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The Effect of Colostrum Quality and Immunoglobulin Amount on Development up to Weaning Period in Holstein Friesian Calves

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ABSTRACT

This study was conducted to determine the quality of given colostrum to calves born in three different dairy farms in Eregli district of Konya and to investigate the development of calves up to 60th day. A total of 71 calves were used in the study. 32 of them were male and 39 of them were female. The effect of sex, enterprises, number of birth and birth month were examined on the colostrum characteristics. Birth weight, 60th day weight, colostrum dry matter, colostrum specific gravity, serum IgG, IgM, IgA at birth and IgG, IgM and IgA values at 60th day averages were determined as 41.78 ± 4.30 kg, 79.57 ± 10.17, kg, 28.60 ± 2.33, 1067.40 ± 9.85 g / L, 0.03638 ± 0.005, 0.0801 ± 0.0041 and 0.0391 ± 0.0045; 0.0342 ± 0.0050, 0.0364 ± 0.0041 and 0.0181 ± 0.0045 mg / L, respectively. The effect of sex on birth weight was statistically significant at P<0.01 level, and the effect of the number of births and enterprises on birth weight was statistically significant at P<0.05 level. The effect of any factor on sixty-day weight was not statistically significant. The effect of birth number on colostrum DM was statistically significant at P<0.01 level. The effect of period factor was very important (P<0.01) for IgM and IgA, but it was insignificant for IgG.

1. Introduction

Healthy breeding of calves is one of the most important issues in terms of economic sustainability of meat and dairy farming. In dairy cattle breeding enterprises, it has vital that calves be grown in a healthy way for the replacement of new breeding instead of animals in the herd. Possible diseases in calves cause low yield in the future. Newborn calves are at risk for many threats because their immunity is not fully developed. Most calf diseases and deaths after birth are caused by low immunoglobulin density (Goyena et al., 1997).

Newborn calves face significant challenges until they adapt to environmental conditions. The first weeks of their lives can be challenging. The calves getting over this period have a high chance of survival. In addition, calf losses in the first three months period can increase up to 20% according to running conditions (Bardakçıoğlu, 2001).

Calves should receive sufficient and quality colostrum to avoid endangering their lives. Because the immune substances (immunoglobulins, antigens, and antibodies) in the colostrum provide passive immunity by protecting calves from the disease. For this reason, colostrum should be provided with sufficient amount of immune agents. Immunoglobulins are the most important immunological agents, especially IgG, IgM, and IgA.

Pakkanen and Aalto (1997) reported that cow colostrum contains mostly IgG and a small amount of IgA, IgD, IgE, and IgM. The major immunoglobulins that act as antibodies are IgG, IgA, and IgM.

Koç (2013) stated that IgG, which constitutes 85-90% of the immune proteins in the colostrum, is effective in systemic 3 immunities, IgM is effective in the early immunity and protection from and septicemia, and IgA is not fully known for its duty, and all these three immune proteins should be found for an effective immunity.

Islam et al. (2005) reported that 35.2% of calf deaths occurred in the first month after birth. According to the researchers, the major cause of these deaths is the lack of adequate development of passive immunity, which means that the required level of quality colostrum is not taken.

In Turkey, it has been reported that the proportion of neonatal calves lost is 1-8% in the professional ani-

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mal raising enterprises, and this percentage is even higher in public enterprises (Çelik, 2013).

Genç (2015) stated that the amount of immunoglobulin in the blood serum of the calf should be determined within 24–48 hours after birth so that it can be determined whether passive immunity has developed or not. He also reported that IgG detection is a widely used indicator to evaluate immunoglobulin status in calf blood and colostrum. He remarked that in order to ensure adequate passive immunity in calves, the IgG concentration in the blood should be at least 10 g /l by the end of the 48th hour after the birth, and that the calves with a serum IgG value of 10 grams or higher are less likely to catch the disease than the calves that have not caught this rate.

As a result of studies on immunity in calves, it is emphasized that more than 50 grams of IgG should be present in one liter of colostrum to provide adequate passive immunity (Arthington, 2001).

The aim of this study was to determine the quality of colostrum given to Black Holstein calves reared in three different farms in Eregli district of Konya, and to investigate the effect of colostrum in the development of calves up to 60th day.

2. Materials and Methods

The animal materials to be used in the study consist of the calves born in three different dairy farms in Konya Ereğli district. A total of 71 calves were used in the study. 32 of them were male and 39 of them were female. The effect of sex, enterprises, number of birth and birth month were examined on the colostrum characteristics.

Colostrum quality was determined by establishing the relationship between colostrum gamma globulin content and colostrum density with colostrometers. The colostrometer give results basing on the relationship between the amount of Ig in the colostrum and the specific weight. The colostrum obtained from each cow after delivery was cooled to 20° C within the first 24 hours and filled into a beaker and the specific weight was measured with colostrometer. Colostrum classification is based on specific weights (Anonymous, 2006).

Accordingly, colostrum with a specific weight of >1.045 g / ml is classified as good quality, colostrum of 1.035-1.045 g / ml is classified as medium quality and colostrum of <1.035 g / ml is classified as low quality.

Blood samples were taken from vena jugularis to vacuum tubes in the experimental and control group calves on the 3rd day after birth, with venosafe plastic vacuum blood collection tubes and apparatus under necessary hygiene measures. Blood samples were sent to the laboratory for determination of IgM, IgG and IgA antibody levels. After 30 minutes at room temperature, the samples were centrifuged at 3500 rpm for 10 minutes to obtain serum samples and IgG, IgA and IgM antibody levels were determined from blood serum.

Only one calf died in the examined farms. Therefore, survival data were not evaluated.

In this study, the effects of factors such as parity, enterprise, season and age, which were thought to be effective on colostrum quality, were evaluated. Duncan multiple comparison test was applied to compare the sub-groups of the factors whose effects were found to be significant from the investigated factors, and statistical significance was checked and lettered (Duncan, 1955).

LSMLMW Least-Squares and Maximum Likelihood General Purpose Program developed by Harvey (1987) was used to determine the effect of yield characteristics approached according to mathematical models, least squares mean and variance analysis.

The mathematical model used in the analysis of the factors affecting colostrum quality;

$$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

It is in the form of the terms contained in these models

Y_{ijklm}= Colostrum dry matter of animal give birth in the i. month, j. enterprise, k. calf sex, l. parity,

μ = the expected average of the population,

a_i = i. the effect of birth month (February = 1, March = 2)

b_j = j. the effect of the enterprises (1, 2, 3),

c_k = k. the effect of calf sex (Female = 1, Male = 2),

d_l = 1. the effect of parity (1,2,3 ..),

e_{ijklm} = represents normal, independent, chance-dependent error.

3. Results and Discussion

Birth and sixtieth day weights

The LSM and SE values of the birth and sixtieth day weights of the animals examined were determined as 41.78 ± 4.30 and 79.57 ± 10.17 kg, respectively. While gender was effective on the birth and sixtieth day weight at P<0.01 level, and the number of births and enterprise was effective at P<0.05 level, the month of birth had no effect. The effect of any factor on the sixtieth day weight was not significant.

In the study, LSM and SE values of the factors that had effects on birth and sixty-day weight are presented in Table 1.

Table 1
The LSM and SE values of the factors that have effects on birth and sixtieth-day weight

Factors		N	Birth Weight	Sixtieth-day Weight.
Gender**	Female	39	39.46±0.79^{b}	79.75± 2.06
	Male	32	42.45±0.89^{a}	81.62± 2.24
Enterprise*	1	50	42.87±0.61^{A}	79.22± 1.59
	2	10	40.34±1.36^{AB}	79.72± 3.53
	3	11	39.65±1.31^{B}	83.11± 3.35
Number of Birth*	Single births	39	39.83±0.81^{B}	80.88± 2.17
	Multiple Births	32	42.08±0.87^{A}	80.49± 2.42
Month of Birth	February	40	41.13±0.80	78.69± 2.41
	March	31	40.78±0.88	82.68± 2.24

$^{A, B}$: P <0.05, $^{a, b}$: P <0.01: Differences between the means indicated by different letters in the same column are important

In the examined enterprises, the birth weight of males was approximately 3 kg higher than females. This is an expected case. The average birth weight of 41.78 ± 4.30 kg is very close to the general average reported for the Holstein breed. However, in the studies conducted on the subject; Ayaşan et al. (2016) determined the mean birth weight for Holstein Friesian breed as 42.24 kg, while Doğan (2014) determined the mean birth weight in calves born in winter and spring as 43.99 ± 0.89 kg and 40.90 ± 0.91 kg, respectively. These results reported by the researchers are slightly higher than the value obtained in the present study.

On the basis of enterprises, the highest average was obtained from the number one enterprise and the lowest average was obtained from number three enterprise. The differences between enterprises in terms of birth weight were found to be statistically significant (P<0.05). As well as the share of the father line in birth weight, the size of the mother, whether the mother gave first or more births, differences in the feeding and care applied to the animals may have caused birth weights to be different. Moreover, the mean birth weight of the mothers who had multiple births was 2.25 kg heavier than the birth weight of the mothers that had their first birth, and this difference caused a statistically significant difference (P<0.05).

There was no difference in the weights of the sixtieth day in the investigated farms, and it was observed that the animals with low birth weight compensated for these differences until the sixtieth day.

Colostrum dry matter and specific gravity

The LSM and SE values of dry matter (DM) and specific gravity (SG) values of colostrum obtained from the animals examined in the study were found to be 28.60 ± 2.33% and 1067.40 ± 9.85 g/L, respectively. Out of the factors such as calf gender, enterprise, the number of births and month of birth which were thought to have an effect on colostrum DM and SG, only the number of births had an effect on DM at the level of P<0.01, but the effects of other factors were insignificant.

The LSM and SE values of the factors thought to have an effect on dry matter and specific gravity values of the colostrum samples obtained from the study are presented in Table 2.

Table 2
The LSM and SE values of the factors that have effects on colostrum DM and SG values

Factors		N	DM (%)	SG (g/L)
Gender	Female	39	28.81±0.45	1067.58±1.93
	Male	32	28.86±0.48	1066.38±2.06
Enterprise	1	50	28.50±0.34	1067.86±1.43
	2	10	28.83±0.74	1068.52±3.15
	3	11	29.16±0.73	1064.56±3.08
Number of Births*	Single Births	39	27.87±0.47^{B}	1065.31±2.04
	Multiple Births	32	29.80±0.49^{A}	1068.64±2.17
Month of Births	February	40	29.24±0.44	1067.53±1.89
	March	31	28.43±0.48	1066.42±2.06

*: P <0.05, A, B :Differences between the means indicated by different letters in the same column are important

The specific gravity or relative density of the colostrum can be measured as an objective indicator of its quality. The device that measures the specific gravity of the colostrum is called a colostrometer. It has been reported that good quality colostrum should have a specific gravity greater than 1.056 g / L, whereas the specific gravity of normal milk is 1.032 (Wattiaux, 2008).

Kaygısız and Köse (2007) measured colostral density in the colostrum and divided the colostrum into three classes as good quality, medium quality, and bad quality. They have stated that the density of good-quality colostrum is higher than 1045 mg/ml, this value ranges from 1035 to 1045 mg/ml in medium quality colostrum and is less than 1035 mg/ml in low-quality colostrum.

Zinc sulfate test (ZST) can also be used to measure Ig levels in blood serum. In this method, serum IgG concentration less than 5 mg/ml is indicative of a failure in passive transfer immunity. Calves with this level are likely to have a high mortality rate. A value of 10-20 mg/ml indicates a moderate level of immunity (Rice and Rogers, 2003).

In the study of Göncü et al. (2013), the quality of colostrum and serum immunoglobulin levels in calves were compared in Holstein cows and heifers. The average density of colostrum samples collected in the study was determined as 1063.90 ± 1.67 g / L.

Blood immunoglobulin levels (mg / L)

The LSM and SE values of the immunoglobulin levels in the blood of calves reared in the farms subject to the study on the day of birth and on the sixtieth day for IgG, IgM and IgA were determined as 0.03638 ± 0.005, 0.0801 ± 0.0041 and 0.0391 ± 0.0045; 0.0342 ± 0.0050, 0.0364 ± 0.0041 and 0.0181 ± 0.0045 mg/L, respectively.

The effect of the period factor on the amounts of immunoglobulin was very significant (P <0.01) for IgM and IgA, but was not significant for IgG. LSM and SE values of the factors studied on immunoglobulin levels are given in Table 3.

Table 3
The LSM and SE value (mg/L) of the factors that have effects on the amount of immunoglobulin

Factors		N	IgG	IgM	IgA
Period	At Birth	71	0.0363 ± 0.005	0.0801 ± 0.0041[a]	0.0391 ± 0.0045[a]
	On the Sixtieth Day	71	0.0342 ± 0.0050	0.0364 ± 0.0041[b]	0.0181 ± 0.0045[b]

[a, b:] P <0.01, Differences between the means indicated by different letters in the same column are important

There was not much difference in IgG at birth and on the sixtieth day, but significant decrease in IgM and IgA occurred. The amount of IgM decreased to approximately 1/3 of that at birth on day sixtieth and the amount of IgA decreased to about half. IgG is the most common type of antibody in the body. It is found in all body fluids. It constitutes 75-80% of the antibodies. Therefore, there was not much reduction.

Genç (2015) determined the plasma IgG amount at 52.7 mg/ml in the sixth hour and reported that this value decreased to 4.8 mg/ml at 48th hour.

Conneely et al. (2014) in their study of the amount of serum immunoglobulin in dairy breed cattle have determined serum IgG concentration as 1.03 g / L at the zero hours. They remarked that after 24 h the serum IgG concentration increased to 39.1 g / L.

The birth and sixtieth day weights of the calves examined in the study were 41.78 ± 4.30 and 79.57 ± 10.17 kg, respectively. Although the difference between birth weights was significant, this difference disappeared at the sixtieth day. The survival rate of the calves was 98.60%. In other words, only one of the 71 calves that were the subjects of the study died. According to the colostrum quality classification, the average specific gravity value measured by colostrometer was found as 1067.40 ± 9.85 g / L. So colostrum qualities were found very high. The relationship between this result and the survival of calves is very high.

The mean DM of colostrum was found as 28.60 ± 2.33% and it was higher than the colostrum dry matter values reported in the literature. When the specific gravity and DM values are considered together, colostrum quality seems quite high.

The averages obtained for immunoglobulin amounts for IgG, IgM and IgA at birth and on the sixtieth day were 0.03638 ± 0.005, 0.0801 ± 0.0041 and 0.0391 ± 0.0045; 0.0342 ± 0.0050, 0.0364 ± 0.0041 and 0.0181 ± 0.0045 mg / L. According to these results, Ig was provided above the limits determined by the sources indicating that at least 10 g/L immunoglobulin should be given to newborn calves. This result was also reflected in the survival of calves.

In conclusion, it can be said that colostrum management was very well performed in the three farms investigated and therefore the calf losses were very low. These enterprises should work meticulously in this way to set an example for other enterprises. Businesses who have successfully survived the first four weeks of calf loss are more likely to minimize calf losses in the later periods by carefully observing the maintenance and feeding programs. As a result, the enterprises investigated have been found quite successful in terms of colostrum management.

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