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SERUM IMMUNOGLOBULIN (IgG, IgM, IgA) CONCENTRATION IN COWS AND THEIR CALVES

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ABSTRACT

The objective of this study was to determine the relation between the immunoglobulin (Ig) concentration in the cow serum and colostrum and subsequent Ig concentrations in the calf serum. Black and White dairy cows (n = 64) and their calves were examined. Blood samples were taken from cows at approximately 1 month prepartum and 8 weeks postpartum and from calves at the age of 1 and 4 weeks. First milking colostrum samples were obtained. The IgG, IgM and IgA concentrations in the serum samples were measured with the quantitative ELISA. The colostrum Ig concentration was measured with colostrometer. The descriptive statistics and correlation coefficients by Pearson were calculated. Statistically significant positive correlations were established between the serum IgG concentrations in cows and their calves, and between the Ig concentration in the colostrum and serum of calves. Statistically significant positive correlations were established between the IgG ($r = 0.386$, $P = 0.001$) and IgA ($r = 0.350$, $P = 0.004$) concentrations in calves at the age of 1 and 4 weeks. There was no significant correlation between the Ig concentration in colostrum and IgG, IgM and IgA concentrations in the cows' serum. Calf serum IgG and IgA obtained in the 1st week showed a positive relationship with the IgG concentration in the serum and colostrum of the cows. Positive correlations between IgG and IgA in the calf serum in the 1st and 4th week of life indicate that calves with a higher Ig concentration in the 1st week also have a higher Ig level later when they already produce their own immunoglobulin.

Key words: cattle / cows /calves /immunology /serum immunoglobulins

1 INTRODUCTION

In the calf rearing, the key management objective is to ensure that calves survive and remain healthy. Newborn calves receive immunoglobulin (Ig) with the passive transfer from colostrum. Timely ingestion and absorption of colostral immunoglobulin is crucial for calves' health because the colostral Ig provide systemic and local protection in the intestine. Calves which do not receive enough colostrum or receive colostrum with a low concentration of Ig grow slower and are more prone to disease or to death than calves which receive colostrum of good quality (Nocek *et al.*, 1984; Quigley *et al.*, 1995). There are differences between herds in the average serum Ig concentration as well as in the number of hypogamaglobulinemic calves (Ig < 5 mg/ml) (Hancock, 1985).

Colostrogenesis, i.e. the prepartum transfer of Ig from the maternal circulation into mammary gland secretions, begins several weeks prior to parturition (Besser and Gay, 1994). The immunoglobulin transport through the intestinal mucosa follows the mechanisms of receptor transmitted transocytosis. According to the research, variations in the alleles for a particular protein sequence of bovine neonatal IgG-Fc receptor are suspected to also have an impact on the immunoglobulin level of newborn calves (Laegreid *et al.*, 2002).

Differences between breeds have been found for cow serum and colostrum Ig concentrations (Muller and Ellinger, 1981; Dolenc, 1998; Morin *et al.*, 2001). Cows

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could be categorised in different phenotypes regarding the intensity and the quality of immune response. The immune status of a periparturient cow can influence the passive immunity and the health of the calf (Detilleux *et al.,* 1994; Mallard *et al*., 1998; Heriazon *et al.,* 2011)

The objective of this study was to determine the relation between the immunoglobulin (Ig) concentration in the cow serum and colostrum and subsequent Ig concentrations in the calf serum.

2 MATERIAL AND METHODS

Sixty-four cows of black and white breed and their calves were included in the research. After calving, the calves received 1.5 litre of colostrum from their mother via teat bottle. For the first four days, the calves were administered mothers' colostrum and milk three times daily. Blood samples were taken from the cows at approximately 1 month pre partum and 8 weeks postpartum. Blood samples from the calves were taken at the age of 1 and 4 weeks. The serum samples were stored at –22 °C until analysis. The concentrations of IgG, IgA and IgM in the blood serum samples were measured using the quantitative ELISA (Bovine IgG (IgA, IgM) ELISA Quantitation Kit, Bethyl laboratories, UK). The concentration of total Ig was measured in the first milking colostrum samples of the cows using colostrometer (Bergophor, Germany). The measurements were performed at room temperature (22 °C). Data were processed with the SPSS (Ver 15) statistical program. Data were checked for normality and then the descriptive statistics for the investigated parameters was calculated. The median value was calculated instead of the mean because the IgM and IgA data were not normally distributed. The logarithmic transformation of the IgM and IgA data was done before the Pearson's correlation coefficients were calculated. Data for IgG, IgA and IgM concentration in calves at the age of 1 and 4 weeks were compared with the t test for paired samples.

3 RESULTS

Lower concentrations of all the investigated Ig classes were measured in calves at the age of 4 weeks in comparison with the values established at the age of 1 week; differences were statistically significant in the case of IgG ($P = 0.001$) and IgA ($P = 0.004$).

The mean concentration of Ig in colostrum samples was 88.11 ± 31.47 g/L.

Statistically significant positive correlations were established between the IgG ($r = 0.386$, $P = 0.001$) and IgA ($r = 0.350$, $P = 0.004$) concentrations in calves at the age of 1 and 4 weeks and also between the IgA and IgM concentration at 4 weeks of age ($r = 0.335$, $P = 0.005$).

There was no significant correlation between the Ig concentration in colostrum and the IgG, IgM and IgA concentrations in the cows' serum.

4 DISCUSSION

In calves at the age of 4 weeks, lower concentrations of all the investigated Ig classes were measured in comparison with the values established in the 1st week of age. The IgG concentrations measured in our study were higher (Table 1) than established by some authors (Erhard *et al*., 1999; Panivivat *et al.,* 2004). The dynamics of IgA and IgM with age matched the establishments of Rajala and Castren (1995). The concentration of Ig in the calf serum decreases in the first weeks of life. However, it increases later on due to auto-synthesis (Erhard *et al.,* 1999). Therefore, the production of Ig is influenced by a calf's organism and by environmental factors (antigens, feeding, etc.) (Hancock, 1985).

Concentrations of all Ig classes of cows in our research were higher than measured in calves (Table 1). The mean concentrations of IgG and IgM in cows were higher, whereas those of IgA were lower than established by Devery-Pocius and Larson (1983) where their measured average concentrations were15.8 g/L IgG_1, 13.6 g/L IgG_2, 1.6 g/L IgM and 0.6 g/L IgA in black and white cows aged 5–8 years. Our mean values for IgG and IgM were higher than values measured by Williams *et al.* (1975) in

Table 1: *The immunoglobulin concentration in serum samples of cows and calves*

Ig concentration (g/L)	Cows antepartum	Cows postpartum	Calves 1 week	Calves 4 weeks
IgG (mean, SD)	42.13 ± 12.21	42.33 ± 11.43	26.23 ± 15.30	20.55 ± 12.96
IgM (median, quartiles)	5.15 (3.15, 9.09)	5.35 (3.37, 6.80)	1.13 (0.66, 2.43)	0.88 (0.53, 1.74)
IgA (median, quartiles)	0.33 (0.18, 0.50)	0.38 (0.15, 0.57)	0.54 (0.18, 1.46)	0.10 (0.06, 0.16)

Table 2: *Correlation coefficients between the investigated variables*

	IgG (calves, 1 wk.)	IgG (calves, 4 wks.)	IgM (calves, 1. wk.)	IgM (calves, 4 wks.)	IgA (calves, 1 wk.)	IgA (calves, 4 wks.)
IgG (cows, a.p.)	0.341**	0.367**	0.176	0.127	0.340**	0.260*
IgG (cows, p.p)	0.491***	0.474***	0.251	0.071	0.313*	0.113
IgM (cows, a.p.)	0.138	0.091	0.180	0.138	0.172	0.120
IgM (cows, p.p.)	0.168	0.190	0.246	0.185	0.339**	0.352**
IgA (cows, a.p.)	0.062	−0.150	−0.047	0.099	−0.088	−0.048
IgA (cows, p.p.)	0.266*	0.088	0.293*	0.132	0.172	0.105
Colostrum	0.335**	0.352**	0.284*	0.006	0.376**	0.053

* $P \le 0.05$, ** $P \le 0.01$, *** $P \le 0.001$

Ayrshire cows where the concentration of IgG was 20.67 ± 4.56 g/L, of IgM was 2.71 ± 1.22 g/L and of IgA was 0.32 ± 0.16 g/L, what is in accordance with our results. In Jersey cows, even lower concentrations of the serum IgG (7.3 ± 0.52 g/L), IgM (1.72 ± 0.16 g/L) and IgA (0.20 ± 0.03 g/L) were established (Logan *et al.,* 1981). The results of different studies indicate that there are variations in the Ig level between breeds but these variations could also be partly influenced by different methods of measuring.

The concentration of Ig in colostrum was adequate (above 50 g/L) in most cows in our study. The results agree with the findings of Rajala and Castren (1995) who measured the average concentration of 76.2 g/L in the colostrum samples of Finish Ayrshire cows. In Swedish dairy cows, the average concentration of Ig, measured with colostrometer was 61.9 ± 31.2 g/L (Svensson and Liberg, 2006). In the research of Franklin *et al.* (1998), the average concentration of Ig measured with the colostrometer was 77.6 g/L, 83.7 g/L and 89.2 g/L for Holstein cows in the 1st, 2nd and 3rd–6th lactation, which is consistent with our results.

We found no significant correlations between immunoglobulin in the cows' serum and colostrum but the Ig in colostrum and serum has been measured applying different methods. Murphy *et al.* (2005) studied the serum and colostrum IgG_1 concentrations in different breed types of cows and they found no significant effect of cow breed type on the serum IgG_1 concentration pre- and postpartum or on the colostrum IgG_1 concentration. The same authors calculated the correlation coefficients between the IgG_1 concentration in the calf serum and in the cow serum and they found no significant correlation.

Our study shows statistically significant positive correlations between IgG concentrations in the serum of cows and their calves. The quality of colostrum was positively correlated with the concentration of IgG, IgA and IgM in the calves' serum in the 1st week and with the IgG in the 4th week of life (Table 2). A similar correlation between the concentration of IgG in the colostrum and in the serum was also found by Erhard *et al.* (1999). Dolenc (1998) ascertained good association between IgG_1, IgG_2 and IgM in colostrum and blood of calves (r = 0.91–0.97), and a lower correlation for IgA. Also Bender and Bostedt (2009) found a significant correlation between IgG and IgM in colostrum and in calves' serum at the age of 24 hours. Detilleux *et al.* (1994) studied the influence of genetics on the various immune cell functions and concentrations of IgG_1, IgG_2 and IgM in the periparturient Holstein cows. The highest heritability was established for IgM pre- and postpartum and for IgG_2 after calving. Regarding the antibody response to an antigen, cows could be categorized by phenotypes for high or low immune response based on the magnitude and kinetics of the response during the periparturient period (Mallard *et al.* 1998; Heriazon *et al.* 2011). The same authors believe that the immune status of a cow in the period around calving importantly influences passive immunity and health of a calf due to mechanisms that allow the transport of immunoglobulin and cells from blood into mammary gland secretions.

5 CONCLUSION

The calf serum IgG and IgA obtained in the 1st week showed a positive relationship with the IgG concentration in the serum of cows.

The quality of colostrum was positively correlated with the concentration of IgG, IgA and IgM in the calves' serum in the 1st week and with IgG in the 4th week of life.

The positive correlations between IgG and IgA in the calf serum in the 1st and 4th week of life indicate that calves with the higher Ig concentration in the 1st week also have a higher Ig level later when they already produce their own immunoglobulin.

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