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URAEMIA IN THE MARE: EFFECTS OF SEASONAL VARIATIONS, OF ENERGY LEVEL OF THE DIET AND INDIVIDUAL DIFFERENCES

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Résumé

L'URÉMIE CHEZ LA JUMENT: EFFETS DES VARIATIONS SAISONNIÈRES, DU NIVEAU ÉNERGÉTIQUE DE LA RATION ET DES DIFFÉRENCES INDIVIDUELLES. — On a étudié les variations de l'urémie chez la jument de race lourde placée dans différentes conditions. Une étude sur 35 juments au cours de la saison de pâturage indique une urémie moyenne variant entre 48,5 et 67,5 mg/100 ml de plasma, selon la saison et la nature de l'herbe. Les valeurs les plus élevées sont obtenues sur des prairies exploitées au 1er cycle. Les mêmes juments recevant des régimes hivernaux présentent des urémies plus faibles: 28,6 à 36,0 mg/100 ml. Une étude portant sur 15 juments recevant des régimes isoazotés comprenant du concentré distribué à deux niveaux différents, en complément de foin et de paille, entre 2 mois avant et 8 jours après le poulinage, montre que, si le stade physiologique a peu d'influence sur l'urémie, celle-ci est plus élevée pour les juments à bas niveau de concentré (35,6 à 44,0 mg/100 ml de plasma selon les périodes) que pour les juments à haut niveau de concentré (25,8 à 33,3 mg/100 ml). Enfin, une analyse portant sur deux troupeaux de 7 et 5 juments ayant subi 9 prélèvements tout au long de l'année montre que l'effet individuel est très important. Il n'a pas pu être expliqué par l'âge des animaux. Ces mesures ont permis de préciser quelques sources de variation de l'urémie autres que la teneur en azote de la ration.

In the horse, as in other species, blood urea has a dual origin: protein degradation in the digestive tract and catabolism of amino acids in the liver. This seems related to the level of nitrogen intake in the diet, as Slade *et al.* (1970), Prior *et al.*, (1974) and Meyer (1983) among others, have shown. Therefore blood urea can be an easy criterion for the estimation of nitrogen nutrition, especially since the time when samples were taken with regard to meal time (Doreau *et al.*, 1981a), physiological stage (Doreau *et al.*, 1981b; Rogers *et al.*, 1981), or level of intake (Dieterich and Holleman, 1973; Sutton *et al.*, 1977), all seem to have only a slight effect on blood urea level. Other factors have, as yet, been scarcely studied. So, in this trial, the effects of season, particularly when mares are at pasture, energy level, by means of an increased concentrate intake, and individual differences have been described.

Materials and Methods

Animals and feeding management

Thirty-five heavy French breed mares (15 Comtoises, 11 Bretonnes, 4 Ardennaises, 4 local mountain breeds,

1 Percheronne), aged 3 to 15 years (mean : 6 years) with a mean liveweight of 700 kg, were used. They were managed outside for one whole year, in paddocks with stalls for individual concentrate distribution and forage racks from January till April ; then at pasture from April to December. The foaling took place in March, on average. They were divided into three herds of 11, 12 and 12 mares.

During wintering, the first two herds, with mares aged 5 to 15 years, were fed 4.3 kg DM hay of natural grassland, 1st crop, wheat straw *ad libitum*, and 1.8 or 3.6 kg DM of concentrate. The mean straw intakes were respectively 6.3 and 5.8 kg DM. Concentrates were formulated so that the two diets gave the same amount of digestible nitrogen and minerals. They included, respectively, 25 % maize, 56 % soybean cake and 19 % minerals in one diet, and 67 % maize, 22 % soybean cake and 11 % minerals in the other. According to the new tables of the nutritive value of horse feeds (INRA, 1984), the crude protein, MADC (corrected digestible crude protein), crude fiber and UFC (net energy feed unit for horses) concentrations of the diet were respectively 9.9 and 9.5 % ; 5.1 and 4.9 %, 32.1 and 27.9 %, 0.44 and 0.53. The daily crude protein and MADC intakes were 1.23 and 1.30 kg, 0.63 and 0.67 kg.

The third herd, with mares aged 3 and 4 years, was fed 1.7 kg DM of a concentrate which included 66 % maize, 26 % soybean cake and 8 % minerals, and hay *ad libitum*, whose level of intake was 15.2 kg DM. The concentrations of the diet in crude protein, MADC, crude fiber and UFC were 10.7 %, 5.0 %, 25.9 % and 0.55, the daily crude protein and MADC intake were 1.80 and 0.85 kg.

At pasture, herds 1 and 2 were mixed and turned out to the same parcels. Herd 3 grazed parcels close to the others. The pastures differed throughout the year according to geographical situation, altitude cycle and kind of grass management. Details are given in table 1. No concentrates were given at all.

Blood samplings

Blood was drawn from the jugular vein, between 2 and 4 pm. Uraemia was determined in deproteinized plasma, using a colorimetric method with diacetylmonoxime (Moore and Sax, 1965).

The effect of season and kind of pasture was studied by means of nine samplings over the whole year, on mares of the three herds (table 1). The mares were generally dry and pregnant during samplings of February and December, but were lactating when other samples were taken. The number of samples varied between 26 and 34 from one period to another.

The effect of energy level and physiological stage was analyzed on seven and eight mares from herds 1 and 2, whose foaling took place at least one week before turning-out to grass, at six periods (2 and 1 months, 8 and 1 days before foaling, 1 and 8 days after foaling). From one period to another, the number of samples was four to seven for the herd receiving a low level of concentrate and five to eight for the other. Only three mares from each herd were taken for all samplings, during the six periods.

The influence of individual differences was studied separately on seven and five mares from herds 1 and 2 from which nine samplings were taken throughout the year, covering various physiological stages and diets, without any differences, for a same sampling in diet or physiological stage, from one animal to another.

The influence of age was determined on 22 mares from herds 1 and 2, managed together at pasture. The analysis was carried out on the individual means of six samplings. Mares aged three or four years, which were all in herd 3, could not be used.

Results and Discussion

Effect of season and kind of pasture (table 1)

Uraemia was always higher in grass samples than in winter diet samples, as in cattle (Rowlands *et al.*, 1975). It was higher than reference values for horses (Tasker, 1966 ; Bost *et al.*, 1970 ; Ekman, 1976 ; Jeffcott, 1978). In particular, turning-out to grass was concomitant with a very high and very significant increase (72 %) in uraemia.

Samples from the same kind of winter diets did not differ from February to April. On the other hand, the different samplings at pasture differed greatly. The highest uraemias were noted at pasture, in first-cycle grazing. They were among the highest observed in the literature available : Slade *et al.* (1970) and Reitnour and Treece (1971) noted values that were as high with diets that contained 2.5 to 3 % urea. The effect of the nature of grass seems to be more important than that of season, since, with samples taken within one week, in June, the turning-out from a second cycle in semi-mountain pasture, to a first cycle in the mountain, was concomitant with a 39 % increase in uraemia. The nitrogen content of grass probably plays a leading role, as assessed by Owen *et al.* (1978) : measurements made in the present experiment or which involved similar pastures (Groupe de Recherches INRA sur les hauts pâturages dégradés des Monts-Dore, 1979 ; Demarquilly, 1981) make it possible to place the crude protein content of forages grazed in the first cycle, from 15 to 20 % ; that of forages grazed in the second or third cycle, from 12 to 15 %, and that of the forage grazed in December at 10 %. There are certainly other causes of variation, for uraemia is slightly lower during the summer than in December : during this period, mares had been dry for two months, had low food requirements and consumed very limited amounts of forages, as attested by the constant weight loss observed. In addition, uraemia is higher with grass than with processed forages and concentrates for the same crude protein content.

Effect of energy level during late pregnancy and early lactation (table 2)

With a two-way analysis of variance, uraemia was shown to be significantly higher in mares receiving the low energy level. However, despite some apparent variations, physiological stage had

no effect, and neither did interaction between diet and physiological stage. These results, obtained with all available data, are confirmed with statistical analysis only in mares which underwent all samplings. The increased uraemia, when energy intake decreased, although nitrogen intake remained the same, could be explained by the deamination of excess amino acids, which were to be used for energy (Sykes, 1978). A similar observation made with milk urea, which is always very closely

Table 1. — Influence of season and kind of pasture on uraemia in heavy mares.

Nature of diet	Uraemia (mg/100 ml plasma) (mean ± SD) (Number of mares)
Winter diets	
February Hay *ad libitum* + concentrate, straw *ad libitum* + hay + concentrate	31.2 ± 6.1 (32)
March Hay *ad libitum* + concentrate, straw *ad libitum* + hay + concentrate	28.6. ± 10.5 (28)
April Hay *ad libitum* + concentrate, straw *ad libitum* + hay + concentrate	36.0 ± 12.7 (26)
Pasture	
April Semi-mountain (Altitude : 800 m) natural grassland, 1st Cycle	61.9 ± 10.9 (28)
June Semi-mountain natural grassland, 2nd Cycle	48.5 ± 7.5 (28)
June Mountain (Altitude : 1 300 m) natural grassland, 1st Cycle	67.5 ± 9.1 (30)
July Mountain natural grassland, 2nd Cycle	50.9 ± 7.7 (31)
September Mountain natural grassland, 3rd Cycle	54.8 ± 12.2 (34)
December Semi-mountain natural grassland, ungrazed during summer and autumn, whole year growth	57.4 ± 8.8 (27)

Table 2. — Effect of level of energy intake and physiological stage on uraemia in heavy mares.

Physiological stage	Uraemia (mg/100 ml plasma) (mean ± SD) (Number of mares)	
	Low level of energy intake	High level of energy intake
Before foaling		
2 months	35.6 ± 2.8 (6)	28.8 ± 3.4 (5)
1 month	41.1 ± 9.0 (6)	31.9 ± 4.1 (6)
8 days	40.2 ± 7.6 (7)	30.3 ± 4.5 (8)
1 day	44.0 ± 10.9 (4)	30.8 ± 7.1 (5)
After foaling		
1 day	42.5 ± 10.0 (6)	33.3 ± 12.8 (7)
8 days	41.2 ± 8.9 (6)	25.8 ± 3.0 (6)

related to uraemia, was noted in cattle (Gordon and Forbes, 1970). So, the effect of energy intake itself on uraemia seems different with respect to the equilibrium between energy and nitrogen intake. The lack of evolution of uraemia during late pregnancy confirms the results of Lumsden *et al.* (1980), Rogers *et al.* (1981) and Doreau *et al.* (1981b). The slight variations between late pregnancy and early lactation have already been observed elsewhere (Doreau *et al.*, 1981b). Nevertheless, all these data have been obtained only with well-fed mares.

Effect of individual differences

For each group of mares managed identically during the whole year, without any differences in winter diet or in parcel of grazed grass and for the group of mares managed on the same pastures, a Friedman analysis of variance on ranks was made. In both groups, the individual effect appeared significant. The same results had been noted with goats (Bas *et al.*, 1980).

In order to study the influence of age, the 22 mares on pasture were separated into three classes: five to seven years, eight and nine years and ten years and more. A Kruskal-Wallis test on means of six samplings was made. No significant difference could be shown in relation to age, as it has been sometimes noticed in cows (Hewett, 1974).

The individual standard deviation of uraemia varied between 2.2 and 13.7 mg/100 ml. This difference is not easy to explain; nevertheless, the coefficient of variation seemed to be higher at pasture than with winter diets. Assuming a 5 % type I error and a 50 % type II error, the minimal number of mares necessary to estimate the mean uraemia of a herd with a maximal error of 10 mg/100 ml can be calculated and varies, according to the period, between 3 and 16.

Conclusions

This trial has furthered understanding of uraemia in the mare and of its practical interpretation. Firstly, it has shown some feeding-related causes of variation: the nature of the diet, and, particularly, of grass, and the level of energy intake. Secondly, a close look at individual variations has shown that several animals per herd must be used in order to characterize the uraemia in a metabolic profile.

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Summary

Uraemia variations in the heavy breed mare were studied in different situations. A study with 35 mares during an entire grazing season was conducted. The mean uraemia varied between 48.5 and 67.5 mg/100 ml plasma, with season and type of grass. The highest values were found with first-cycle pasture grass. Uraemia was lower with winter diets: 28.6 to 36.0 mg/100 ml. A study using 15 mares fed isonitrogenous diets based on hay or straw, and concentrates offered two different levels, between two months before and 8 days after foaling, showed that the physiological stage had a very moderate effect on uraemia, but that it was higher with a low concentrate level (35.6 to 44.0 mg/100 ml plasma from one period to another) than with a high concentrate level (25.8 to 33.3 mg/100 ml). An analysis on two herds of 7 and 5 mares sampled 9 times during a whole year showed that the individual effect is highly significant. It could not be explained by age differences. These measurements have further defined some sources of variation other than the nitrogen concentration of the diet.

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