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Neonatal levels of plasma thyroxine in male and female calves fed a colostrum or immunoglobulin diet or fasted for the first 28 hours of life.

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Summary. The effect of diet on changes in plasma thyroxine levels was studied in 83 newborn Friesian × Holstein calves. Fifty-four received four copious meals of first-milking colostrum at 4, 10, 16 and 22 neonatal hours. At the same time, 24 animals received four meals of a solution of colostrum immunoglobulins containing little energy, and 5 calves were kept fasted. The last two treatments resulted in lower plasma thyroxine levels than those in colostrum-fed calves. At the same time, plasma thyroxine level was higher in females than in males during the first neonatal week.

Introduction.

Food restriction and fast have already been shown to influence thyroid function but results on changes in blood thyroxine (T4) levels are not consistent. An increase was noted in humans (Azizi, 1978 ; Burman *et al.*, 1979 ; Suda *et al.*, 1978), birds (May, 1978 ; Almeida and Thomas, 1981) and rabbits (Takagi *et al.* 1978), but rats (Chopra, 1980 ; Hastings and Zeman, 1979 ; Heinen *et al.*, 1981), piglets (Slebodzinski *et al.*, 1982) and ruminants (Bahnak *et al.*, 1981 ; Blum *et al.*, 1980 ; Blum and Kunz, 1981 ; Blum *et al.*, 1981 ; Tveit and Almlid, 1980) show a decrease.

In the latter species, several physiological states (gestation, growth, maintenance) have already been examined, but little is known about the influence of diet on the thyroid function around birth. The aim of the present work was to study the effect of diet on changes in the plasma T4 levels of newborn calves. The influence of sex has also been investigated.

Material and methods.

Animals. — Four groups (A, B, C, D) of newborn Friesian × Holstein calves were used. All of them were born in the same dairy herd. Group A calves (n = 40) were born during the winter of 1979-80, those of group B (n = 16) during the winter of 1980-81, those of group C (n = 11) during June and July, 1981, and those of group D (n = 16) during the winter of 1981-82. Of the 83 animals studied, 44 were males and 39 were females. All of them were born at term by normal and spontaneous parturition, often slightly accelerated by mild traction on the forelimbs of the calf after they appeared outside the vulva of the dam. No pharmacodynamic agents were used to facilitate parturition. All the animals born during winter were kept warm with an infra-red light from birth.

Diets (table 1). — Twenty-eight hours after birth and twice a day thereafter, the calves were fed with a standard milk replacer. Previously, they had been fed four times, *i. e.* exactly 4, 10, 16 and 22 h after birth, except for 5 calves of group C (subgroup Cf) which were completely fasted till the first meal at 28 neonatal hours.

TABLE 1
Calf distribution according to sex and diet.

	Diet until neonatal hour 28				Sex	
	Total	Colostrum	Solution of colostrum immunoglobulins	Complete fast	Male	Female
Group A	40	40	–	–	20	20
Group B	16	–	16	–	8	8
Group C	11	6	–	5	8	3
Group D	16	8	8	–	8	8
					44	39

With respect to the four meals mentioned above, the calves of group A were fed colostrum from the first milking of their dams, possibly mixed with that of other cows when parturitions were spaced at very close intervals. The quantity given at each meal was 25 g of colostrum/kg of body weight. Six animals of group C (subgroup Cc) and 8 from group D (subgroup Dc) received pooled first-milking colostrum on the same basis as that used for group A calves.

Instead of colostrum, all group B calves and 8 group D (subgroup Di) animals were fed a solution of immunoglobulins (29 g/kg of body weight/meal) extracted from bovine colostrum by a process described elsewhere (Grongnet *et al.*, 1985). The percentage of solution dry matter was 123 g/kg, 84 g of which were immunoglobulins and the rest mostly bovine serum albumin.

All the animals, except those of subgroup Cf which were fasted, were offered the first four meals in a bucket fitted with a teat at the bottom. In case of inappetence, manual pressure was applied to the teat or oesophageal intubation was used so that the feeding program was carried out.

Considering the quantities offered, the kinetics of delivery and the mean percentage of dry matter of first-milking colostrum (29 % ; Foley and Otterby, 1978), it may be assumed that group A and subgroup Cc and Dc calves had a high-level diet. Comparatively, group B and subgroup Di diets were restricted since they provided only 60 % of the quantity of dry matter offered to the animals of group A and subgroups Cc and Dc, and they had extremely low levels of lipids and carbohydrates.

Sampling and analysis. — The blood of all the calves was sampled by puncture of the jugular vein according to kinetics beginning at the moment of birth ; all calves older than 28 hours were sampled before the morning meal. When in the experimental procedure, the blood of calves less than 28 hours old was to be sampled simultaneously with the meal, sampling was carried out just before the meal was given.

The blood mixed with a drop of lithium heparinate was centrifuged immediately. The corresponding plasma was then frozen at − 23 °C till analysis. The total T4 level was determined in all samples by Elisa method through EMIT-SYVA-bio Merieux (R) reagents.

The results were analysed by analysis of variance or Student's t-test.

Results.

At the moment of birth, mean plasma T4 levels were statistically identical among all the groups (total mean : 12.9 ± 4.1 µg/100 ml). The subsequent profile

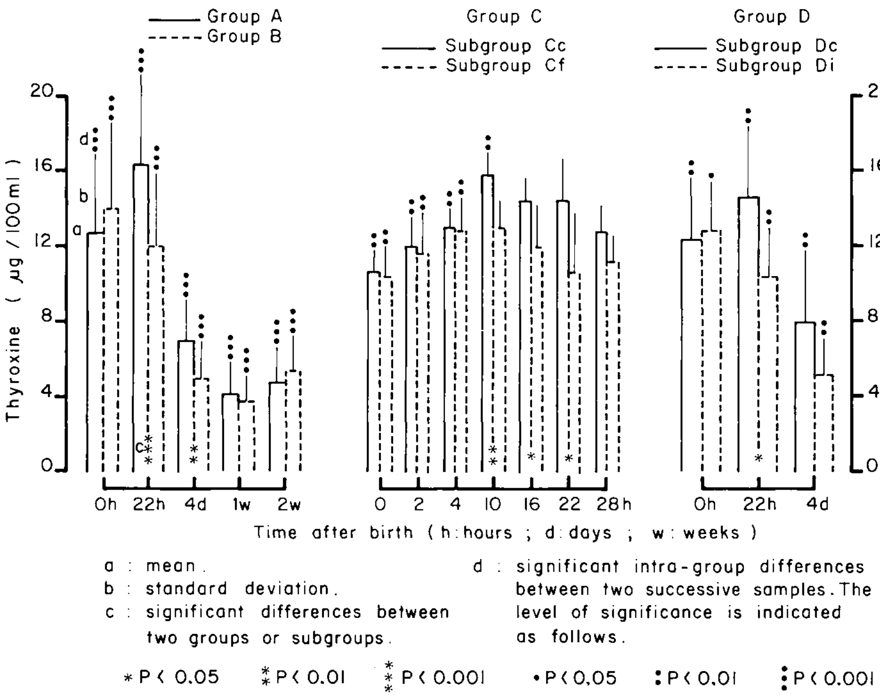

FIG. 1. — *Changes in the plasma thyroxine levels of dairy calves during the neonatal period. Effect of the diet.*

depended on the diet (fig. 1). In groups A and Dc subjected to a high dietary level, the maximal level was recorded 22 h after birth. In groups B and Di submitted to a restricted diet, the maximal level occurred at birth. Since blood sampling around birth was more frequent in group C, more results were available ; they confirmed these observations, although slight differences were found. For instance, in spite of fasting, subgroup Cf showed a rise in the T4 level after birth, but it was weak and transient. On the contrary, in the well-fed animals of subgroup Cc, there was a greater increase in circulating T4 so that the plasma level at 22 h after birth was higher than at birth, even if the maximal level for this subgroup occurred at 10 neonatal hours.

With respect to the influence of sex (fig. 2), a two-way analysis of variance showed that sex had a significant effect at birth. Its influence remained significant during the first neonatal week and was characterized by a higher plasma T4 level in female calves.

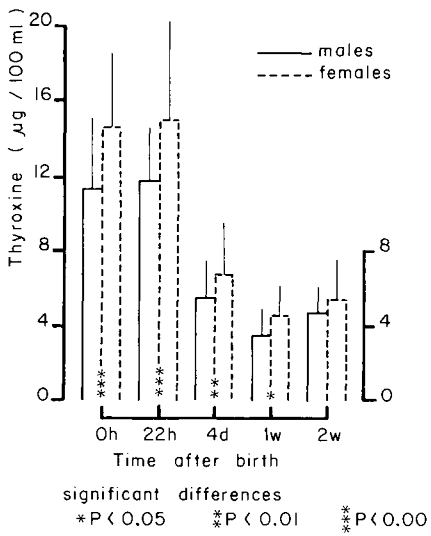

FIG. 2. — *Changes in the plasma thyroxine levels of dairy calves during the neonatal period. Effect of sex.*

Discussion.

The mean plasma T4 levels we recorded in calves at birth or a few days later are similar to those observed by many other authors (Cabello and Michel, 1974 ; Davicco *et al.,* 1982 ; Kahl *et al.,* 1977 ; Nathanielsz and Thomas, 1973). However, all of them, except Davicco *et al.* (1982) found that the blood sampling closest to birth gave the maximal plasma T4 level. This may be because not enough samples were studied or that they were not collected at the exact postpartum time when the transient rise occurred. On the contrary, the frequent and precise sampling practiced by Davicco *et al.* (1982) showed an increase in the plasma T4 level between 0 and 6 h after birth, identical to the one in subgroup Cc of the present study. However, as all the authors cited above, Davicco *et al.* found that the T4 level at 24 h after birth was lower than that at birth. Even if there is general agreement as to the profile of plasma T4 (identical to that recorded in the more poorly-fed calves in this study), this does not mean that our results on the best-fed calves (group A, subgroups Cc and Dc) are astonishing. We have no intention of questioning the rigor of the experiments cited above but, on reading over the experimental procedures, it seems to us that those authors paid less attention to the diet of the calves they studied than we did ; this might result in rather poorly fed newborn calves. Diet seems to have an unquestionable influence on the thyroid function. Its origin is difficult to understand in the absence of results on TSH. On the other hand, it is crucial to determine the plasma triiodothyronine (T3) level in order to ascertain whether hepatic T4 deiodination in newborn calves is inhibited by a low dietary plane. Such a phenomenon, clearly demonstrated in rats (Balsam and Ingbar, 1979 ; Kaplan and Utiger, 1978 ; Naito *et al.,* 1981) and piglets (Slebodzinski *et al.,* 1982), has been shown to result in a decrease of circulating T3 in these species (Chopra, 1980 ; Hastings and Zeman, 1979 ; Heinen *et al.,* 1981 and Slebodzinski *et al.,* 1982, respectively) ; this phenomenon has also been shown in humans (Azizi, 1978 ; Burman *et al.,* 1979 ; Suda *et al.,* 1978), adult sheep (Blum *et al.,* 1980), growing bulls (Blum and Kunz, 1981 ; Blum *et al.,* 1981 ; Tveit and Almlid, 1980), deer (Bahnak *et al.,* 1981), chickens (May, 1978) and quails (Almeida and Thomas, 1981).

The effect of sex on neonatal thyroxinemia has already been studied. A higher level was reported in baby girls by Bouckaert *et al.* (1978), Perez-Comas (1974) and Prato *et al.* (1980). In cattle the results are less clear ; O'Kelly and Wallace (1979) failed to demonstrate any difference between males and females, but Kahl *et al.* (1977) observed a difference which, although non-significant, agreed with the results presented here.

Conclusion.

In addition to the accurate immune protection obtained in calves given first-milking colostrum, copious meals given very soon after birth seemed to stimulate the thyroid function. Numerous questions remain unanswered, and the effect of the dietary plane on peripheric T4 deiodination must be investigated. Moreover, it would be appropriate to identify the nature of the dietary components stimulating the thyroid function since, in the present work, the composition of the diets differed as well as their general plane.

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Résumé. *Effet des premiers repas sur l'évolution du taux plasmatique de thyroxine chez le veau nouveau-né.*

On a étudié chez le veau nouveau-né de génotype Frison × Holstein, l'influence du régime alimentaire sur le taux de thyroxine plasmatique. Quatre vingt trois animaux ont été observés ; 54 ont reçu quatre abondants repas de colostrum de première traite, pendant les 22 premières heures de leur vie aérienne. Dans le même délai, 24 ont reçu quatre buvées d'une solution d'immunoglobulines de colostrum, de faible valeur énergétique et cinq ont été laissés au jeûne complet. Ces deux derniers traitements se sont traduits par des concentrations plasmatiques en thyroxine inférieures à celles relevées sur les individus ayant reçu du colostrum. Simultanément, on a pu montrer que, jusqu'à l'âge d'une semaine, les femelles avaient une concentration plasmatique en thyroxine supérieure à celle des mâles.

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