet, a lower body condition score at foaling and a shortage in energy and especially nitrogen caused a decrease in foal growth when compared with HQ diet (1 196 *vs* 1 473 g/d between birth and 5 wk).

mare / voluntary intake / pregnancy / lactation

Résumé — Effet de la qualité du foin sur l'ingestion volontaire chez la jument et sur la croissance de son poulain. *Deux lots de 7 juments de selle d'un poids moyen de 550 kg après poulinage ont reçu à volonté entre 4 semaines avant et 5 semaines après la mise bas des régimes comprenant 90% de foin et 10% de concentré. Un lot recevait un foin de bonne qualité, l'autre un foin de mauvaise qualité.*

En fin de gestation, les quantités ingérées ont été légèrement plus élevées (de 1,0 à 1,4 kg de MS) avec le bon foin qu'avec le mauvais foin (P > 0,05). L'ingestion s'est considérablement accrue en début de lactation (18,6 et 21,1 kg MS en 3e semaine respectivement pour les régimes à base de mauvais et de bon foin). La différence entre régimes est restée supérieure à 1,5 kg MS, montrant ainsi une mauvaise adaptation à court terme de l'appétit des juments à l'accroissement de leurs besoins nutritionnels.

Avec le régime à base de mauvais foin, la vitesse de croissance des poulains a été plus faible qu'avec le régime à base de bon foin (respectivement 1 196 et 1 473 g/j entre la naissance et 5 semaines). La cause en est probablement la conjonction d'un état corporel médiocre et d'une sous-alimentation.

jument / ingestion / gestation / lactation

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INTRODUCTION

With different diets based on medium- or high-quality hays given *ad libitum*, mares are able to meet their energy and nitrogen requirements at early lactation, owing to a high level of intake (Boulot, 1987; Doreau *et al*, 1988b). No data are available about feeding low-quality hays around foaling. In horses at maintenance, no relationship can be established between voluntary intake and the nutritive value of forage. Nutritive requirements are almost always excessive. Between-forage differences in intake can be attributed to factors such as palatability (Boulot, 1987). In high-requirement animals, such as lactating mares, it can be assumed that the low nutritive value of hay is compensated for by an increase in voluntary intake, so that nutritional requirements are met. The aim of the present study is to compare in mares the voluntary intake of a good quality hay and a low quality hay in late pregnancy (low requirement period) and early lactation (high requirement period), and to analyse the influence on foal growth.

MATERIALS AND METHODS

Animals and experimental conditions

Fourteen mares of Anglo-Arab and Selle Français breeds aged 7–10 yr were used. They were allotted to 2 groups according to liveweight, body condition score, growth rate of their foal during the previous lactation and theoretical date of foaling. The experiment lasted from 5 wk before this date until 5 wk after foaling. The mares were kept indoors in individual boxes. They received the same experimental diet throughout the trial.

Feeding

The first group (LQ) received a diet containing 90% of a low quality hay (tall fescue, first cut, flowering stage) and 10% of concentrates (67% barley, 25% soybean meal, 4% beet molasses, 4% mineral premix). The 2nd group (HQ) received a diet containing 90% of a mixture of 2 hays in pre-determined proportions: 60% of natural grassland, second cut (NG) and 40% of cocksfoot, 2nd cut (C), and 10% of the same concentrates as for group LQ.

These diets and water were given *ad libitum*. The refusal rate for hay was around 10%. The amounts of hay and concentrates offered to the mares were adjusted daily according to the refusals of the previous day. Hay was given twice daily at 08 00 and 16 00 (60% and 40% respectively) and concentrates at 08 00. In the HQ group, NG and C hays were offered at 08 00 and 16 00 respectively.

Measurements and analyses

The amount of feed proposed to the mares was weighed every day; refusals were weighed 5 d a week. In the HQ group it was observed that refusals almost exclusively involved C hay, probably because it was less palatable than NG hay. As a consequence it was considered in calculations that all refusals were C hay. The dry matter of offered and refused feeds was measured once a week by drying at 80 °C for 48 h. A representative sample of each feed was taken by weekly samplings for analyses of nitrogen (Kjeldahl method), ash (oven mineralization during 6 h at 550 °C), NDF and ADF contents (Goering and Van Soest, 1970). Results are given in table I. Energy and nitrogen values of feeds were evaluated in net energy unit (UFC, *ie* Unité Fourragère Cheval) and corrected digestible crude protein (MADC, *ie* Matières Azotées Digestibles Cheval) according to INRA tables (1984).

Mares were weighed 5 and 3 wk before the theoretical date of foaling, in order to determine their weights 4 wk before foaling. Mares and foals were weighed immediately after foaling,

Table I. Composition and nutritive value of feeds.

	in % DM				*per kg DM*	
	Crude protein	*ADF*	*NDF*	*Ash*	*UFC*	*MADC (g)*
Tall fescue hay	5.7	38.2	71.5	7.2	0.47	17
Natural grassland hay	11.9	26.9	44.2	10.0	0.68	61
Cocksfoot hay	11.3	33.5	64.5	11.0	0.63	58
Concentrates	21.4	6.4	16.9	8.7	1.01	176

then 14, 28 and 35 d after foaling. The mares' body condition scores were determined 5 wk before foaling, immediately after and 35 d after foaling, according to the method designed by Martin-Rosset and Vermorel (in preparation).

Statistical analyses were performed using the Student *t*-test.

RESULTS

Feed intake

The effective percentage of hay in the 2 diets was 91% whatever the week. In the HQ group, the ratio between NG and C hays was 67:33, since refusals consisted of C hay.

Variations in feed intake are shown in figure 1. Voluntary intake slightly decreased between 4 and 1 wk before foaling: from 11.3 to 10.9 kg DM in the LQ group and 12.7 to 12.1 in the HQ group. The difference in voluntary intake between the 2 diets was between 1.4 and 1.0 kg DM depending on the week, and was always non-significant, as the standard deviation was between 1.4 and 2.8 kg DM depending on the diet and the week.

During early lactation, intake sharply increased. Maximum intake was reached in the 3rd wk: 18.6 and 21.1 kg DM for the LQ and HQ diets respectively. In the 2nd wk of lactation intake was 97.5 (LQ) and 94.5% (HQ) of the maximal value. The difference between the 2 diets was about 1.5 kg DM in the 1st and 2nd wk, 2.5 kg DM in the 3rd wk and about 1.7 kg DM during the 4th and the 5th wk of lactation. The difference was only significant in the 3rd week of lactation ($P < 0.05$).

The estimated net energy and digestible crude protein intakes were calculated for 3 subsequent periods differing in voluntary

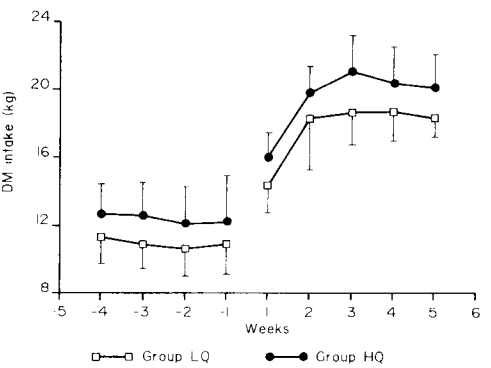

Fig 1. Variation in dry matter intake during the wks before and after foaling (mean and standard deviation).

intake: last month of pregnancy, 1st wk of lactation and 2nd to 5th wk of lactation. The ratios between estimated intakes and theoretical requirements were calculated (table II), assuming that they were on average 5.7 UFC and 530 g MADC in the 11th month of pregnancy and 9.7 UFC and 1040 g MADC in the 1st month of lactation (Doreau, 1990). With the LQ diet, the energy balance was around 100% in pregnancy but less than 100% in the 1st week of lactation. The nitrogen balance always showed a large deficit. Energy and nitrogen were in excess with the HQ diet whatever the physiological stage.

Variations in liveweight and body condition

There was no significant difference in mare liveweight between diets (table III). When the conceptus weight assumed to be 1.45 times the foal weight at foaling (INRA, 1984), is taken into account, liveweight increased by 10 and 12 kg during the last month of pregnancy for the LQ and HQ diets respectively. The increase in liveweight between foaling and the 5th wk of lactation is a consequence of the increase in digestive content. According to Martin-Rosset *et al* (1986), a variation of 1 kg DM intake corresponds to a difference of 3.5 kg in digestive content. When corrected for this factor, the differences in mare liveweight between foaling and the 5th wk of lactation were −14 and −10 kg for the LQ and HQ diets respectively. All these variations were non-significant.

Body condition score decreased during the last month of pregnancy for the LQ diet but not for the HQ diet: −1.08 ± 0.40 pt *vs* −0.18 ± 0.37 pt, $P < 0.01$. No variation was observed between foaling and the 5th wk of lactation for either of the 2 diets.

Foal liveweight did not significantly differ between diets at birth and in the 5th wk of lactation. Daily liveweight gain between birth and 2 wks was not significantly higher for the HQ diet than for the LQ diet: 1594 ± 320 and 1338 ± 330 g respectively. The difference was significant ($P < 0.05$) between birth and 5 wk (1 473 ± 211 *vs* 1 196 ± 192 g) and between 2 and 5 wk (1 399 ± 209 *vs* 1 095 ± 183 g).

Table II. Calculated nutritional intakes and balances.

	Pregnancy last month	*Lactation 1st wk*	*Lactation 2nd–5th wk*
Group LQ			
Energy intake (UFC)	5.7	7.4	9.6
Protein intake (g MADC)	342	426	579
Energy balance (1) (%)	100	76	99
Nitrogen balance(1) (%)	65	41	56
Group HQ			
Energy intake (UFC)	8.6	11.0	14.1
Protein intake (g MADC)	876	1101	1431
Energy balance (1) (%)	151	113	145
Nitrogen balance (1) (%)	165	106	138

(1) Ratio between calculated intakes and theoretical requirements.

Table III. Mare and foal liveweights, mare body condition scores (means and standard deviations).

	Group	*Mare liveweight (kg)*	*Mare body condition score*	*Foal liveweight (kg)*
4 wk before foaling	LQ	612 ± 28	3.04 ± 0.51	–
	HQ	612 ± 37	3.04 ± 0.62	–
Immediately after foaling	LQ	539 ± 26	1.96 ± 0.64	57.0 ± 2.9
	HQ	545 ± 40	2.86 ± 0.64	54.4 ± 2.5
2 wk after foaling	LQ	553 ± 23	–	75.3 ± 4.0
	HQ	572 ± 41	–	75.8 ± 5.6
5 wk after foaling	LQ	562 ± 35	1.93 ± 0.35	96.9 ± 8.8
	HQ	581 ± 35	3.04 ± 0.47	103.3 ± 7.6

DISCUSSION

Feed intake

The mean levels of intake and the variations around foaling are consistent with the results of previous studies with forage-based diets (Duncan and Gleize, 1985; Boulot, 1987). A very long eating period (Boulot *et al,* 1987) allows intakes higher than 170 g per kg metabolic weight. Steady intake during the last month before foaling is sometimes observed in mares; however, decreases (Boulot, 1987), as observed in ruminants, or even increases as reported by Sasimowski and Budzynski (1988). These results might be related to an increase in the progesterone/oestrogen ratio (Pashen, 1984).

From a study of the literature, no relationship could be established in horses with low requirements between nutritive value and voluntary intake (Chenost and Martin-Rosset, 1985; Cymbaluk and Christensen, 1986; Boulot, 1987). The slight difference between diets LQ and HQ in pregnancy is probably due to a difference in palatability.

The great increase in energy and nitrogen requirements between pregnancy and lactation does not modify the discrepancy of intake between the 2 diets. Mares do not seem able to adjust their intake to their nitrogen requirements, at least in the short-term. The differences in nutritive value is probably too low, when compared with the trial of Laut *et al* (1985) which showed an increased intake with ponies at maintenance fed a ration mixed with sawdust. The low body condition score might also be involved in a higher intake than that observed for diet LQ. In a previous work, dry matter intake was higher in thin mares than in fat mares (Doreau *et al,* 1988b), but animals were thinner than in the present trial. The cause of the limitation in intake was either a low palatability, as in pregnancy, or a physical limitation due to the repletion of the large intestine: a resistance to aboral flow has been shown by Sellers *et al* (1979) at the pelvic flexure of the colon. Further information could be obtained by increasing the length of the ex-

periment. The long-term effect of body reserves has also been observed by Meyer (1980) in ponies at maintenance: very fat ponies decrease their voluntary intake. In the present study, the difference in body condition score was perhaps too low to have consequences for feed intake.

Utilization of nutrients

In pregnancy, the estimated nutritional balances of the LQ group were slightly negative for energy and very negative for nitrogen. The absence of negative consequences of a low energy level on foal birthweight was shown by Martin-Rosset and Doreau (1980) and Banach and Evans (1981); however no data were available on nitrogen deprivation and the spare mechanisms are unknown. The slight undernutrition of the LQ group probably caused a weight loss in mares. This is not shown in the results, probably because of an error in the estimation of conceptus weight, or a change in body composition, *eg* the replacement of lipids by water, as in ewes (Bocquier and Theriez, 1984). The hypothesis is strengthened by the significant decrease in body condition score.

The cumulative effect of a low body condition at foaling and of undernutrition during lactation results in a decrease in foal growth, as observed in a trial carried out by Henneke *et al* (1981). A slight decrease in milk yield was observed by Doreau *et al* (1988b) in thin mares, although they ate more than fat mares, but the mares' body condition was lower than in the present trial. The difference in growth rate was not significant during the first 2 wks even though nutritional balances were the most negative: it may be that, as in cows, milk yield in the first wk of lactation does not depend on feeding. After this period, milk production might be limited by the drastic shortage of nitrogen, as is commonly observed in cows or as shown by Doreau *et al* (1988a) in mares. The moderate extent of the differences in foal growth from one diet to the other is surprising, when compared with the large differences in energy and nitrogen supplies. There are several possible explanations: 1) errors may have been made in the determination of nitrogen requirements or energy value of forages; 2) mares may mobilize body reserves in early lactation although this is not reflected by variations in body condition score; 3) foal liveweight gain composition is perhaps lower in energy in the LQ group than in the HQ group. The reliability of our results should now be verified by further experiments.

CONCLUSION

With main feeds, maintenance energy requirements can be met by horses if they are fed *ad libitum.* In lactation, when nutritional requirements are high, diets mainly consisting of low-quality hays do not enable mares to meet their requirements. The origin of this limitation and the possibility of a long-term regulation with the same diet should be studied.

The use of low-quality hays in feeding mares around foaling does not allow us to optimize mare performances if concentrates are given in limited amounts. This may be due to the shortage of nitrogen, since forage proteins have a low digestibility in horses. This hypothesis could be tested by a further experiment in which the effects of energy and nitrogen are dissociated.

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