IMMUNOGLOBULIN DYNAMICS WITH AGE IN CALVES FROM FARMS IN SLOVENIA

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Abstract

The aim of the study was to investigate the dynamics of immunoglobulin concentration in calf serum regarding the age of animals and influence of the farm. Seventy and one Holstein Friesian calves from two herds were serially sampled from birth to the age of 20 weeks. The calves received 1–1.5 l of colostrum by teat bottle, within 1 to 3 h after birth. The serum concentrations of IgG, IgA, and IgM were measured with ELISA. In colostrum samples from their mothers, the total Ig concentrations were estimated with a colostrometer. Age had a significant effect on the concentrations of immunoglobulins (P<0.001). The farm had significant effect on the concentration of IgG and IgM (P<0.001) and also on IgA (P=0.014). The temporal dynamics of serum IgG concentration was similar on both farms, but not in the case of IgA and IgM. In calves from farm 2, higher concentrations of IgA and IgM were established after the 5th week of life. That was associated with the incidence of respiratory diseases observed in calves on this farm. The calves of both farms were divided into three groups regarding the IgG concentration in the 1st week of life, and further IgG dynamics with age was investigated. The effect of group was statistically significant (P<0.001) indicating that the calves have different abilities for IgG production.

Key words: calves, age, environment, immunoglobulins, Slovenia.

The immune status of calves has been investigated in numerous studies with the aim of improving their state of health. The findings regarding the relationship between morbidity and the Ig status of calves differ among the studies. In herds with higher morbidity, the association was stronger than in herds with low morbidity (3, 5, 19). Morbidity in calves is higher in the first months of life (15, 17). In the first weeks of life, the immune system of calves is not able to respond at the level of adult animals and they are more susceptible to infection in this period. It is essential they get colostrum soon after birth to effectively absorb colostral immunoglobulin (Ig) (2, 11). The generally-accepted serum limit of the Ig should be at least 10 g/L IgG 24–48 h postpartum (1). The concentration of Ig in calf serum decreases in the first weeks of life; however it increases later on because of auto-synthesis (4). Therefore, the production of Ig is influenced by the calf’s organism and by environmental factors (antigens, feeding) (7). Results dealing with the concentration and dynamics of immunoglobulin in calf serum obtained by different researchers depend on measuring methods, study designs, etc. This makes the comparison of the results more difficult. The aim of the research was to investigate the dynamics of Ig (IgG, IgA, IgM) in calves’ serum from birth to the age of 20 weeks and to study the influence of the farm on further Ig dynamics, and the level and Ig dynamics between calves with different IgG concentration in the 1st week of life.

Material and Methods

In the research, Holstein Friesian calves and their dams from two farms were included. Thirty calves and 32 dams were from farm 1 with 200 dairy cows and 34 calves; and 28 dams were from farm 2 with 230 dairy cows. In both herds the calves got 1–1.5 l of mother’s colostrum by teat bottle, within 1 to 3 h after birth. The colostrum and milk were given three times daily for the first 4 d; later they received milk twice daily. At day 10 of age, the calves had free access to starter and hay. They were weaned at the age of 4 months. At the age of 1–1.5 months, the calves from farm 1 were moved from maternity barn to a bigger pen outside the barn. The calves from farm 2 were moved to the calf rearing barn at the age of 3–4 weeks. Six pens were in this barn, each for 10–15 calves, which were kept there until the age of 6–7 months. The barn was never empty due to the constant inflow of calves. For each calf the time of birth and the time of the first colostrum intake was recorded. The state of health of the calves and their dams was monitored. Diarrhoea was diagnosed, as faeces with a consistency looser than...
normal was observed for at least one day. Respiratory disease was defined when increased respiratory sounds at lung auscultation occurred and the disease was treated, and mild respiratory disease was characterised only by nasal discharge without treatment. Three calves died in the first weeks of life and some were lost from the study before the end of the study because they were sold.

In colostrum samples the Ig concentrations were estimated with colostrometer (Bergophor) at room temperature (22°C) following the producer instructions. Blood samples were taken once weekly until the age of 6 weeks, and at the age of 8, 12, 16, and 20 weeks. Serum samples were stored at -22°C until analysis. Serum concentrations of IgG, IgA, and IgM were measured with ELISA (Bovine IgG, IgA, IgM ELISA Quantitation Kit, Bethyl Laboratories). The measurements for each Ig class were performed on all samples on the same day.

Statistical analyses were processed with SPSS (ver 15.0). The mean values and standard deviations were calculated for the age of cows and concentration of Ig in colostrums. The data between farms were compared with the Student’s t-test.

In data on calves, the descriptive statistics for concentrations of different Ig classes were calculated regarding age and group. Because the data for IgA and IgM were not normally distributed, the median and 1st and 3rd quartile were calculated. The effect of age and farm was assessed with an analysis of variance (mixed model). The analysis was corrected for repeated measurements and included age and farm as fixed effects and calves as random effect. The Bonferroni test was used to investigate the significance of differences between age groups for IgG and Dunnett T3 test for IgA and IgM.

**Results**

The mean age of cows did not differ statistically significantly between the farms (P=0.342). In the cows from Farm 1 there was significantly (P=0.020) higher Ig concentration in colostrum than in cows from farm 2. In 16 (43.2%) of calves from Farm 1 and in 17 (50.0%) from Farm 2, the disease was detected at least once. The most cases of the disease were observed in 1st month of life (Fig. 1). In the first three weeks (mean age 14 d), mainly gastrointestinal disturbances (diarrhoea) and later on (mean age 32 d) chiefly respiratory diseases were diagnosed. The duration of the diseases was in both herds short and in most cases lasted 2–3 d. In calves from farm 2, some cases of mild respiratory symptoms were observed 1–2 weeks after moving them to the calf-rearing barn.

Age had a significant effect on the concentrations of IgG, IgM, and IgA (P<0.001) (Table 1). The mean concentration of IgG decreased after birth up to the 3rd week of age; later it increased to the end of the investigated period. The concentrations of IgA and IgM decreased up to the 4th week, and afterwards they increased with age.

The farm had a significant effect on the concentration of IgG (P<0.001). The calves from farm 2 had for average 8.10 g/L lower values than calves from farm 1 (Fig. 2). The farm had also a significant effect on IgA, where the P value was 0.014 and on IgM, where P was 0.001. The temporal dynamics of IgA and IgM concentrations was different between farms (Fig. 3). The concentration of IgA had a significant effect on the concentration of IgM and vice versa (P<0.001).

The data on calves from both farms were divided into three groups regarding IgG concentration in the 1st week of life (low <11.0 g/L, middle 11.0–41.0 g/L, high >41.0 g/L), and then the IgG dynamics with age was investigated. Low concentration of IgG was established in nine calves from farm 1 and in 11 calves from farm 2. The calculation of mean IgG values for the aforementioned three groups for all bleedings indicated that differences between groups remained through the whole investigated period, and the effect of the farm was statistically significant (P <0.001) (Fig. 4). The groups showed no difference regarding IgA and IgM level. In the investigated period, the disease was observed in 55.0% of calves from the low IgG group, in 46.15% from middle IgG, and only in 23.08% from the high IgG group.

![Fig. 1. The number of diseased calves in relation to the farm and age.](image-url)
Fig. 2. The dynamics of IgG concentration in relation to age in both groups of calves.

Fig. 3. The dynamics of IgM and IgA concentrations (median) in relation to age in both groups of calves.

Fig. 4. The comparison of IgG dynamics in calves in relation to IgG concentration in the 1st week of age.
IgA. The concentration of IgA and IgM after the 5th week of age was higher in calves from farm 2 compared to farm 1. This indicates a higher microbial stimulation of the immune system in calves from farm 2 and was most likely associated with the cases of mild respiratory diseases observed on this farm.

The differences between calves regarding the IgG concentration in 1st week, which remained to the end of investigated period (Fig. 4) were reported also by others (3, 7, 11). These reports indicate that the calves have different abilities for IgG production, which is influenced not only by colostrum supply, but is based on antigen stimulation as well. The differences exist also later on when the calves have already developed active immunity. The data indicate the relationship between groups with different IgG concentration and incidence of disease what is in agreement with other studies (14, 19).

The findings regarding temporal dynamics and concentrations of different Ig classes distinguish among the studies. The differences in concentrations are influenced by differences in breeds, herds, etc. But the results of different researchers vary also because they used different methods to measure Ig concentrations. Additionally, different producers of tests use their own standards, which are not the same for all tests, which was also established by Garry et al. (5). The results of different studies would be more comparable if equal (uniform) standards for all tests were used.

In conclusion, the age of calves and the farm influenced the concentrations of the investigated Ig classes (IgG, IgA, IgM). The differences in IgG concentration established between groups indicate that IgG level is influenced not only by colostrum supply, but also by other factors, and that calves have different abilities for IgG production. The moving of calves from farm 2 into calf rearing barn caused the incidence of mild respiratory diseases and higher concentrations of IgA and IgM in serum compared to calves from farm 1. For this reason we believe that measuring IgA and IgM concentrations in calves older than one month, when they are already able to produce higher amounts of their own immunoglobulins, could be helpful for the detection of subclinical infections, which are hardly detected in the herd.

### Table 1

<table>
<thead>
<tr>
<th>Age (weeks)</th>
<th>n</th>
<th>IgG (g/L) Mean ± SD</th>
<th>Median</th>
<th>1st quartile</th>
<th>3rd quartile</th>
<th>1st quartile</th>
<th>3rd quartile</th>
<th>IgA (g/L)</th>
<th>1st quartile</th>
<th>3rd quartile</th>
<th>IgM (g/L)</th>
<th>1st quartile</th>
<th>3rd quartile</th>
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<tbody>
<tr>
<td>1</td>
<td>71</td>
<td>26.15 ± 15.18</td>
<td>0.54</td>
<td>0.18</td>
<td>1.46</td>
<td>0.15</td>
<td>2.85</td>
<td>0.66</td>
<td>2.43</td>
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<tr>
<td>2</td>
<td>70</td>
<td>20.65 ± 12.92</td>
<td>0.18</td>
<td>0.08</td>
<td>0.36</td>
<td>1.33</td>
<td>1.20</td>
<td>0.65</td>
<td>1.98</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>71</td>
<td>19.81 ± 12.40</td>
<td>0.15</td>
<td>0.07</td>
<td>0.21</td>
<td>1.07</td>
<td>12.16,20</td>
<td>0.64</td>
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<td>4</td>
<td>68</td>
<td>20.88 ± 12.80</td>
<td>0.10</td>
<td>0.06</td>
<td>0.16</td>
<td>0.88</td>
<td>12.16,20</td>
<td>0.53</td>
<td>1.74</td>
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<td>5</td>
<td>67</td>
<td>24.82 ± 14.14</td>
<td>0.12</td>
<td>0.07</td>
<td>0.28</td>
<td>1.14</td>
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<td>0.48</td>
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<tr>
<td>6</td>
<td>66</td>
<td>30.44 ± 14.42</td>
<td>0.16</td>
<td>0.09</td>
<td>0.35</td>
<td>1.19</td>
<td>12.20,3</td>
<td>0.56</td>
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<td>8</td>
<td>66</td>
<td>32.34 ± 14.90</td>
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<td>12</td>
<td>62</td>
<td>35.17 ± 11.68</td>
<td>0.21</td>
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<td>1.76</td>
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<td>16</td>
<td>62</td>
<td>33.26 ± 12.23</td>
<td>0.32</td>
<td>0.07</td>
<td>0.59</td>
<td>2.85</td>
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<td>20</td>
<td>57</td>
<td>40.54 ± 13.58</td>
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<td>0.84</td>
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The age groups differ significantly (P<0.05) from age groups marked with superscript figures.
References