KSÜ Tarım ve Doğa Derg 28 (1), 265-273, 2025
KSU J. Agric Nat 28 (1), 265-273, 2025
https://doi.org/10.18016/ksutarimdoga.vi.1573908

Influence of Breed, Season, Sex, and Parity on Mortality of Holstein Friesian and Brown Swiss Calves

Veysel Fatih ÖZDEMİR[1]✍
[1]Department of Animal Science, College of Agriculture, Ataturk University, 25240 Erzurum, Türkiye
[1]https://orcid.org/0000-0003-3035-7695
✉: veyselfatihozdemir@gmail.com

ABSTRACT

This study aimed to investigate the effects of season, parity, sex, and breed on preweaning mortality in calves. Records of 1890 Brown Swiss and Holstein Friesian calves born and reared in Atatürk University Cattle Farm, Erzurum, were used in the study. The data of the study were analyzed using the Chi-Square test available in the SPSS statistical program. Study results showed that season had a statistically significant impact on calf mortality ($p < 0.05$). The highest mortality rate was observed in spring (11.5%) and winter (11.0%) born calves, while the mortality rate was significantly lower in summer (7.3%) and autumn (6.3%) born calves. There was no statistically significant effect of calf sex on mortality. Similarly, calves born to primiparous and multiparous dams did not differ significantly in terms of mortality. The mortality rate of Holstein Friesian calves was slightly lower than Brown Swiss calves. While 87.5% of the calves born in the spring died in the first month of life, only 51.9% of the calves born in the summer died in the first month after birth ($p < 0.01$). The mortality of female calves was significantly lower than that of male calves in the first month, but higher in the second month. The parity of the dam did not have a significant effect on the age of mortality. Similarly, there was no statistically significant difference in mortality age between Brown Swiss and Holstein Friesian calves. During the first month after birth, Holstein Friesian calves had a slightly higher mortality rate (78.1%) than Brown Swiss calves (75.2%).

Animal Science

Research Article

Article History
Received : 26.10.2024
Accepted : 02.01.2025

Keywords
Brown Swiss
Calf mortality
Holstein Friesian
Non-genetic factors

Siyah Alaca ve Esmer ırkı Buzağılarda Irk, Mevsim, Cinsiyet ve Paritenin Mortalite Üzerine Etkisi

ÖZET

Bu çalışmanın amacı, sütten kesim öncesi dönemde buzağı ölümleri üzerine mevsim, parite, ırk ve cinsiyetin etkilerini araştırmaktır. Çalışmada Erzurum'da Atatürk Üniversitesi Sığırcılık İşletmesinde doğan ve yetiştirilen 1890 Esmer ve Siyah Alaca ırkı buzağıya ait kayıtlar kullanılmıştır. Çalışmanın verileri SPSS istatistik programında bulunan Ki-Kare testi kullanılarak analiz edilmiştir. Araştırma sonuçları, mevsimin buzağı ölümleri üzerinde istatistiksel olarak önemli bir etkiye sahip olduğunu göstermiştir ($p < 0.05$). En yüksek ölüm oranının ilkbahar (%11,5) ve kış (%11,0) mevsimlerinde doğan buzağılarda gözlendiği, ölüm oranının yaz (%7,3) ve sonbahar (%6,3) mevsimlerinde doğan buzağılarda önemli ölçüde düşük olduğu belirlenmiştir. Buzağı cinsiyeti ile mortalite arasında istatistiksel olarak anlamlı bir ilişki olmadığı tespit edilmiştir. Benzer şekilde, sırasıyla primipar ve multipar analardan doğan buzağılar arasında da ölüm oranları açısından önemli bir fark gözlenmemiştir. Siyah Alaca buzağıların ölüm oranının Brown Swiss buzağılara göre daha düşük olduğu belirlenmiştir. İlkbaharda doğan buzağıların %87,5'i yaşamlarının ilk ayında ölürken, yazın doğan buzağıların yalnızca %51,9'u doğumdan sonraki ilk ayda öldüğü belirlenmiştir ($p < 0,01$). Dişi buzağıların ölüm oranının ilk bir aylık yaşta erkek buzağılardan önemli ölçüde düşük olduğu ancak ikinci ayda daha yüksek olduğu tespit edilmiştir. Paritenin buzağıların ölüm yaşı üzerinde önemli bir etkisi gözlenmemiştir. Benzer şekilde, Esmer ve

Zootekni

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 26.10.2024
Kabul Tarihi : 02.01.2025

Anahtar Kelimeler
Buzağı ölümleri
Esmer
Genetik olmayan faktörler
Siyah Alaca

Siyah Alaca ırkı buzağılar arasında ölüm yaşı bakımından istatistiksel olarak anlamlı bir fark olmadığı gözlenmiştir. Doğumdan sonraki bir aylık yaşa kadar, Siyah Alaca buzağıların ölüm oranının (%78,1) Esmer buzağılardan (%75,2) daha yüksek olduğu belirlenmiştir.

Atıf Şekli: Özdemir, V.F. (2025) Influence of Breed, Season, Sex and Parity on Mortality of Holstein Friesian and Brown Swiss Calves. *KSÜ Tarım ve Doğa Derg 28* (1), 265-273. https://doi.org/10.18016/ksutarimdoga.vi.1573908
To Cite : Özdemir, V.F. (2025) Influence of Breed, Season, Sex and Parity on Mortality of Holstein Friesian and Brown Swiss Calves. *KSU J. Agric Nat 28* (1), 265-273. https://doi.org/10.18016/ksutarimdoga.vi.1573908

INTRODUCTION

Livestock production is a major contributor to the global economy, accounting for nearly 40% of total agricultural production in developed countries and 20% in developing countries (Acosta and De los Santos-Montero, 2019). The cattle sector plays a significant role in meeting the world's demand for animal protein, producing over 81% of the world's milk and 19% of the world's meat (FAOSTAT, 2024). In this context, the health and productivity of dairy cattle, particularly calves, are central to sustaining the industry. However, calf mortality is a major cause of economic loss in the global livestock industry (Abebe et al., 2023; Özdemir & Yanar, 2024), and a major concern in all countries with extensive livestock production systems, and is exacerbated in developing countries by poor management practices (Ferede et al., 2014). The mortality rate in calves in the USA has been reported to be 6-8% (Jorgensen et al., 2017) and this rate is significantly higher in developing and underdeveloped countries. The future of cattle enterprises depends significantly on the calves (Medeiros et al., 2022), and calf rearing is highly critical for the success of cattle enterprises because the calves play a crucial role in ensuring a sustainable milk supply, replacing aging cows, and contributing to the genetic improvement of the herd (Kaygısız et al., 2022a; Gomes et al., 2021). The mortality in the calf-rearing period is considerably high (Gessess et al., 2021), and the majority of calf losses take place in the period before the weaning period (Zucali et al., 2013). High mortality rates in this period have a significant economic impact on farming systems, reducing the number of animals that can be sold, animal welfare, selection, and genetic improvement (Schmidek et al., 2013). Reducing calf mortality is therefore the first and foremost objective of cattle farms. A good understanding of the factors that may influence calf mortality is essential for the development of prevention strategies (Sedo et al., 2023). Several factors, including genetic, management, and environmental variables, can affect the survival of calves (Mee et al., 2019). Calf mortality has been the subject of a great deal of research and many factors that may have an influence have been the subject of detailed investigation. However, the effects of environmental and non-genetic factors on calf mortality have, to knowledge, not been studied extensively. This study aimed to investigate the effects of season, dams' parity, breed, and sex on calves' mortality before weaning on a dairy herd.

MATERIALS and METHOD

The data used in the study were the records from 18 years (1998 - 2016) for Brown Swiss and Holstein Friesian calves born and reared at the Atatürk University Cattle Farm in Erzurum (1821 m above sea level, 39°55'15.49' N, 41° 17'12.90 E). A total of 1890 records were used in the study. As this is a research and application farm, records from calves used as part of research studies were excluded from the study.

The breeding was practiced by artificial insemination. The newborn calves were allowed to suckle their dams for the first three days after birth for colostrum feeding. Subsequently, they were then taken into individual pens. Due to the harsh climatic conditions of the region, the calves are reared in an enclosed barn with heating. Individual pens were littered with straw. The straw bedding was removed and replaced daily. The calves were fed two feeds a day until weaning at 60 days of age. The milk amount offered to calves is kept constant at 10% of calves' birth weight. The starter and dry hay were fed to calves, once a day in the morning. Dry hay was harvested from natural pastures in the area. The calves had unlimited access to calf starter, dry hay, and clean water. They were weaned when they reached 60 days of age.

Records from 1134 Brown Swiss and 756 Holstein Friesian calves were used in the study. Only the records from the first 2 months of life until weaning were considered. The mortality data was first categorized as 1 (died) and 2 (did not die) to be able to analyze the effects of these factors on preweaning mortality. To analyze the effect of parity, we categorized parity as 1 (primiparous) and 2 (multiparous). The season was coded as 1 (spring), 2 (summer), 3 (autumn), and 4 (winter) based on the calves' birth dates. The sex of the calves was coded 1 (female) and 2 (male). Breed was coded as 1 (Brown Swiss) and 2 (Holstein Friesian). The influence of these factors on the mortality of calves was analyzed by the Chi-square test. Subsequently, the effects of these factors on the mortality age of calves in the first two months of age were analyzed. For this purpose, the data of 190 calves who died in the first two months of age were selected and categorized as 1 (died in 1-30 days of age) and 2 (died in 31-60 days of age). The numbers have been inserted into SPSS and the Chi-square test was applied to data to determine the

effects of season, sex, breed, and parity on the mortality age of caves (SPSS, 2020). To investigate the effects of season, sex, and parity on calf mortality across different breeds, mortality data was separated by breed. Using the frequencies module, we analyzed the data and calculated percentage values. The results were then presented in graphical format for clearer comparisons between breeds.

In the Chi-square test, the formula used to measure the deviation of observed and expected frequencies is as follows,

$$x^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

In this formula:

x^2 = Chi-Square

O_i = Observed value

E_i = Expected value

n = Number of observations

The study has been approved by Atatürk University, Agricultural Faculty Ethics Committee Chairmanship (Session No: 2024/26 Decision No: 2024/1).

RESULTS

The effect of season, sex, parity, and breed on the mortality of calves before weaning has been presented in Table 1. The season had a statistically significant effect ($p < 0.05$) on the mortality rate. Mortality was significantly less in the summer (7.3%) and autumn (6.3%) seasons. The mortality of female calves was slightly higher than that of male calves. However, the differences were not statistically significant. Similarly, parity had no statistically significant effect on the mortality of pre-weaned calves, with mortality rates of 10.8% and 9.8% for calves born to primiparous and multiparous dams, respectively. In comparison to Brown Swiss calves, Holstein Friesian calves had a slightly lower mortality rate. However, this difference did not reach a statistically significant level.

Table 1. Effects of season, sex, parity, and breed on the mortality of calves
Tablo 1. Mevsim, cinsiyet, parite ve ırkın buzağı ölümleri üzerindeki etkileri

		Mortality	Number of Calves Born	Percentage (%)	Chi-Square
Season	Spring	96	834	11.5	$p < 0.05$
	Summer	27	371	7.3	
	Autumn	11	175	6.3	
	Winter	56	510	11.0	
Sex	Female	89	872	10.2	$p = 0.448$
	Male	101	1018	9.9	
Parity	Primiparous	55	509	10.8	$p = 0.281$
	Multiparous	135	1381	9.8	
Breed	Brown Swiss	117	1134	10.3	$p = 0.349$
	Holstein Friesian	73	756	9.7	
	Total	190	1890	10.1	

Table 2 shows the effect of season, sex, parity, and breed on the age at which calves died in the period before weaning. Throughout the study, the first and second-month mortality rates were 76.3% and 23.6% respectively. Study findings showed that season had a statistically significant effect on age at death ($p < 0.01$). While 87.5% of spring calves died in the first month of their life, only 51.9% of summer-born calves died in the first month. Furthermore, autumn and winter calves had mortality rates of 72.7 % and 69.6 % respectively. Even though sex did not have a statistically significant influence on age at mortality ($p = 0.065$), female deaths were significantly lower than male deaths in the first month but higher in the second month. The parity of the dam had no significant effect on the age at which the calves died. There was a slight difference between the mortality of calves born to primiparous dams and those born to multiparous dams in the first month and the second month. Similarly,

between Brown Swiss and Holstein Friesian calves, there was no statistically significant difference in age at death. During the first month after birth, the mortality rate of Holstein Friesian calves was slightly higher (78.1 %) than that of Brown Swiss calves (75.2 %).

Table 2. Effects of Season, sex, parity, and breed on the mortality age of calves
Tablo 2. Mevsim, cinsiyet, parite ve ırkın buzağıların ölüm yaşı üzerindeki etkileri

		Mortality in 1-30 days	Mortality in 31-60 days	Total Mortality	Chi-Square
Season	Spring	84 (87.5%)	12 (12.5%)	96	$p < 0.01$
	Summer	14 (51.9%)	13 (48.1%)	27	
	Autumn	8 (72.7%)	3 (27.3%)	11	
	Winter	39 (69.6%)	17 (30.4%)	56	
Sex	Female	63 (70.8%)	26 (29.2%)	89	$p = 0.065$
	Male	82 (81.2%)	19 (18.8%)	101	
Parity	Primiparous	41 (74.5%)	14 (25.5%)	55	$p = 0.424$
	Multiparous	104 (77.0%)	31 (23.0%)	135	
Breed	Brown Swiss	88 (75.2%)	29 (24.8%)	117	$p = 0.394$
	Holstein Friesian	57 (78.1%)	16 (21.9%)	73	
Total		145 (76.3%)	45 (23.6%)	190	

Figure 1 shows the average mortality age of calves in the different seasons. The average age of calf mortality was determined to be 12.3 years in the spring season, 29.4 years in the summer season, 12.5 years in the autumn season, and 18.7 years in the winter season. The spring and autumn seasons were found to be the seasons in which the earliest calf deaths occurred, while the mortality age of the calves in the summer season was considerably high in comparison to the other seasons.

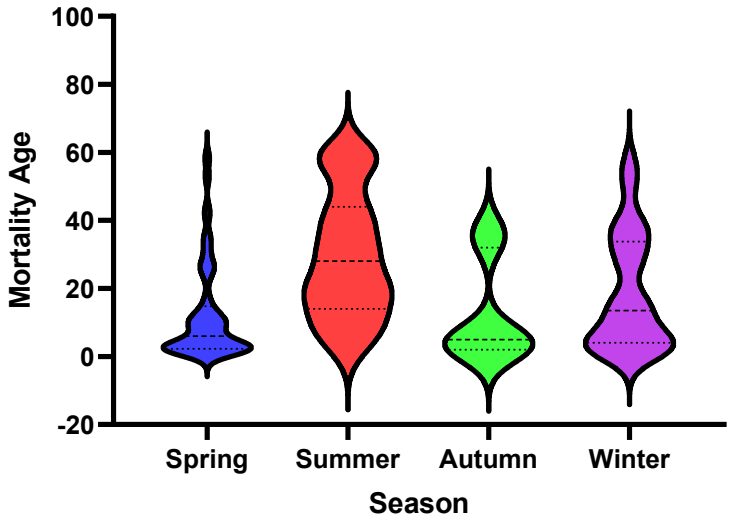

Figure 1. The distribution of the calf mortality ages in different seasons
Şekil 1. Buzağı ölüm yaşlarının farklı mevsimlere göre dağılımı

The mortality rates of pre-weaned Brown Swiss and Holstein Friesian calves born at different times of the year are presented in Figure 2. The findings of the study showed that the mortality rate of Brown Swiss calves born in the spring (12.1%) was significantly higher than the mortality rate of Holstein Friesian calves born in the summer (10.6%). Mortality was significantly higher in summer-born Holsteins Friesian (9.0 %) than in Brown Swiss calves (6.4 %). Mortality rates did not differ between autumn and winter calves. However, Brown Swiss calves born in winter (11.8%) had a higher mortality rate than Holstein Friesian calves (10.8%) in the pre-weaning period.

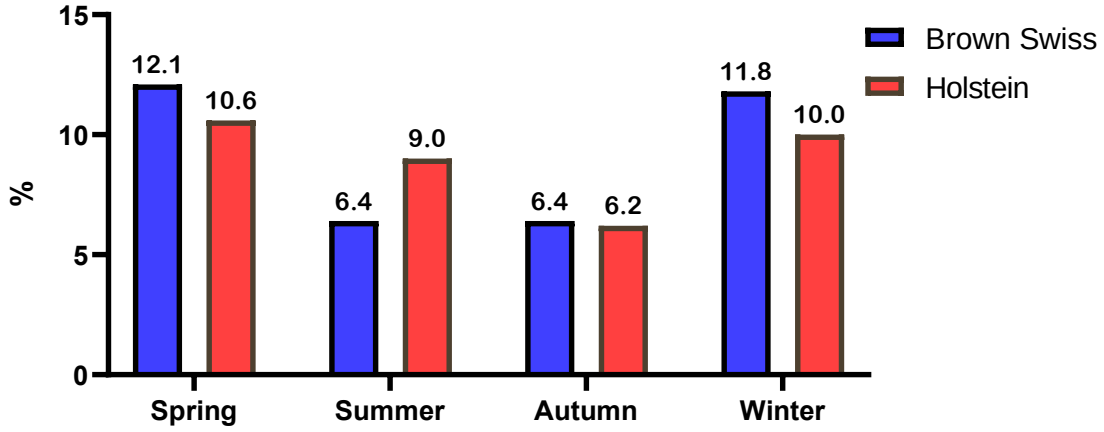

Figure 2. Mortality rates of pre-weaned Brown Swiss and Holstein Friesian calves born in different seasons
Şekil 2. Farklı mevsimlerde doğan sütten kesilmiş Esmer ve Siyah Alaca buzağıların ölüm oranları

The mortality rates of female and male calves of the Brown Swiss and Holstein Friesian breeds in the period before weaning are shown in Figure 3. Results showed that Brown Swiss female calf mortality (9.7%) was slightly lower than Holstein Friesian female calf mortality (10.8%). Male calf mortality differed significantly between the two breeds. There was no difference in mortality between autumn and winter-born calves. However, mortality in winter-born Brown Swiss calves (11.8%) was slightly higher than in Holstein Friesians (10.8%).

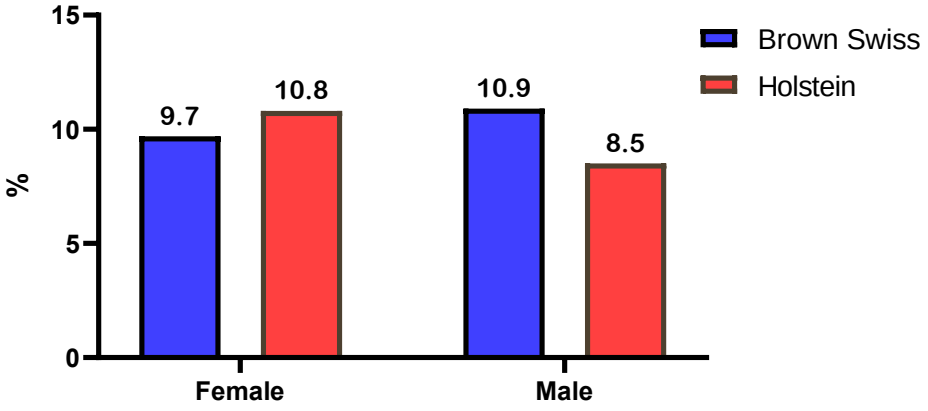

Figure 3. Mortality rates of Brown Swiss and Holstein Friesian female and male calves
Şekil 3 Esmer ve Siyah Alaca dişi ve erkek buzağıların ölüm oranları

Mortality rates of Brown Swiss and Holstein Friesian calves born from multiparous and primiparous dams in the pre-weaning period are shown in Figure 4. Brown Swiss calves having primiparous cows had a mortality rate of 10.3 percent, while Holstein Friesian calves had a mortality rate of 11.5 percent. Brown Swiss calves born to multiparity dams had a slightly higher pre-weaning mortality rate (10.3%) than Holstein Friesian calves (8.9%).

DISCUSSION

Mortality in calves in early life has mostly been attributed to infectious agents (Khan and Khan, 1991). However, some other factors may have an impact on the mortality and survival rate of calves such as season, sex, breed, and parity of the dam. To develop preventative strategies, it is essential to monitor all the factors that may influence the mortality of calves (Sedo et al., 2023). Within the first months of life, calves are highly susceptible to disease, and the mortality rate is considerably high in this period (Lora et al., 2018). Temperature extremes (hot and cold) can lead to stress in calves and increase their susceptibility to diseases. In certain seasons, certain diseases are more prevalent. In the autumn and winter seasons, the incidence of respiratory diseases increases considerably especially when animals are housed together (Gulliksen et al., 2009). In addition, most enteric pathogens are widespread during the winter season (Berber et al., 2021).

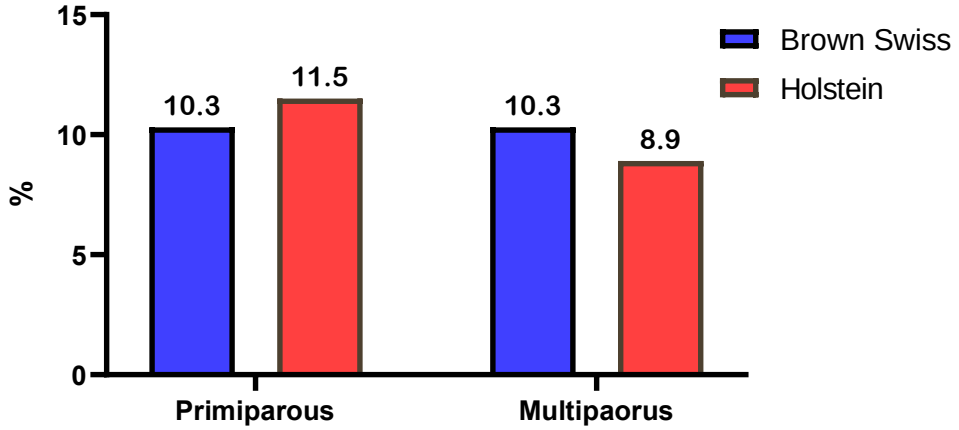

Figure 4. Mortality rates of Brown Swiss and Holstein Friesian calves born to primiparous and multiparous dams
Şekil 4. Primipar ve multipar analardan doğan Esmer ve Siyah Alaca ırkı buzağıların ölüm oranları

In the current study, the effect of season on calf mortality was significant ($p < 0.05$). The calf mortality was determined to be the highest in spring (11.5%) and winter (11.0%) seasons, whereas the mortality was considerably lower in summer (7.3%) and autumn (6.3%) born calves. Furthermore, the mortality of Brown Swiss calves was higher as compared to Holstein Friesian calves in winter, but lower in summer. Svensson & Liberg (2006), Pannwitz (2015), and Ismail & Muhaffel (2022) have also reported that the highest mortality rates were observed in winter seasons. During the winter months, calves experience cold stress and heat loss due to low temperatures. Thus, the mortality of calves is significantly high in the winter and early spring seasons due to exposure to harsh climatic conditions (Kozat, 2018). When newborn calves leave the warm environment of the uterus after birth and are exposed to the cold outside conditions, they experience dramatic changes in body temperature. Comparable results have also been reported by Ismail & Muhaffel (2022) and Ndung'u et al. (2024) who indicated that calf mortality was the highest in winter and spring months. The results of the study are consistent with the literature, especially considering that the study was conducted in harsh and cold Eastern Anatolian conditions. Moreover, the effect of season was also significant ($p < 0.01$) on the mortality age of calves. The above information is supported by this result. Newborn calves are highly susceptible to cold stress and heat loss due to low temperatures. Especially immediately after birth, calves' thermal protection systems are not fully developed, so lack of heat can increase mortality. Calf mortality was significantly high in the first month, in the spring season accounting for 87.5% of calf losses. However, this rate was drastically lower compared to other seasons with only 51.9% of calf mortality in summer-born calves. After this season, autumn and winter accounted for 72.7% and 69.6% of calves lost in the first 1 month of life respectively. Throughout the study, the mortality in the first and second months was determined to be 76.3% and 23.6% respectively. Comparably, Kaygısız et al. (2022b) reported that 97.6% of the calf losses occurred in the first month of life in Andırın District of Kahramanmaraş.

Calf sex is thought to influence perinatal calf mortality, with male calves being almost twice as likely as females (Mee et al., 2019). Mee et al. (2011) reported that male calves tend to have longer gestation periods than female calves, which increases the risk of perinatal loss. Although a slightly higher mortality rate was observed in female calves within two months in the current study, mortality of male calves in the perinatal period (first month) was found to be significantly higher (81.2%) than that of female calves (70.8%). However, after 1 month of age, the mortality rate of female calves was significantly higher than that of male calves. Compared to Holstein Friesian males, Brown Swiss male calves had a higher pre-weaning mortality rate. High male calf mortality rates at the beginning of their lives are often reported in the literature (Riley et al., 2004; Østerårs et al., 2007; Bleul, 2011; Baykan & Özcan, 2019). Schmidek et al. (2013) reported that a possible explanation for higher early mortality of male calves is the higher birth weight of male calves leading to calving difficulty, thus increasing mortality risk.

Dam parity is recognized as among the major factors influencing the survival of calves in the pre-weaning period (Bunter & Johnson, 2013; Gesseess et al., 2021). Mortality in calves is reported to be higher in calves born from primiparous dams than in multiparous dams (Mee et al., 2014). The reason for this may be the calving difficulty in young heifers which leads to higher mortality risk for the calves that are born. Lombard et al (2007) reported that calving assistance is required in more than half of the calvings (51.2%) in primiparous calvings, whereas the assisted calving rate for multiparous dams was 29.4%. The findings of the current study indicated that the mortality in the pre-weaning period was higher in calves having primiparous dams (10.8%) than in calves having

multiparous dams (9.8%), but the difference was not statistically significant. A higher pre-weaning mortality rate has also been reported for primiparous dams as compared to multiparous dams by Segura-Correa et al. (2018). In addition, Brown Swiss calves from multiparous dams had a higher mortality rate in comparison with the Holstein Friesian calves. Comparably, van Pelt et al. (2012) reported that calf survival increases in parallel with the increase in the dam parity. A higher mortality rate for primiparous dam calves has also been determined by Olsson et al. (1993). In the current study dam parity had no statistically significant effect on mortality age of calves.

Resilience, resistance to diseases, and adaptability to environmental conditions vary significantly based on breeds, all of these factors have a crucial role in the survival and mortality of calves. For example, Davis et al. (2020) noted that mortality rates of calves were 3.5%, 3.6%, and 5.3% in the first 1 month and 7.7%, 6.7%, and 9.1% between 1 month and 6 months of age in Red Holstein Friesian and Jersey calves raised in Denmark. In this study, pre-weaning mortalities were found to be 10.3% and 9.7% for Brown Swiss and Holstein Friesian calves, respectively. The first-week mortality rate of Holstein Friesian calves has been reported as 7.95% by Kaygısız et al. (2017). There was no significant effect of breed on the mortality ages of calves. In the first months of their life, the mortality rate of Brown Swiss calves was 75.2% and Holstein Friesian calves was 78.1% among all the calves that died in the pre-weaning period. Comparable results have also been reported by Koçak et al. (2008) who found that the first-month survival rate of Holstein Friesian calves was higher than Brown Swiss calves. In contrast, Koşum & Kaygısız (2019) found that the mortality of Brown Swiss calves was lower than Holstein Friesian calves in the first week of life. Baykan & Özcan (2019) reported a lower mortality rate for Brown Swiss calves in comparison with the Simmental calves.

CONCLUSION

High calf mortality rates in the pre-weaning period are among the major problems faced by the cattle sector. Among the factors influencing calf mortality are season, sex, breed, and parity of the dam. The findings of this study indicated that the effects of the season were significant on calf mortality, with the highest calf losses occurring in calves born in the spring and winter due to the cold stress and heat loss from harsh climatic conditions experienced during winter and early spring. Furthermore, mortality in Brown Swiss calves was higher than Holstein Friesian calf mortality in winter but lower in summer. The mortality of male calves at one month of age was significantly higher than that of female calves. Increased mortality of males in the first year of life may be due to increased birth weight of males leading to calving problems and increased risk of mortality. In addition, compared to Holstein Friesian males, Brown Swiss male calves had a higher mortality rate. Calves born to primiparous dams had a slightly higher mortality rate before weaning than calves born to multiparous dams. This may be due to calving difficulties in young heifers, resulting in a higher mortality risk for the calves born. Between Brown Swiss and Holstein Friesian calves, there was no statistically significant difference in pre-weaning mortality. In addition, the mortality rate of Brown Swiss calves born to multiparous dams was higher than the mortality rate of Holstein Friesian calves.

ACKNOWLEDGEMENT

I would like to thank my colleagues Mete Yanar, Recep Aydın, Bahri Bayram, and Rıdvan Koçyiğit for their support in collecting data and designing the study.

Author Contributions

VFÖ: Collection of the data, design of the study, analysis of the data, interpretation of the results, and writing the manuscript.

Conflict of Interest

There is no conflict of interest.

Ethical Statement

The study has been approved by Atatürk University, Agricultural Faculty Ethics Committee Chairmanship in 2024 (Session No: 2024/26; Decision No: 2024/1).

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