

INFLUENCE OF COLOSTRAL IMMUNITY ON GAIN AND HEALTH STATUS IN CALVES

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ABSTRACT

The calves are born without their own immunoglobulins (Ig), hence they get them by drinking of colostrum. For their health it is crucial to get enough Ig as soon as possible after birth. The research included 36 dairy calves, which were monitored from birth to the age of 24 weeks. The Ig content in colostrum was measured with colostrometer. In the calf serum, it was determined indirectly, by measuring the enzyme activity of gamma glutamyl transferase (GGT) or concentration of total serum protein (TSP), in the first week of life. The concentration of serum albumin (Alb) was also measured. The calf health status was regularly monitored; weight gain was assessed with chest girth measuring. Mean gains in calves which got ill were lower than in healthy ones; though the difference was not statistically significant. The statistical analysis showed that Ig concentration in colostrum influenced concentration of TSP and GGT activity in calf serum, but not the concentration of Alb. Time of first drinking of colostrum had a statistically significant influence on GGT, but not on the TSP and Alb. The serum Alb concentration differed between male and female calves. The correlation between Ig concentration in colostrum and TSP concentration and GGT activity in calf serum was statistically highly significant. Activity of GGT was in statistically significant correlation with TSP concentration. Optimal supply with colostrum of good quality is important for calf health, but a good management is also essential.

Key words: cattle / calves / colostrum / immunology / immunity / health status

VPLIV KOLOSTRALNE IMUNOSTI NA PRIRAST IN ZDRAVSTVENO STANJE PRI TELETIH

IZVLEČEK

Teleta se rodijo brez lastnih imunoglobulinov (Ig). Le-te dobijo šele po pitju kolostruma. Zadostna in pravočasna oskrba z njimi je ključnega pomena za zdravje teleta. V raziskavo smo vključili 36 telet črno-bele pasme. Spremljali smo jih od rojstva do starosti 24 tednov. Koncentracijo Ig v kolostrumu smo določali s kolostrometrom, v serumu teleta pa posredno z merjenjem aktivnosti encima gama glutamil – transferaza (GGT) in koncentracije celotnih serumskih beljakovin (CSB). Merili smo tudi koncentracijo albuminov (Alb) v prvem tednu starosti. Pri teletih smo redno spremljali zdravstveno stanje ter ugotavljali prirast s pomočjo merjenja prsnega obsega. Povprečni prirasti pri obolelih teletih so bili nižji kot pri zdravih, vendar razlika ni bila statistično značilna. Statistična analiza je pokazala, da je količina Ig iz zaužitega kolostruma vplivala na koncentracijo CSB in na aktivnost GGT, ne pa na koncentracijo Alb v serumu telet. Čas prvega pitja kolostruma je statistično značilno vplival na aktivnost GGT, ne pa na vsebnost CSB in količino Alb. Koncentracija Alb v serumu se je pri moških in ženskih teletih razlikovala. Ugotovili smo visoko statistično značilno korelacijo med količino Ig v kolostrumu in vsebnostjo CSB v krvnem serumu preiskovanih telet ter statistično značilno korelacijo med Ig v kolostrumu in aktivnostjo GGT. Aktivnost encima GGT je v

statistično značilni korelaciji z vsebnostjo CSB. Dobra oskrba s kakovostnim kolostrumom je pomembna za zdravje telet, zelo pomemben pa je tudi dober management.

Ključne besede: govedo / teleta / kolostrum / imunologija / imunost / zdravstveno stanje

INTRODUCTION

The calves are born without their own immunoglobulins (Ig), because the bovine epitheliochorial placenta is impermeable for protein macromolecules. They get Ig with their first colostrum meal. The calf intestine is able to absorb macromolecules like Ig, without previous destruction, within 24 hours after birth. At this time the enzyme activity is minimal, what enables the transport of macromolecules in the small intestine and their absorption. For the calf's health it is crucial to get the adequate amount of colostrum immediately after birth. The calves, which are poorly provided with colostrum, get an infection more often and have higher mortality than good provided calves. Calves, which are ill, have lower weight gain; this has a negative influence on the cost efficiency of breeding (Caldow *et al.*, 1988). Morbidity and mortality in neonatal calves have complex aetiologies. Factors often linked to outbreaks of disease, are associated with inadequate amount of colostrum, exposure to a potentially virulent pathogen, inadequate hygiene, and less than optimal nutritional support (Tyler *et al.*, 1999b). Many researches were made to investigate the connection between immunoglobulin status and health of the calves (Virtala *et al.*, 1999; Douglas *et al.*, 1996; Tyler *et al.*, 1999b), and connection between colostrum quality and immunoglobulin concentration in calves serum (Rajala and Castren, 1995; Erhard *et al.*, 1999).

The immunoglobulin absorption is influenced by volume, Ig concentration of ingested colostrum and the time of first drinking. This is most important for absorption of IgG and IgM (Kim and Schmidt, 1983; Stott *et al.*, 1979). The Ig concentration in colostrum can be measured via colostrometer (Mechor *et al.*, 1991); in the calf's serum, it could be indirectly determined, by measuring the activity of enzyme gamma glutamyl transferase (GGT), which is present in colostrum in high concentration and is absorbed like Ig with passive transfer (Wilson *et al.*, 1999; Braun *et al.*, 1982). Another indirect way to measure serum Ig is measuring the amount of total serum protein (TSP) (Naylor *et al.*, 1977).

The aim of our research was to assess the influence of the colostrum quality and time of first drinking on the health status of calves and to determine difference in gain, between healthy calves and ill calves till 24 weeks of life.

MATERIALS AND METHODS

36 dairy calves; 19 male and 17 female were included in the research. All calves were from the same herd, consisting of 200 dairy cows. The calves, which were born in October and November 2003, were monitored from birth till 24 weeks of life. The calves were housed in individual boxes first week after birth; afterwards they were in groups of 10 calves. All the time they were on the straw bed, which was regularly changed. First four days of life they got their dams' colostrum and milk; they were fed three times a day with 1–1.5 litre milk per meal. Later on they were fed two times a day with maximum 3–4 litres milk from treated cows per meal. First week they suckled milk from a nipple pail, later on they drunk from the trough. From their first week of life, they had free access to the starter and hay. They were weaned at four months of age.

All calves got, the first time after birth, 1–1.5 litre of their dams' colostrum. For each calf we took notes of first drinking of colostrum and measured the colostrum quality via colostrometer (produced by Bergophor, Germany), by colostrum temperature 22 °C (Mechor *et al.*, 1991).

Through whole period of research the health status, the time and kind of disease (scours, respiratory disease) or death of calves were registered. The weight gain was determined with measuring the chest girth. The girth was measured once weekly till 6 weeks of age, then in 8., 12., 16., 20. and 24. week of age. A blood sample from each calf was taken in first week of life from vena jugularis in vacuum tubes (Venoject®). The activity of GGT, TSP and Alb concentration in calf serum were measured by biochemical analyser Cobas Mira (La Roche).

The data were statistically processed by SAS/STAT (Version 8). The statistical parameters: mean value (\bar{x}), standard deviation (SD), coefficient of variability (CV) were assessed for the investigated parameters of colostrums, blood and serum. The phenotypic correlations between Ig concentration in first colostrum and activity of GGT, amount of TSP and Alb were also assessed.

To calculate the analysis of variance, the following statistical model was used:

$$Y_{ijklm} = \mu + S_i + H_j + T_k + C_l + e_{ijklm}$$

μ = mean value of the model

S_i = influence of sex (i=1, 2)

H_j = influence of health status (j=i, h)

T_k = influence of time of first drinking of colostrum (c=0.5.....6.5)

C_l = influence of Ig concentration in first colostrums (l=20.....145)

e_{ijklm} = accidental error of the model (rest)

RESULTS AND DISCUSSION

The chest girth, in calves included in our research, almost did not increase till 4. week of life and later it increased regularly for 2–3 cm per week till end of investigated period, that is 24 weeks. In calves, which got ill (n=12) in investigated period, the gains were lower, than in healthy ones (n=24), but the difference was not statistically significant. Caldow *et al.* (1988) determined a statistically significant difference in gain ($P < 0.001$) between healthy and ill calves. The periods of disease, in our calves, lasted only a few days and that is why it is considered they did not have an important influence on their gain.

Table 1. Mean girths in calves with regard to age

Age in weeks	n	\bar{x} girth (cm)	SD	CV %	Min.	Max.
1	36	79.37	2.78	7.71	73.00	86.00
2	36	79.43	3.20	10.25	73.00	89.00
3	36	79.47	3.06	9.39	72.00	85.00
4	36	82.24	3.91	15.30	73.00	92.00
5	36	84.72	3.89	15.12	75.00	93.00
6	36	87.17	4.45	19.80	79.00	98.00
8	36	93.43	4.94	24.36	82.00	103.00
12	36	104.94	4.46	19.88	97.00	112.00
16	36	115.23	5.50	30.29	106.00	130.00
20	36	126.00	9.80	96.00	117.00	177.00
24	36	130.23	6.37	40.58	120.00	154.00

The mean GGT activity in calves, which were healthy in the investigated period was 564.48 ± 457.41 U L⁻¹ and 345.33 ± 290.07 U L⁻¹ in calves which got ill, but the difference was not statistically significant. The mean concentrations of TSP and Alb in healthy calves were

55.87±7.34 g L⁻¹ and 26.14±1.47 g L⁻¹. In calves, which got ill the mean concentration of TSP and Alb were 51.69±6.01 g L⁻¹ and 27.49±2.19 g L⁻¹ but the difference in both parameters was not statistically significant. Naylor *et al.* (1977) determined a statistically significant ($P < 0.001$) higher morbidity in calves, which had plasma protein concentration under 60 g L⁻¹, than in calves with plasma protein concentration above 60 g L⁻¹. They claim that, plasma total proteins are as good as serum Ig, to predict the disease susceptibility, during first five weeks of life. Tyler *et al.* (1999a) also compared methods for measuring the serum Ig concentration in clinically ill calves and determined that GGT activity above 50 U L⁻¹ and concentration of TSP above 55 g L⁻¹ show sufficient amount of Ig in serum in comparison with direct measuring of serum Ig. Braun *et al.* (1982) determined a higher GGT activity in calf's serum first and second day after birth (370–5000 U L⁻¹). Also the differences in activity of GGT ascertained in our research were big.

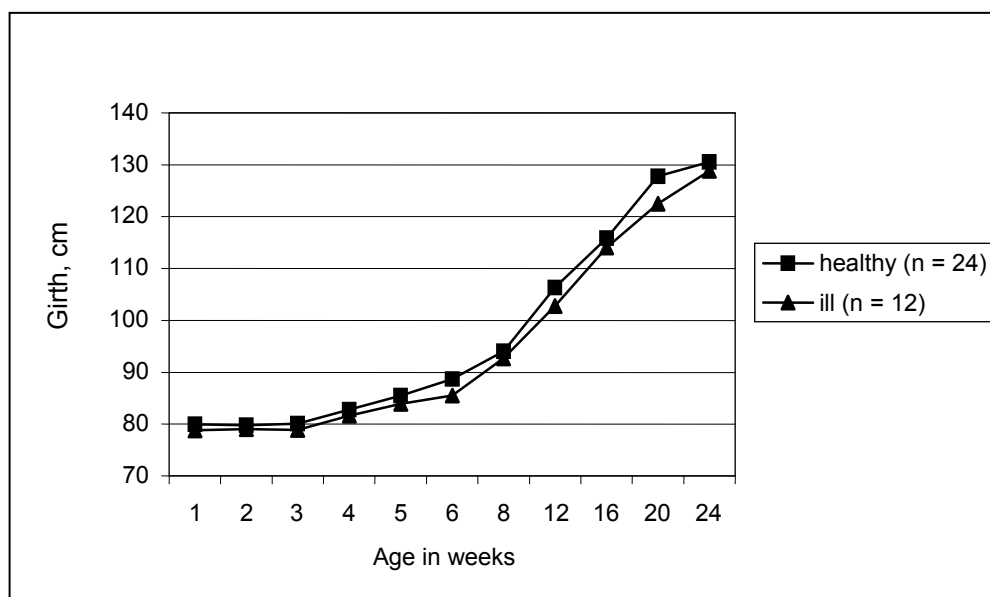


Figure 1. Girth in healthy and ill calves with regard to age.

A statistically significant correlation between GGT activity, concentration of TSP and health status of calves was not determined during this research. Other authors reported similar findings; they did not ascertain a statistically significant correlation between IgG amount in plasma, mean daily gains and morbidity (Caldow *et al.*, 1988; Douglas *et al.*, 1996). Other researches show that calves with low values of IgG become ill and die twice frequently than calves with high serum IgG (Virtala *et al.*, 1999; Douglas *et al.*, 1996). Rajala and Castren (1995) failed to explain the appearance of diarrhoea only with Ig concentration in calf serum.

In colostrum of dams with healthy calves the mean Ig amount was a little bit higher (96.5±7.01 mg ml⁻¹) than in this where the calves get ill (89.0±9.46 mg ml⁻¹); the difference was not statistically significant. Mean Ig concentration in colostrum that was determined in our research, was a little bit higher, than the concentration measured by other authors, namely 76.2 mg ml⁻¹ (Rajala et Castren, 1995). The influence of Ig concentration in colostrum on GGT activity and concentration of TSP was statistically significant, what is consistent with findings of Nocek *et al.* (1984). Rajala et Castren (1995) also determined a statistically significant correlation between Ig concentration in colostrum and in calf serum ($P < 0.05$).

In table 3 phenotypic correlations for investigated parameters in monitored calves are shown. Statistically significant correlation between the Ig concentration in colostrum and the amount of TSP and GGT activity in serum of calves was determined. The activity of GGT was in a statistically significant correlation with TSP amount. Any statistically significant correlations, between other investigated parameters, were not ascertained. The Ig content in colostrum had a statistically significant influence on activity of GGT ($P=0.041$), concentration of TSP ($P=0.0008$) and a little bit smaller influence on concentration of Alb ($P=0.0601$). The time of first drinking of colostrum had a statistically significant influence on GGT activity ($P=0.0532$) but not on concentration of TSP ($P=0.9258$) and Alb ($P=0.9814$). The majority of calves (88.89%) suckled colostrum in first three hours after birth.

Table 2. Basic statistical data for values GGT, TSP, Alb in serum and Ig in colostrum

Parameter	n	\bar{x}	SD	CV, %	Min.	Max.
GGT in $U L^{-1}$	36	437.17	406.47	85.90	30.00	1762.00
TSP in $g L^{-1}$	36	54.13	7.04	13.02	41.60	74.40
Alb in $g L^{-1}$	36	26.70	1.90	7.11	23.10	32.60
Ig in $mg ml^{-1}$	35	93.28	33.41	35.81	20.00	155.00

Table 3. Phenotypic correlations for investigated parameters

Parameter	Ig in colostrum $mg ml^{-1}$	GGT $U L^{-1}$	TSP $g L^{-1}$	Alb $g L^{-1}$
Ig/ colostrum $mg ml^{-1}$	1.000	0.3862 *	0.6328 ***	-0.1250 ns
GGT $U L^{-1}$		1.000	0.3958 *	-0.2195 ns
TSP $g L^{-1}$			1.000	-0.0376 ns
Alb $g L^{-1}$				1.000

The calves were getting ill in age 1–40 days; at the beginning of disease the mean age was 16.3 ± 3.06 days. The most often diseases were diarrhoea and respiratory diseases. In faeces samples from calves with diarrhoea was ascertained the presence of *Cryptosporidium* and Rota virus.

With analysis of variance the influence of sex, health status, time of first drinking colostrum and Ig concentration in colostrum on GGT activity, TSP and Alb amount in serum was assessed; the part of explained variance was showed. With our statistical model 45.47% variability for Alb amount, 37.29% variability for concentration of TSP and 28.73% variability for GGT activity, was explained. Statistically significant ($P < 0.05$) influence on GGT activity had time of first drinking of colostrum and Ig concentration in it. The TSP amount is statistically significant ($P < 0.001$) influenced by colostrum Ig concentration. The sex, health status and Ig concentration in colostrum had a statistically significant influence on Alb.

CONCLUSIONS

For health and normal gain of calves it is very important that they get a sufficient amount of quality colostrum immediately after birth. The time of first drinking, the amount and quality of colostrum has an important influence on immune status of the calf. The calves which got ill had

lower values of GGT and TSP in blood serum. Concentration of Ig in colostrum they drunk, was lower than in colostrum which got the healthy calves. Management, exposure to virulent pathogen and nutrition have an important influence on the occurrence of disease in calves.

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