Comparison of immunoglobulin (IgG, IgM) concentrations in calves raised under organic and conventional conditions*

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ABSTRACT
The objective of study was conducted on to compare immunoglobulin (Ig) concentrations in calves raised under organic and conventional conditions. 30 newborn Holstein Friesian calves (15 rose under organic and 15 under conventional conditions) in two dairy cattle farms. Blood samples were taken from 30 newborn calves at birth (before taking colostrum) and on 14th day to compare immunoglobulin (Ig) concentrations in calves raised under organic and conventional conditions. Furthermore, blood and colostrum samples were also taken from the mothers included into the study. IgG and IgM concentrations in colostrum and blood serums were determined using commercial ELISA kits. IgG concentrations at birth (0.79±0.34, 1.64±0.95 mg/mL) and on the 14th day (46.5±21.5, 70.5±27.8 mg/mL) in calves raised under organic conditions were lower than those raised under conventional conditions (p<0.01). Calves raised under organic conditions also had lower IgM concentrations than calves raised under conventional conditions at birth (0.23±0.03 and 0.28±0.11 mg/mL, respectively) and on the 14th day (2.76±0.56 and 4,30±1.03 mg/mL, respectively) (p<0.05, p<0.01). IgG concentrations in the blood serum of cows raised under conventional conditions were higher than those raised under organic conditions (p<0.01), while no difference was found with respect to IgM concentrations (p>0.05). No difference was found in the IgG and IgM concentrations of colostrum obtained from cows raised under organic and conventional conditions. In both the husbandry systems, positive and significant (p<0.01) correlations were found between the Ig concentrations of the mothers and offsprings. Consequently, it can be suggested that higher Ig concentrations in cattle raised under conventional conditions might be due to poorer environmental conditions.

Key words: Colostrum, Immunoglobulin, IgG, IgM, Organic cattle husbandry.

INTRODUCTION
Serum immunoglobulin concentration in dairy cattle is an important indication of immunity against pathogenic microorganism. IgG concentrations increase in herds exposed to adverse environmental conditions contaminated with pathogen (Quigley, 2002; Mendansa, 2011). In cows inoculated with vaccines containing E.Coli, Coronavirus and Rota antigens, Ig concentrations may increase due to special antibodies generated against these pathogens (Möstl and Bürki, 1988).

There are numerous studies investigating the amount of Ig at dairy cattle farms, effects of genetic and environmental factors on the amount of Ig, and the relationships between the amount of Ig and certain growth and development characteristics at conventional dairy cattle farms (DeNise et al., 1989; Godden, 2008; Furmen-Fratczak et al., 2011; Gelsinger et al., 2014). Organic dairy cattle farms, on the other hand, differ from conventional farms with respect to the limited use of concentrate feed in rations, the allocation of a certain amount of space per cattle inside and outside the barn, the requirement of having access to pasture, and the prohibition of the use of substances such as hormones, antibiotics, etc. as feed additives and estrous cycle regulators. To our knowledge, there is no study on the detection of Ig concentrations in cattle raised under organic conditions. To this end, this study aimed to determine and compare serum Ig concentrations in calves raised under organic and conventional conditions.

MATERIALS AND METHODS
Experimental animals and their management: This study was conducted at two dairy cattle farms, one organic and the other conventional located in Kelkit country in the province of Gümüşhane in the Eastern Black Sea region of Turkey. A total of 30 neonate Holstein Friesian calves, 15 from the organic farm and 15 from the conventional farm, were included into the study. The study was carried out for 5
months from 15.01.2015 and 15.06.2015, in accordance with
the protocol no. 2014/10 of 11.03.2014 of the Karadeniz
Technical University Local Ethical Committee on Animal
Experiments.

At the organic dairy cattle farm all the activities
such as animal raising, nutrition, sheltering and veterinary
intervention were managed according to Organic Farming
Regulations (Anonymous, 2002; Anonymous, 2005)
published by the Ministry of Food, Agriculture and Livestock
Government of Turkey. As required by the regulation,
regular ration of cattle consisted of 60% coarse fodder and 40%
concentrate feed as per dry matter. At the organic dairy cattle
farm cows in lactation were fed 10 kg of dry clover and
fodder, 15 kg of corn silage, and 10 kg of concentrate feed per
day. The dry period of cows was 60 days on average.
Newborn calves were fed with 1.5-2.0 L of colostrum
obtained from their mothers with a feeding bottle. Calves
were separated from their mothers and taken to their
individual stables at the end of the 1st day. They were fed with
their mother’s colostrum twice a day for two more days.
Calves were fed with milk equal to 10% of their body weight
during the weaning period.

At the conventional dairy cattle farm cows in
lactation were fed with 6 kg of fodder, 20 kg of corn silage,
2 kg of peas and 6 kg of concentrate feed per day. Average
dry period of cows in these farms was 60 days. Newborn
calves were fed with 1.5-2.0 L of colostrum obtained from
their mothers with a feeding bottle. Calves were kept with
their mothers for three days. During this period, they were
fed with the mother’s colostrum twice a day. Calves were
fed with milk equal to 10% of their body weight during the
weaning period.

Blood and colostrum sampling: In both the farms, 10 mL of
blood was taken from the vena jugularis of each healthy
cow that gave birth successfully. Similarly, 10 mL of blood
was taken from the vena jugularis of each calf that had no
postnatal health problems, before receiving colostrum and
at 14th day of age. The blood samples were centrifuged at
3500 rpm for 10 minutes, and the separated serum samples
were aliquoted, and kept at -20°C, and maintained until all
samples were collected. In addition, colostrum samples were
taken after birth from each cow included into the study, and
kept at -20°C until meta-analysis. IgG and IgM concentrations in
serum and colostrum samples of cows and calves were determined with the ELISA method by using
the kits of Bethyl Laboratories (IgG, Catalog No: E10-118;
IgM, Catalog No: E10-101), and taking into account the
recommendations of the manufacturer (Jezek et al., 2012; Gelsinger et al., 2014).

**Statistical analyses:** The following mathematical method
was used while testing the effect of the husbandry type on
IgG and IgM concentrations in serum and colostrum acquired
at various periods.

Model: \[ Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm} \]
\( \mu \): Expected mean,
\( a \): the effect of husbandry type (1: organic, 2: conventional),
\( b \): the effect of sex (1: male, 2: female),
\( c \): the effect of birth order (1: single birth, 2: multiple birth),
\( d \): the effect of the season (1: winter, 2: spring)
\( e_{ijklm} \): random error

Student’s t-test was employed while comparing the difference between two means (SPSS).

**RESULTS AND DISCUSSION**

**IgG concentrations in cattle raised under organic and
conventional conditions at various periods:** The serum
IgG concentrations of cows and their offsprings rose at
organic and conventional dairy cattle farms are provided in
Table 1.

<table>
<thead>
<tr>
<th>Periods</th>
<th>Husbandry Type</th>
<th>Mother (mg/mL)</th>
<th>Calf (0 hours)</th>
<th>Calf (14th day)</th>
<th>Colostrum (mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>29.1±2.4</td>
<td>0.79±0.34</td>
<td>46.5±21.5</td>
<td>67.2±29.4</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>55.8±7.9*</td>
<td>1.64±0.95*</td>
<td>70.5±27.8*</td>
<td>65.7±24.3</td>
</tr>
</tbody>
</table>

*Significant difference observed compared to the results obtained from animals raised under organic conditions (p<0.01), X ± S (arithmetic mean ± standard deviation)
Phenotypic correlations between colostrum and serum Ig concentrations: Phenotypic correlations between serum Ig concentrations at various periods in cows and their offsprings raised under organic and conventional conditions are presented in Table 3.

In both husbandry systems, there were positive and significant correlations between the cows’ and offsprings’ IgG concentrations. Although a positive and significant (p<0.01) correlation was found between the mother’s serum IgM concentration and the calf’s IgM concentration on the 14th day, this correlation was not significant for the postpartum period. A positive and significant correlation was identified between colostrum IgG concentration and the calf IgG concentration. The coefficients and significance level of these correlations were higher in the organic husbandry system.

Postpartum serum IgG concentrations in cows raised under conventional conditions were 90% higher than the concentrations in cows raised under organic conditions. IgG concentrations might have turned out to be lower in cattle raised under organic conditions due to the more favorable environmental conditions created by husbandry practices focusing on animal health and welfare. Nevertheless, further research should be performed to shed more light on this issue.

In the present study, postpartum serum IgG concentrations in Holstein Friesian cows raised under conventional conditions (55.8 mg/mL) were found to be higher than the concentrations of 15.0 g/L and 42.3 g/L reported for the same breed by Herr et al. (2011) and Jezek et al. (2012), respectively. The value found for the organic farm, in turn, was relatively more in agreement with previously reported results. The high concentration of IgG found at the conventional dairy cattle farm implied that various pathogenic factors might be present in the mentioned herd (Quigley, 2002; Mendonsa, 2011).

There was no difference between husbandry systems in terms of colostrum IgG concentrations. Colostrum IgG concentration was lower than the reported range of 71.9 and 88.1 g/L by various researchers (Murphy et al., 2005; McMartin et al., 2006; Jozica et al., 2010; Furman-Fratczak et al., 2011; Gelsinger et al., 2014). Colostrum IgG concentration varies with the cow’s health status, the amount of colostrum produced, calving season and other factors, and older cows produce colostrum with a higher Ig concentration (Quigley, 2002).

Since the placenta, which ensures the connection between the mother and the fetus during gestation, prevents antibodies from passing to the fetus, serum Ig concentrations in neonate calves’ blood are rather low (Weaver et al., 2000). In this study, it was found that the postnatal IgG concentrations of calves delivered under conventional conditions 0.85 mg/mL were higher than those delivered under organic conditions (p<0.01). Godden et al. (2009), Haines and Godden (2011), and Tristan et al. (2014) reported IgG concentrations for the mentioned period in the same breed of calves as 0.25±0.23, 0.30±0.01 and 0.20±0.07 mg/mL, respectively. The value obtained in this study was higher than those reported in the above mentioned studies.

Serum IgG concentrations on the 14th day in calves raised under conventional conditions 24 mg/mL were higher than that of calves raised under organic conditions, which

Table 3: Phenotypic correlations between colostrum and serum Ig concentrations

<table>
<thead>
<tr>
<th>Table 3: Phenotypic correlations between colostrum and serum Ig concentrations</th>
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</thead>
<tbody>
<tr>
<td><strong>IgG</strong> (calves, at birth)</td>
</tr>
<tr>
<td>Organic Husbandry System</td>
</tr>
<tr>
<td>IgG (Mother)</td>
</tr>
<tr>
<td>IgM (Mother)</td>
</tr>
<tr>
<td>IgG (colostrum)</td>
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<tr>
<td>IgM (colostrum)</td>
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<tr>
<td>Conventional Husbandry System</td>
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<tr>
<td>IgG (Mother)</td>
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<td>IgM (Mother)</td>
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<tr>
<td>IgG (colostrum)</td>
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<td>IgM (colostrum)</td>
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</tbody>
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**, Significant (P<0.01), *: Significant (P<0.05)
indicates a significant difference (p<0.01). Ig concentrations increase during periods of contamination with diseases and pathogens, and exposure to infection (Güngör and Bastan, 2004; Mendonsa, 2011). Although the intestines of newborn calves are sterile, Ig concentrations increase as they are exposed to adverse environmental conditions and higher levels of pathogens (Quigley, 2002). In this respect, it was reported that the number of bacteria decreased considerably in pasteurized colostrum (Gelsinger et al., 2014). IgG concentrations in calves raised at conventional dairy cattle farms might be found higher than those raised in organic farms as a result of the former’s exposure to adverse environmental conditions. Nevertheless, further research should be performed to shed light on this issue. Serum IgG concentrations of Holstein Friesian calves on the 14th day was found higher than the average concentrations (13.9-26.23 mg/mL) reported by several researchers (Akbulut et al., 2003; Godden et al., 2009; Haines and Godden 2011; Jezek et al., 2012) for various postnatal periods. Although this difference was attributed to different adverse environmental conditions, further research is necessary to achieve more accurate results.

IgM concentrations in the blood serums of cattle were lower than the IgG concentrations. IgM develops immunity to systemic infections, especially against viruses (Diker, 2005; Mendonsa, 2011). Although the postpartum serum IgM concentrations in cows raised under conventional conditions were higher than those of cows raised under organic conditions, the difference was not statistically significant (p>0.05). This value was reported within the range of 2.6 and 5.35 mg/mL in various studies (Herr et al., 2011; Mendonsa, 2011; Jezek et al., 2012). Although colostrum IgM concentrations in cows raised under organic conditions were higher than those raised under conventional conditions, the difference was not statistically significant (p>0.05). The same value was reported as 3.7 and 4.2 mg/mL by Herr et al. (2011) and Mendonsa (2011), respectively.

Postnatal (before receiving colostrum) and 14th day IgM concentrations in calves raised under conventional conditions were higher than those raised under organic conditions (p<0.05; p<0.01). Postnatal IgM concentrations were reported as 3.30 and 1.13 mg/mL by Akbulut et al. (2003) and Jezek et al. (2012), respectively. The basic difference between organic and conventional dairy cattle farms is based on nutrition and husbandry practices. Compared to conventional farms, production is carried out under more convenient environmental conditions and herd management is performed more professionally at organic dairy cattle farms in Turkey. The higher concentrations of both IgG and IgM in cattle raised at conventional farms might be due to the more adverse environmental conditions prevalent in these farms.

In both husbandry systems, positive and significant phenotypic correlations were identified between the mother’s and offsprings’ Ig concentrations. Mother’s serum IgG concentration and offspring’s postnatal (before receiving colostrum) and 14th day serum IgG concentrations were found to be highly correlated. A similar correlation was noted by Jezek et al. (2012) as well. According to these results, a crucial way of taking precautions against passive transfer failure would be to determine the mother’s postpartum serum IgG concentration. Although positive and significant correlations were identified in both husbandry systems between the mother’s serum IgM concentration and the offspring’s serum IgM concentration on the 14th day, this correlation was not significant for the postnatal period (before receiving colostrum). Jezek et al. (2012) reported that the phenotypic correlations between the mother’s and offspring’s serum IgM concentrations are not significant. In line with the result reported by Jezek et al. (2012), positive and significant correlations were observed between colostrum and the serum IgG and IgM concentrations in calves at various ages.

**CONCLUSION**

IgG concentrations in Holstein Friesian calves raised in the Eastern Black Sea region of Turkey were found to be higher than the values reported for the same breed. Serum IgM concentrations of calves and mothers raised under conventional conditions were significantly higher than those raised under organic conditions. This difference might be due to the adverse environmental conditions the cattle are exposed to conventional farms. Nevertheless, further research should be performed to shed more light on this issue.

**DISCLOSURE**

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