AGE AND FEED EFFECT ON THE DYNAMICS OF ANIMAL BLOOD BIOCHEMICAL VALUES IN POSTNATAL ONTOGENESIS IN CALVES

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Abstract. This study is part of a complex investigation when at the same time morphofunctional condition of the liver and intragastric ph dynamics in different parts of the stomach are investigated in animal postnatal ontogenesis in association with its feeding. The aim of this study was to determine if the blood biochemical indices change and what are their changes in calves since the birth until calves become ruminants, fed with whole milk or milk replacer, as well as in older calves, fed only with forage and concentrated mixed feed. In order to find it out, the nine animal groups with different age and feeding were formed. The total number of examined animals was 32. Blood was sampled at 6 a.m. Before feeding glucose, urea, creatinin, total bilirubin, albumin, ALAT, ASAT, a-amylase, Ca, P, alkaline phosphatase were determined in the blood serum. The dynamics of the blood biochemical indices in calves during the first week after the birth showed a more or less cytolytic syndrome in the liver parenchyma. Some blood biochemical indices in older animals differed depending on the feed.

Keywords: urea, kreatinine, total bilirubin, albumin, ALAT, ASAT, alkaline phosphatase, whole milk, milk replacer, postnatal ontogenesis, calf.

AMŽIAUS IR ŠĖRIMO ĮTAKA KRAUJO BIOCHEMINIŲ RODIKLIŲ DINAMIKAI VERŠELIŲ ONTOGENEZĖS METU PO ATVEDIMO

Santrauka. Šis tyrimas – kompleksinių tyrimų dalis, kai tuo pat metu tiriama kepenų morfofunkcinė būklė ir virškinamojo trakto pH įvairiose skrandžio dalyse atsižvelgiant į gyvulio ontogenezę ir priklausomai nuo šėrimo. Tyrimo tikslas buvo nustatyti, ar kraujo biocheminiai rodikliai kinta ir kokie yra tie pakitimai veršelių organizme nuo atvedimo iki to laiko, kai jie tampa atrajotojais, šeriant tik nenugriebtu pienu ar pieno pakaitalais, taip pat vyresnių veršelių organizme, šeriant tik pašarais arba mišriais koncentruotaisiais pašarais. Tuo tikslu buvo suformuotos 9 skirtingo amžiaus veršelių grupės, jiems sudaryti racionai. Iš viso tirti 32 veršeliai. Kraujo pavyzdžiai buvo imami 6 val. ryto prieš rytinį šėrimą. Kraujo serume buvo tiriama gliukozė, šlapalas, kreatininas, bendras bilirubinas, albuminas, ALAT, ASAT, a-amilazė, Ca, P, šarminė fosfatazė. Veršelių kraujo biocheminių rodiklių dinamikai pirmosios savaitės po gimimo metu buvo būdingas didesnio ar mažesnio laipsnio citolitinis sindromas kepenų parenchimoje. Vyresnių veršelių organizme kai kurie biocheminiai rodikliai kito priklausomai nuo šėrimo.

Raktažodžiai: šlapalas, kreatininas, bendras bilirubinas, albuminas, ALAT, ASAT, šarminė fosfatazė, nenugriebtas pienas, pieno pakaitalas, ontogenezė po atvedimo, veršelis.

Introduction. A complex investigation of adaptation processes of the digestive system of calves in postnatal ontogenesis was carried out comprising the dynamics of blood biochemical values. Previous reports in the literature on this matter are quite contradictory. In addition investigations on the physiological changes of blood biochemical values in calves in association with diet are rather few. The vast offer of the commercially produced milk replacers of various types which are fed to calves, makes the situation more complex (M.Fovler, 1998). Proteins, carbohydrates and fat of different origin in milk replacers are digested and absorbed differently in the digestive tract, so they influence differently the motive of the digestive tract, the emptying rate of the stomach, content and secretion of the digestive juices (Guiliteau et al., 1986; Longenbach, Heinrichs, 1997; Beharka et al., 1998; Le-Huerou-Luron et al., 1998; Tollec, Formal, 1998; Zabielski et al., 1999). The opinion of scientists often differs. Some, for example, consider that feeding of calves during the milk period does not affect the secretory process of the pancreas (Wei, Mao, 1993; Le-Drean et al., 1997). Others, on the contrary, prove that the secretion and activity of enzymes of the abomasums and pancreas glands in calves of the same age (56-119 days) in different if they are fed as real ruminants or as milk-fed calves (Le-Huerou-Luron et al., 1992).

The aim of this investigation was to determine if blood biochemical values change and what are the changes in calves from birth to 4 months of age in association with their feed.

The main tasks of the research were:

1. To investigate blood biochemical values in calves on the first day of life, at the age of one week, one, two, three and four months, and in adult cows.
2. To determine dynamics of blood biochemical values in milk – fed calves, feeding them with whole milk or milk replacer which is based on dried skim milk.

Material and methods. Clinical and laboratory examinations were carried out on 32 calves from birth to 4 month of age and adult milking cows. All the animals were formed the following age groups:

- Calves in the first day of postnatal life before feeding with colostrum.
- Calves fed with colostrum (1-6 days of age).
- Calves fed with whole milk (2-4 weeks of age).

- Calves at the age of 5-8 weeks, fed with:
  - milk replacer,
  - whole milk.
- Calves in the transfer period to the forage feed (9-11 weeks old), fed with:
  - milk replacer and starter feed,
  - whole milk and starter feed.
- Animals at the age of 12-16 weeks, fed only with forage and concentrated mixed feed.
- Adult ruminants (2-3 years old dairy cows).

All animals were clinically in good health condition. Blood samples were collected from *v.jugularis externa* from all animals at 6 o'clock before their morning feed. Blood samples from neonates were taken immediately after birth prior to colostrum intake, and two and six hours after colostrums intake. The level of glucose, urea, kreatinine, total bilirubin, albumin, Ca, P, as well as ALAT, ASAT and the activity of alkaline phosphatase were determined in the blood serum.

On the first day of life calves received colostrums four times a day: first 1 l, then 0.5 l of colostrum. Seven-day-old calves were fed three times a day 2 l of whole milk each time, but 4-weak-old ones received 0.5-3 l of whole milk depending on their live weight. There was free access to water and hay during the day time for calves older than two weeks. Five-eight weeks old calves were feed in a different way: one group received whole milk (2.5-3 l three times a day), but the other group was fed milk replacer (0.5 l three times a day). Milk replacer was chosen according to the records in literature – that contains at least 20% milk proteins and 15% fat of animal origin, lactose or glucose, essential amino acids, vitamins, trace elements, pH ranging from 0.5 to 0.0, with good taste and smell qualities (Fovler, 1998). During that week calves got accustomed to he concentrated mixed feed which they received, starting from nine weeks of age two times a day (the amount depended on live weight of calves). Nine-eleven weeks old group continued to receive whole milk (two times a day 3 l each time), but the other group-milk replacer (two times a day 0.5 l each time). Calves at the age of 12-16 weeks received 0.5-0.5 kg of hay, 0.0 kg of the concentrated mixed feed and 0.5-0.0 kg of fodder beet as basal feed (the amount of feed depended on live weight of animals).

Results and discussion. Blood biochemical values in calves associated with their age and feed are shown in Table 1.

Table 1. **Biochemical indices of the calf blood in different age and feeding**

Exp. groups	Statistical indi.ces	Glucose mmol/l	Urea mmol/l	Creatinine mkmol/l	Total Bilirubin mkmol/l	Albumin g/l	ALAT u/L	ASAT u/L	Alkaline phosfatase u/L	Ca mmol/l	P mmol/l
New-born before feeding	Mean St err	1.68 0.0.9	6.04 1.2	193 3.54	5.86 2.4	21.2 0.32	7.16 3.2	23.9 3.54	309.3 12.3	2.67 0.12	1.97 0.17
New-born 4 h. after feeding	Mean St err	5.62 0.21	4.92 0.33	190 11.1	9.5 2.1	22 0.21	9 1.6	38 2.4	315 15.2	2.45 0.14	1.98 0.15
New-born 6 h. after feeding	Mean St err	5.9 0.28	5.0 0.11	174 14.2	11.4 1.3	23.6 1.3	11.2 0.4	59 14.3	320 24	2.48 0.21	2.11 0.18
1 weeks old	Mean St.err	3.78 0.53	5.09 3.8	109 8.45	12.1 5.65	27.4 0.49	13.2 5.95	49.0 16.2	246.8 21.3	2.90 0.21	2.49 0.31
2-4 weeks old	Mean St.err	4.76 0.56	2.17 0.44	94.7 5.11	5.58 1.59	30.7 0.89	6.25 0.49	38.5 2.93	270.7 43.4	3.03 0.09	2.85 0.12
5-8 w. old (milk f.)	Mean St.err	4.29 0.11	1.44 0.07	90.8 2.23	3.20 0.13	32.6 1.2	19.6 2.87	76.2 4.75	189.0 27.8	2.79 0.14	2.76 0.05
5-8. w.old (m.repl.f.)	Mean St.err	3.76 0.22	2.19 0.4	93.0 2.65	5.70 0.69	33.0 2.06	10.8 7.41	63.0 5.21	161.7 22.1	2.56 0.14	2.84 0.57
9-11 w.old (milk f.)	Mean St.err	4.11 0.33	1.44 0.48	90.2 1.94	3.26 1.36	33.1 2.05	25.2 7.5	92.2 17.6	193.6 32.2	2.79 0.09	3.11 0.34
9-11 w.old (m.repl.f.)	Mean St.err	3.83 0.22	1.68 0.4	79.8 2.12	4.03 0.84	32.9 2.01	15.0 6.88	58.5 13.1	144.0 21.3	2.40 0.09	2.87 0.4
12-16 week old	Mean St.err	3.57 0.23	3.23 0.36	75.3 6.52	3.33 1.36	34.1 2.53	33.6 7.1	82.3 15.1	115.3 59.1	2.57 0.11	2.67 0.41
2-3 years old	Mean St.err	2.70 0.21	2.85 0.21	101 8.31	3.08 0.2	35.8 1.83	33.2 6.22	89.8 10.6	46.20 9.45	2.59 0.18	1.98 0.29

The dynamics of blood biochemical values of experimental animals are given in graphic representation, together with reference values in blood of adult cows on "The Merck veterinary manual" (1998). ALAT, ASAT, alkaline phosphates, total bilirubin, urea, albumin and glucose indirectly show evidence of morphofunctional condition of the liver in calves. According to our studies, a calf is born with comparatively low ALAT, ASAT activity (Fig. 1 and 2), but during the first week of postnatal life, the activity of both enzymes increases two times. The increase of the enzyme activity of the liver coincides with period when in a newborn calf morphofunctional condition of the liver is changing. That was also approved by the observed signs of cytolytic syndrome of hepatocytes in animals (Bouda, Jagoš, 1983; Grodzki et al., 1991; Grote, 1992; Brūveris et al., 2000). Another raise of ALAT and ASAT activity was found in calves from 0.5 to 3-4 months of age (Fig. 1, 2). In fact, it is the second critical period in a calf's life, when transition from a preruminant to a ruminant takes place. Undoubtedly, during this process of adaptation the functional role of the liver is one of the most significant; that is shown also by dynamics of other blood biochemical values. Comparison of ALAT and ASAT activity in 5-11 weeks old animals, i.e., the period of life when whole milk or milk replacer was fed to animals, shows that the enzyme activity was higher during the feeding of milk replacer (Fig. 1, 2).

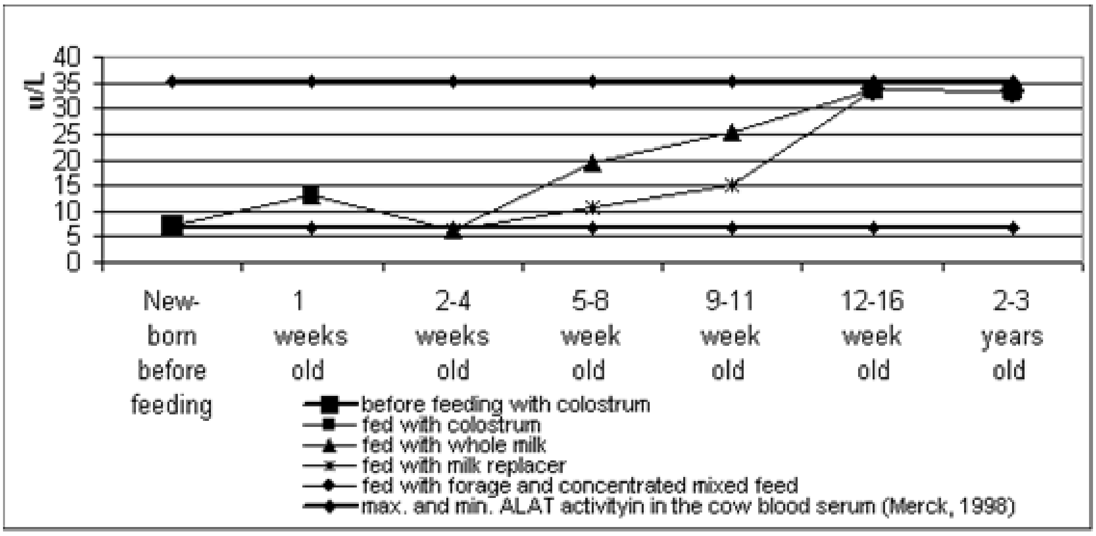

Figure 1. **Age and feed effect on the dynamics ALAT activity in calves blood serum**

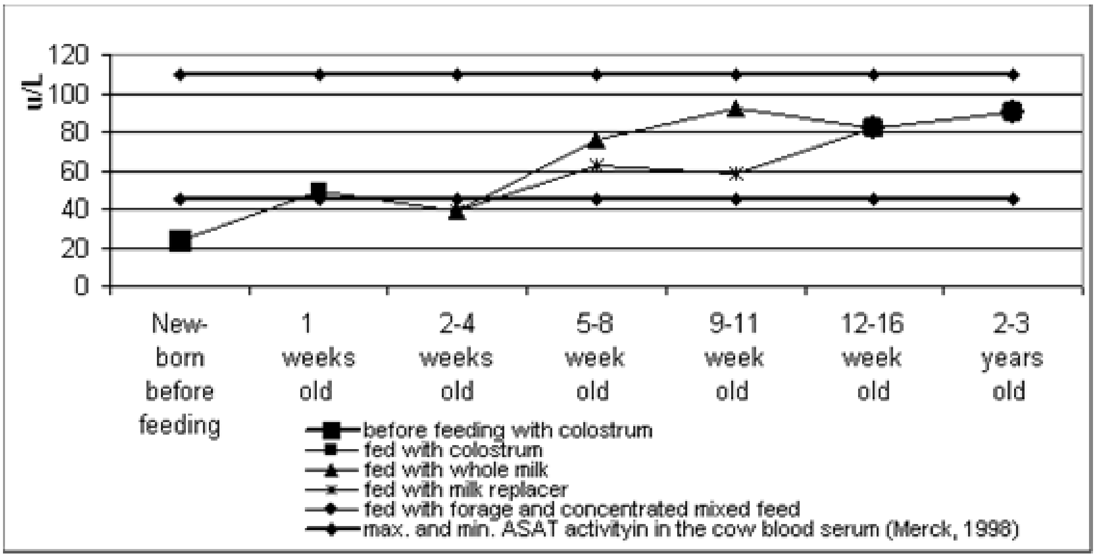

Figure 2. **Age and feed effect on the dynamics ASAT activity in calves blood serum**

Different was the dynamics of alkaline phosphotase in the blood. Investigations show the evidence that a calf is born with very high activity of this enzyme (Fig. 3). It is at least two times higher than in adult animals ($P<0.05$). During the first week of life the activity of alkaline phosphatase tended to decrease, nevertheless, it remained on a very high level in calves to one month of age. Such dynamics of the activities of alkaline phosphatase have also seen observed by other authors (Grodzki et al., 1991; Monilto et al.,1997; Baranow- Baranowski et al, 1998). It is associated with several factors. First of all, with colostrum nutrition and its digestion intensity in the digestive tract (Grodzki et al., 1991; Kurz, Willet, 1991; Monilto et al., 1997). During this process, the activity of alkaline phosphatase may increase even two and three times (Bouda, Jagoš, 1983). Hovever, the high activity of this enzyme in also associated with a certain bile stasis, which is found in calves in the first weeks of their life (Grote, 1992; Brūveris et al., 2000) and with active osteoblast activity in calves in the first months of postnatal life (Jemeļjanovs, 1999). A radical decrease of the alkaline phosphatase was observed in calves after one month of age (Fig. 3), besides, the most radical it was in animals which were fed whole milk, not milk replacer. In calves which received whole milk, the activity of alkaline phosphatase in the blood reached limit of the reference values in 3 months of age, but in those which were fed on milk replacer - in about 3.5 months of age.

These data show evidence that whole milk feeding to calves ensures a little faster functional adaption of the digestive system in the first month of postnatal ontogenesis.

As regards the total bilirubin level in the blood, its amount increased dramatically six hours after colostrum intake ($P<0.05$) (Tab. 1, Fig. 4). The amount of bilirubin on such a maximally high level continued to remain during the whole first week of postnatal life (Fig. 4). These data are associated with the well-known rapid process of erytrocite physiological destruction which is typical with newborn calves, but they also indicate to a certain bile stasis in these animals which is also indirectly approved by the activity of alkaline phosphatase (D.Grote, 1992; Z.Brūveris et al., 2000).

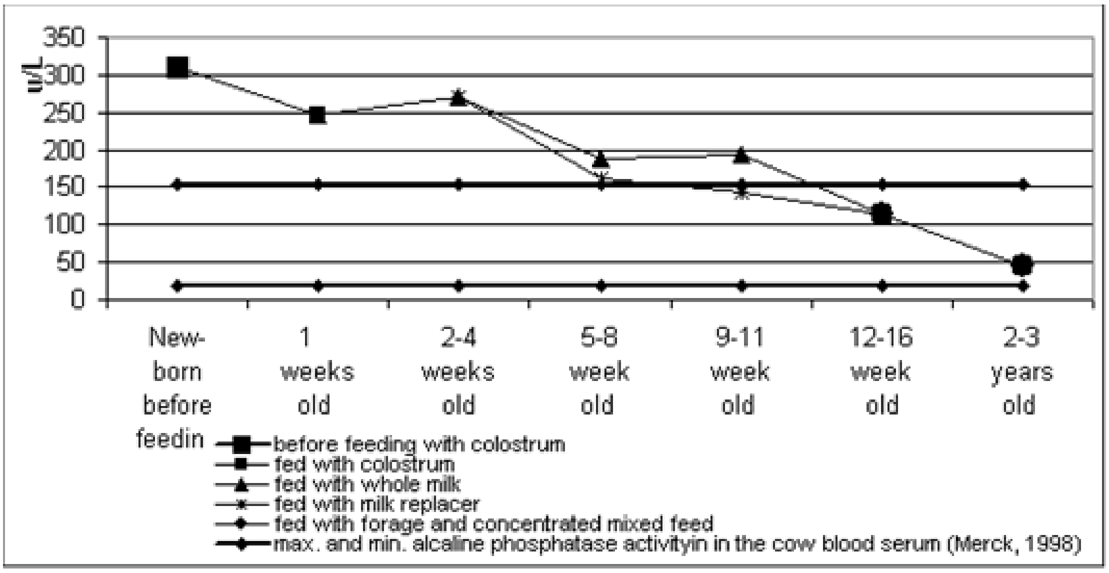

Figure 3. **Age and feed effect on the dynamics alcaline phosphatase activity in calves blood serum**

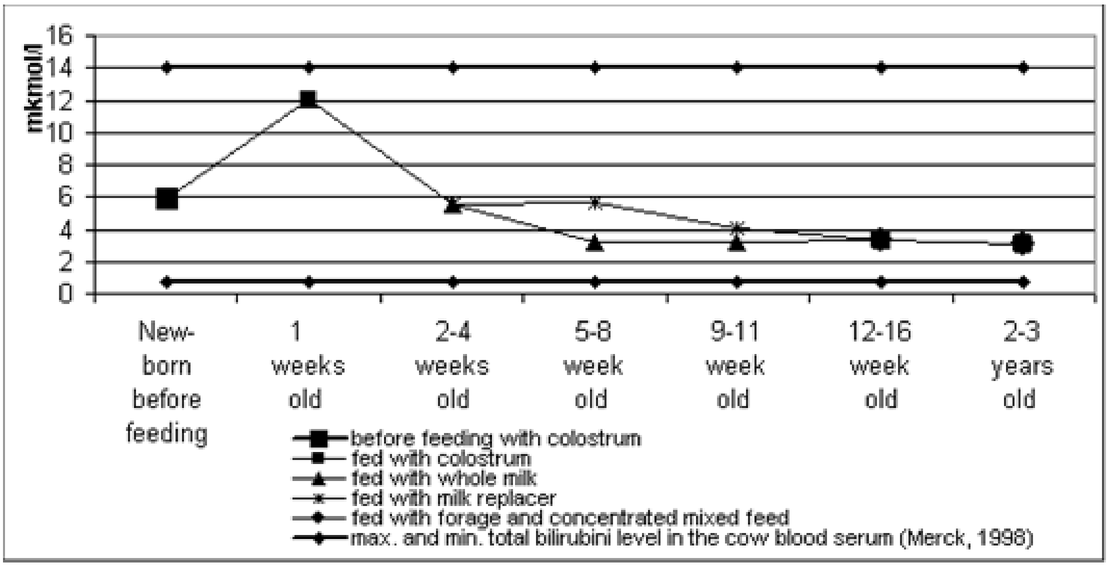

Figure 4. **Age and feed effect on the dynamics total bilirubine level in calves blood serum**

A radical decrease of the bilirubin level and its stabilization was observed in calves till one month of age. Further on, it became more stable in those animals, which were fed on milk replacer, starting with the fifth week of the postnatal life (Fig. 4). It should be pointed out that, in general, bilirubin values in animals used in this study did not exceed the limits which are considered as reference values in adult cows (Merck, 1998). However, within this vast range of reference values, the radical changes of bilirubin values were clearly distinct in calves during the first months of the postnatal life.

In fact, dynamics of urea in the blood of animals used in this experiment is similar (Fig. 5). Rather high level of urea was found in calves after birth and during the first week of life. These data coinsist fully with investigations of other researchers (Bouda, Jagoš, 1983; Steinhardt et al., 1993). A slightly different dynamics of urea after birth is reported by L.Wei and X.Mao (1993). According to these authors, the level of urea in neonates increases gradually within the first four days after birth, after that, it becomes lower. However, our study shows evidence that the maximum of urea level is in calves immediately after birth. During the first week it started to decrease, but very radical decrease was observed during the period of time between the second and the fourth week of life. In calves from one to two months of age, the level of urea in the blood was lowered below the reference value, but at the age of four months it became stable at the lowest level of urea reference value of adult cow. There were no significant differences of dynamics of urea values between 5-11 weeks old calves that were fed on whole milk and those which received milk replacer (Fig. 5).

Calf is born with very high creatinine level in the blood (Fig. 6). It was lessened by the first colostrums intake after six hours. A radical decrease of creatinine concentration was found during the first seven days after birth when it became stable, regardless of feed, at about the level of adult cow.

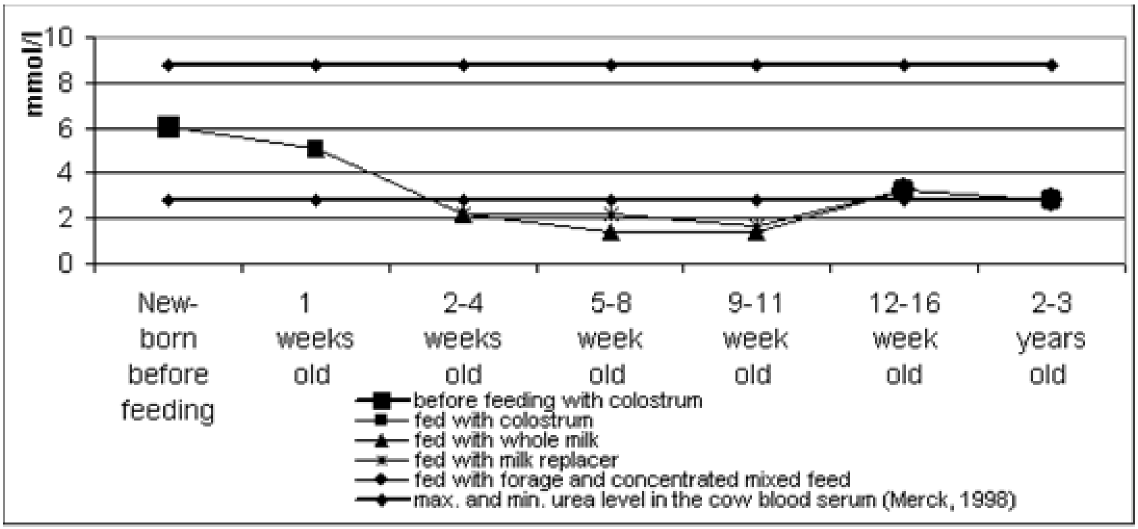

Figure 5. **Age and feed effect on the dynamics urea level in calves blood serum**

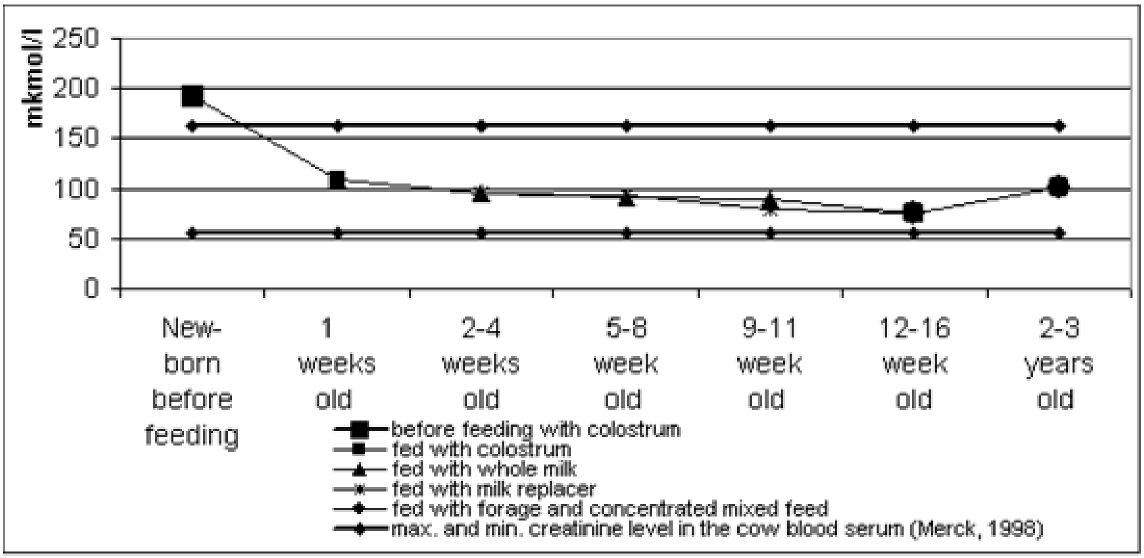

Figure 6. **Age and feed effect on the dynamics creatinine level in calves blood serum**

It is considered that the decrease of creatinine level in the blood serum and the increase of bilirubin values in calves within 24 hours after birth indicate how neonates are adapting to the changes associated with feed intake and maintenance of homeostasis (Kurz, Willet, 1991). Thus, dynamics of these two data indicate, to certain extent, to the procedure of adaptation of the new-born animal in the critical period. Dynamics of the level of glucose and changes of albumin values in the blood show evidence of morphofunctional condition of the liver in the experimental animals. Dynamics of glucose level is not discussed in this presentation because analysis of the changes of this biochemical value associated with animal nutrition and morphofunctional condition of the liver is given in another article in this journal. The amount of albumin and level of glucose in the blood in neonates and not fed calves in rather low (Tab. 1). Stable increase of these values between the birth of calves and 3-4 months of age shows that morphofunctional adaptation process of the liver in successful in these animals.

Conclusion. According to the data obtained, dynamics of the blood biochemical values in calves during the first days and weeks of postnatal ontogenesis, as well as during the transfer period from prerumination to rumination make possible to assess the processes of adaption of the digestive system (partly also excretory system) which are related to feed intake, and in calves at the age of 3-4 months also with metabolic peculiarities when rough forage feeding is started. In neonate calves in the first days of life, as a result of hepatocellular lesions, which are, to some extent, associated to the changes of blood circulation in the liver after birth, the liver enzymes ALAT, ASAT and alkaline phosphatase activity is increased. Urea, creatinine and total bilirubin values in the blood are also high, in return, the level of albumin and glucose is low. That shows evidence that in the first 24 hours after birth metabolism if carbohydrates, proteins and lipids are very intense. During this period of time such organs as the liver, stomach, kidneys (possibly also the pancreas and intestines) are functionally loaded very much.

The decrease of creatinine level, the increase of bilirubin values and albumin level in the blood of calves 24 hours after birth indicate that the critical stage in the animal's life is overcome successfully. At another critical stage in calves aged 3-4 months, when they transfer from preruminant to ruminant status, all the examined blood biochemical values had already become stable. The activity of liver enzymes ALAT, ASAT and alkaline phosphatase were higher in animals which were fed on milk replacer (based on dried skim milk) instead of whole milk. These data show evidence that whole milk nutrition ensures a little faster functional adaptation of the digestive system in calves in the first months of postnatal ontogenesis.

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