

## **Original Research Article**

### **Clinical Signs of Seasonal Disease Dynamics in Calves Caused by Rotavirus and Coronavirus Infections**

#### **ABSTRACT**

The study of animal diseases increases the relevance of the livestock industry, which is the main leading component of the strategy for the development of agriculture in Azerbaijan. An important role of the country. Their research is critical in the implementation of measures to combat rotavirus and coronavirus infections in infant calves. The primary goal of this study was to investigate the seasonal dynamics of accompanying diarrhea in calves caused by rotavirus and coronavirus infection. The research was carried out on farms located in the northwestern region of the Azerbaijan republic.

Fecal samples were used as material and tested by chromatographic immunoassay for the qualitative detection of rotavirus and coronavirus antigen.

The study revealed that the clinical signs of diarrhea in calves caused by rotavirus and coronavirus infections in farms located in the northwest region of the country are relatively similar. However, there was a relatively higher incidence of rotavirus infection, and mortality relative to coronavirus was at a lower level. The occurrence of secondary pneumonia in patients with coronavirus was noted as one of the main clinical signs. The study showed that the trend of infection and death from both diseases changes in different seasons of the year, which from season to season and, as a result, becoming massive causes serious damage to farms, becoming widespread in spring, autumn, and winter.

*Keywords: coronavirus, rotavirus, indigestion, seasonal, diarrhea, serotype.*

#### **INTRODUCTION**

Seasonal changes are one of the most important and predictable systems influencing humans and ecosystems. The spread of many pathogenic infections is seasonal; for example, respiratory diseases in humans and rotaviruses in children are more widespread during the winter months [1, 2]. Seasonal changes repeated every year can cause changes in the biology of the susceptible organism and infections, causing epidemics [3]. However, other leading factors that can also lead to epidemics should be taken into account [4, 5]. The coronavirus pandemic, which is a disease of viral origin that the planet is facing in modern times, has shown that in order to be prepared to prevent such diseases and avoid similar risks in the future, it is extremely important to comprehensively investigate and study diseases of viral origin from the point of view of reducing biological threats [6, 7, 8]. Rotavirus is a viral disease of calves characterized by dyspepsia, diarrhea, and dehydration [9, 10]. At least two different 27 G and 37 P rotavirus genotypes have been identified that can lead to rotavirus infections [11]. Rotaviruses of the Reoviridae family are spherical viruses with a double-stranded, 1-segment RNA genome [12]. Genomic segments encode 12 proteins, six of which are structural proteins (VP1, VP2, VP3, VP4, VP6, and VP7), and six are nonstructural proteins (NSP1–NSP6) [13, 14, 15]. The disease is common in

developed countries with industrially oriented animal husbandry. Usually, 2–3-day-old calves are more susceptible to the disease.

When calves are infected with contagious secondary infections of the gastrointestinal tract (*Escherichia coli*), mortality among sick animals reaches 100% [16, 17, 18, 19].

Coronaviruses are divided into 4 genotypic groups according to their genetic proximity: *Alphacoronaviruses*, *Betacoronaviruses*, *Gamacoronaviruses* and *Deltacoronaviruses*. Coronaviruses in cows are membrane-enveloped RNA viruses with positive polarity belonging to the Coronaviridae family [20, 21]. Betacoronaviruses are coronaviruses that cause SARS-CoV-2 in humans [22, 23]. The virus has a common antigen with strains of human coronavirus, hepatitis in mice and rats, and porcine encephalomyelitis. Transmission of the virus is widespread among animals [24]. Calves become ill from day 10 to 8 weeks of age if they do not have inherited maternal antibodies [25, 26]. Pathogenic viruses that have spread in the environment in different serotypes, mutating and changing their serotypes, cause epizootics, epidemics, and even pandemics. Along with humans, coronaviruses also cause diarrhea in animals, including calves. In the United States, BCoV-WD is more prevalent in the northern states [16].

Rotavirus causes death of nursing calves and leads to serious economic losses for farmers around the world

Rotavirus is one of the most widespread infectious agents worldwide, causing diseases, and it has been extensively studied in depth [28]. The prevalence of rotavirus among calves with diarrhea in India ranges from 11.8% to 26.8% [6]. Rotavirus infection has also been widely studied in European countries. Between 1993 and 2006, the estimated prevalence was 24–47% in Sweden, 42% in outbreaks of diarrhea in the UK, and 37–47.4% in France [30, 31, 32].

According to available statistics in Azerbaijan, 75-95% of infectious diarrhea in calves is caused by *E. coli*, rotavirus, coronavirus and cryptosporidiosis, with rotavirus accounting for 27-36% and coronavirus for 20-26%.

The study of both viruses can play an important role in reducing risks on farms. The goal of this study was to identify seasonal dynamics and clinical signs of rotavirus and coronavirus diseases in calves in the republic's northwestern region.

## MATERIALS AND METHODS

### Study area and climatic characteristics

The study used a statistical database for 2017-2020 on diarrhea that spread among calves (ages 0-90) from the "Holstein-Friesian" breed of cattle imported from abroad to "Gilan Dairy Farms" LLC in the Gabala region, which belongs to the northwestern region republics. The farm has 2,000 head of cattle, and the number of dairy cows ranges from 900. The complex has 7 stalls, a feed production workshop, feed dryers, ancillary buildings, and 120 calf pens. The complex is located in the village of Boyuk-Emily,

Gabala region, the height of the village is 389 meters above sea level; the average temperature in winter is 3.9-9.4 °C, and in summer it is in the range of 15.4-29.5 °C. According to academician B.A. Budagov, the hottest place in the region is marked in the direction of the villages of Kushlar-Kurd-Bayramkokhaly. And the minimum temperature reaching up to -50°C in the region is observed at the top of Bazardyuzu (4466 m). The area's snow cover lasts 45 days. The first autumnal frosts are observed in the 2nd decade of December and January, and the last spring frosts, as a rule, usually occur on April 8th. The average annual number of frost-free days is 241 days, the number of days with temperatures above 5 degrees during the flowering period is 265 days, and the number of days with temperatures above 10 degrees reaches 198 days. The southern slope of the Greater Caucasus, which includes the Gabala region, was divided into six agro-climatic regions. Each of these areas occupies its own place and is important for the development of agricultural territories.

### Collected samples

During this process, fecal samples taken from calves at different times of the year were checked by rapid testing (TMR nutrition calf test-5), their registration was carried out, and the seasonality of infection was determined.

Fecal samples were collected only within the first 24 hours of the first clinical signs in calves aged 4 to 30 days by digital fecal release after the formation of a rectal reflex.

In 2020, 328 samples were taken; in 2019: 342 samples; in 2018: 358 samples; and in 2017: 357 samples.

### Test procedure

In order to clarify the results of the studies, clinical and pathoanatomical research were used, and pathoanatomical necropsies of dead animals were performed. During the necropsy scissors, a surgical knife, a mask, gloves, and sample containers were used.

For testing according to the instructions (TMR Nutrition, calf test-5), kits for express testing were used. Thus, when diagnosing, the BoviD-4/5 rapid test sampling stick, D4 Diarrhea Ag, test strips, sterile gauze, test flask, ready-made solvent inside the flask, test pipette, and sterile gloves were used in the following sequence:

1. The selected samples were dissolved in the solvent, and a pause of 30 seconds was made.
2. Dissolved samples are taken from the solution with a pipette.
3. Four drops of solution were added to each cell.
4. Results were read in 5-10 minutes.
5. Strips showing control and test lines were considered positive for rotavirus infection.
6. In clinical trials, other research methods were used using an electronic thermometer and a phonendoscope.

### RESULTS

The Gabala region is distinguished by a large number of cold days a year. As can be seen from Table 1, the highest temperature in the winter months ranges from 5-7 °C, and in the summer months it

reaches a maximum of 29 °C. Such climatic conditions were regarded as more favorable for enteroviruses.

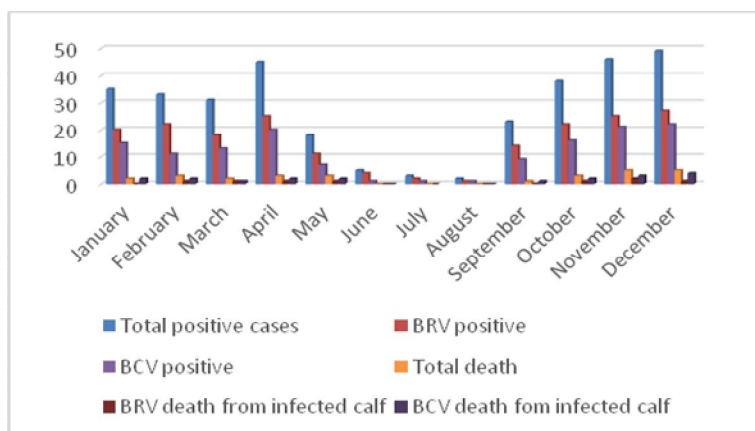
Climate of Gabala region												
Months	January	February	March	April	May	June	July	August	September	October	November	December
Maximum temperature °C (°F)	4.4 (39.9)	5.0 (41.0)	9.4 (48.9)	17.3 (63.1)	21.1 (69.9)	26.0 (78.8)	29.5 (85.1)	28.6 (83.3)	24.8 (76.6)	17.4 (63.3)	11.4 (52.5)	7.0 (44.6)
Minimum temperature °C (°F)	-3.9 (24.98)	-2.8 (41.0)	1.0 (48.92)	6.7 (50.4)	11.2 (59.9)	15.4 (70.3)	18.2 (76.3)	17.4 (76.8)	13.9 (73.0)	8.5 (65.1)	3.0 (56.8)	-1.4 (50.9)
Number of sunny days	10.0	11.0	12.0	13.0	14.0	15.0	15.0	14.0	12.0	11.0	10.0	9.0

**Table 1. Temperature indicators in the Gabala region throughout the year**

Tables 2 and 3 and Diagram 1 show the indicators of calves that tested positive for rotavirus and coronavirus, as well as cases of their death due to the disease in 2020 by months and seasons of the year, as well as a comparative analysis of cattle loss cases from rotavirus and coronavirus.

Results of 2020	January	February	March	April	May	June	July	August	September	October	November	December
Total positive cases	35	33	31	45	18	5	3	2	23	38	46	49
BRV positive	20 (57.1%)	22 (66.7%)	18 (58.1%)	25 (55.6%)	11 (61.1%)	4 (80.0%)	2 (66.7%)	1 (50.0%)	14 (60.9%)	22 (57.9%)	25 (54.3%)	27 (55.1%)
BCV positive	15 (42.86%)	11 (33.33%)	13 (41.94%)	20 (44.44%)	7 (38.89%)	1 (20.00%)	1 (33.33%)	1 (50.00%)	9 (39.13%)	16 (42.11%)	21 (45.65%)	22 (44.90%)
Total death	2 (5.7%)	3 (9.1%)	2 (6.5%)	3 (6.7%)	3 (16.7%)	0	0	0	1 (4.3%)	3 (7.9%)	5 (%)	5 (10.2%)
BRV death from infected calf	0	1 (4.5%)	1 (5.6%)	1 (4.0%)	1 (9.1%)	0	0	0	0	1 (4.5%)	2 (8.0%)	1 (3.7%)
BCV death from infected calf	2 (13%)	2 (18%)	1 (8%)	2 (10%)	2 (29%)	0	0	0	1 (11%)	2 (13%)	3 (14%)	4 (18%)

**Table 2. The dynamics of rotavirus and coronavirus disease spread in Gilan Dairy Farms LLC by month in 2020.**



**Fig. 1. Correlation of positive results in 2020 by months**

As can be seen from Table 2, in the winter period of 2020, 99 heads of cattle were infected with coronavirus and rotavirus infections. Of these, 39 heads of cattle were infected with coronavirus and 60 heads of cattle with rotavirus. The deaths of 5 heads of cattle (with a percentage mortality of 13%) from coronavirus infection and 2 heads of cattle (with a percentage mortality of 3.3%) from rotavirus infection were recorded.

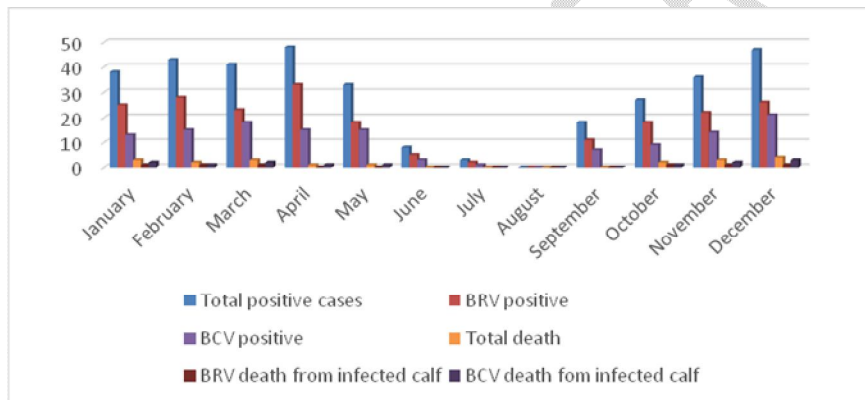
In the spring of 2020, 68 cattle were infected with coronavirus and rotavirus infections, including 28 coronavirus-infected cattle and 40 rotavirus-infected cattle. The cattle losses from coronavirus infection were 4 heads of cattle (13%) and 2 heads of cattle from rotavirus infection (5%).

During the summer season of 2020, the death of 1 head of cattle from infection with coronavirus and rotavirus was registered (percentage mortality: 4%) and not a single case of cattle loss from rotavirus infection. During the autumn season, cases of infection with coronavirus and rotavirus affected 59 heads of cattle (with a mortality rate of 15%) for coronavirus infection and 74 heads of cattle (percentage with a mortality rate of 5.4%) for rotavirus infection.

Results of 2019	January	February	March	April	May	June	July	August	September	October	November	December
Total positive cases	65	70	48	36	33	8	3	2	32	80	88	82
Rotavirus positive	35 (54%)	40 (57%)	28 (58%)	20 (56%)	18 (55%)	5 (63%)	2 (67%)	1 (50%)	18 (56%)	43 (54%)	46 (52%)	42 (51%)
Coronavirus positive	30 (46%)	30 (43%)	20 (42%)	16 (44%)	15 (45%)	3 (38%)	1 (33%)	1 (50%)	14 (44%)	37 (46%)	42 (48%)	40 (49%)
Rotavirus death	2 (6%)	2 (5%)	1 (4%)	0	0		0	0	2 (11%)	3 (7%)	5 (11%)	3 (7%)
Coronavirus death	3 (10%)	3 (10%)	2 (10%)	1 (6%)	1 (7%)	0	0	0	4 (29%)	5 (14%)	6 (14%)	6 (15%)
Total death	5 (8%)	5 (7%)	3 (6%)	1 (3%)	1 (3%)	0	0	0	6 (19%)	8 (10%)	11 (13%)	9 (11%)

**Table 3. The month-by-month dynamics of the spread of rotavirus and coronavirus diseases in Gilan Dairy Farms LLC in 2019**

Table 3 shows the indicators of calves that tested positive for rotavirus and coronavirus by months and seasons in 2019, as well as the mortality rates from diseases by month, including from rotavirus and coronavirus.



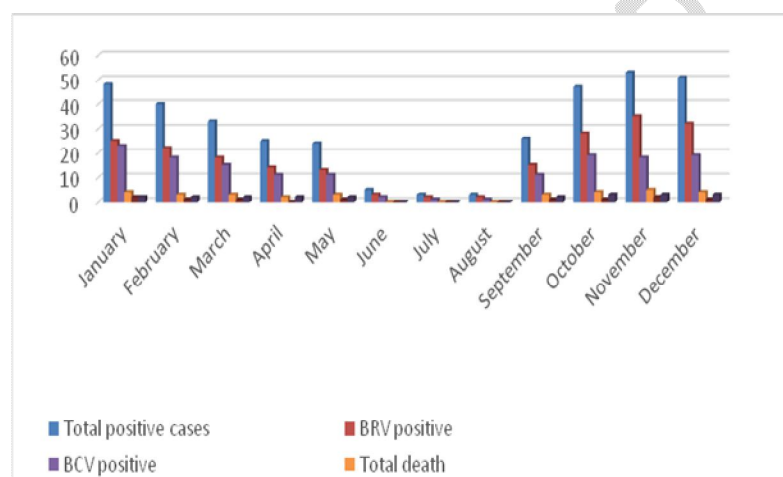
**Fig.2. The month-by-month correlation of positive results in 2019**

Table 4 shows that during the winter season of 2019, 122 heads of cattle were infected with coronavirus and rotavirus infection, including 46 heads of cattle infected with coronavirus and 76 heads of cattle with rotavirus infection. There were **five** cattle loss cases (10%) from infection with coronavirus and **three cattle loss cases** (3.9%). During the summer season, 89 heads of cattle were infected with coronavirus and rotavirus infections, of which 33 heads of cattle were infected with coronavirus and 56 heads of cattle with rotavirus. **There were 2 cattle losses due to coronavirus infection (6% mortality) and 0 cattle losses due to rotavirus infection (0%).** During the summer season, 8 heads of cattle were infected with the coronavirus (percentage mortality 0%), **and 13 heads of cattle were infected with the rotavirus (percentage mortality 0%).** In the autumn of 2019, 44 heads of cattle were infected with the

coronavirus (percentage mortality: 13.6%), and 66 heads of cattle were infected with the rotavirus (percentage mortality: 4.5%).

Results of 2018	January	February	March	April	May	June	July	August	September	October	November	December
Total positive cases	48	40	33	25	24	5	3	3	26	47	53	51
BRV positive	25 (52%)	22 (55%)	18 (55%)	14 (56%)	13 (54%)	3 (60%)	2 (67%)	2 (67%)	15 (58%)	28 (54%)	35 (58%)	32 (55%)
BCV positive	23 (48%)	18 (45%)	15 (45%)	11 (44%)	11 (46%)	2 (40%)	1 (33%)	1 (33%)	11 (42%)	19 (46%)	18 (42%)	19 (45%)
BRV death from infected calf	2 (8%)	1 (8%)	1 (6%)	0 (0)	1 (8%)	0 (0%)	0 (0%)	0 (0%)	1 (7%)	1 (9%)	2 (6%)	1 (10%)
BCV death from infected calf	2 (9%)	2 (11%)	2 (13%)	2 (18%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	2 (18%)	3 (13%)	3 (16%)	3 (16%)
Total death	4 (8%)	3 (8%)	3 (9%)	2 (8%)	3 (13%)	0 (0%)	0 (0%)	0 (0%)	3 (12%)	4 (11%)	5 (10%)	4 (13%)

**Table 4. The month-by-month dynamics of the spread of rotavirus and coronavirus diseases in Gilan Dairy Farms, LLC in 2018**

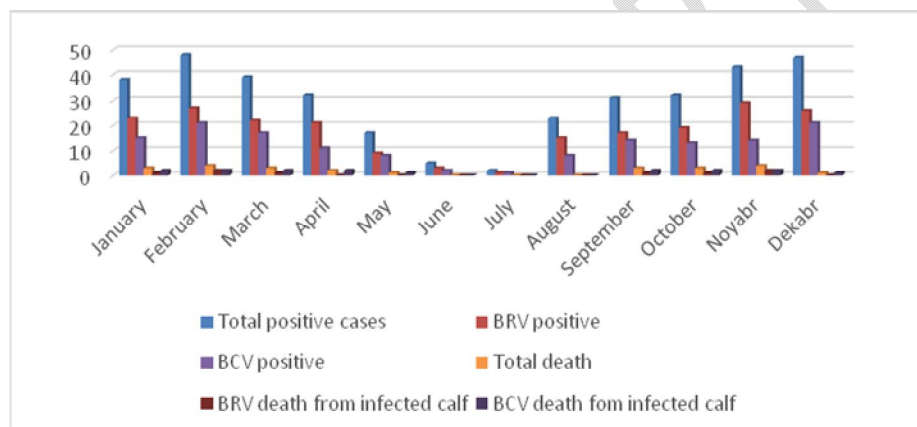


**Fig. 3. Correlation of positive results in 2018 by months**

Table 4 shows that in the 2018 winter season, 56 heads of cattle were infected with coronavirus (percentage mortality: 10.7%), and 65 heads of cattle were infected with rotavirus (percentage mortality: 6.1%). During the spring season of 2018, 24 heads of cattle (with a percentage mortality of 16.6%) were infected with coronavirus, and 30 heads of cattle (with a percentage mortality of 3.3%) were infected with rotavirus. During the summer season, 13 cattle were infected with coronavirus (with a mortality rate of 15.3%) and 19 cattle were infected with rotavirus (with a mortality rate of 5.2%). In the autumn season, 56 heads of cattle were infected with coronavirus (percentage mortality: 16%), and 695 heads of cattle were infected with rotavirus (percentage mortality: 4.2%).

Results of 2017	January	February	March	April	May	June	July	August	September	October	November	December
Total positive cases	38	48	39	32	17	5	2	23	31	32	43	47
BRV positive	23 (52%)	27 (55%)	22 (55%)	21 (56%)	9 (54%)	3 (60%)	1 (67%)	15 (67%)	17 (58%)	19 (54%)	29 (58%)	26 (55%)
BCV positive	15 (52%)	21 (55%)	17 (55%)	11 (56%)	8 (54%)	2 (60%)	1 (67%)	8 (67%)	14 (58%)	13 (54%)	14 (58%)	21 (55%)
BRV death from infected calf	1 (8%)	2 (5%)	1 (6%)	0 (0%)	0 (8%)	0 (0%)	0 (0%)	0 (0%)	1 (7%)	1 (9%)	2 (6%)	0 (10%)
BCV death from infected calf	2 (9%)	2 (11%)	2 (13%)	2 (18%)	1 (18%)	0 (0%)	0 (0%)	0 (0%)	2 (18%)	2 (13%)	2 (16%)	1 (16%)
Total death	3 (8)	4 (8%)	3 (9%)	2 (8%)	1 (13%)	0 (0%)	0 (0%)	0 (0%)	3 (12%)	3 (11%)	4 (10%)	1 (13%)

**Table 5. The month-by-month dynamics of the spread of rotavirus and coronavirus diseases in Gilan Dairy Farms, LLC in 2017**



**Fig. 4. Correlation of positive results in 2017 by months**

## DISCUSSION

To study the clinical symptoms and seasonality of rotavirus and coronavirus diseases in 2018-2021, 1385 samples were studied. Samples were taken from calves aged 0-90 days. According to Qinghe Zhu and others. studies, calf diarrhea is a multifactorial disease caused by a combination of infectious and non-infectious complex risk factors, which include enteropathogenic bacteria, viruses, environmental factors, immune status of the animal, genetic factors, nutrition, of course of labor, childbirth, the structure of the nest of the calf, vaccination of the mother, and the state of health status

calf [17]. In addition to these indicators, our studies have shown that the most common diarrhea of rotavirus and coronavirus origin is calf diarrhea, while the frequency of cases has different characteristics depending on the season and year. According to our observations, diarrhea caused by rotaviruses was registered most often at the age of in children aged 5–15 days. According to the literature, watery yellow diarrhea in calves is a clinical sign of rotaviruses [8,9,10,11,34]. Depression, shock and dehydration occur more often in calves aged up to 5 days [6 of age [35]. The results presented by us showed that depression, decreased milking reflex, diarrhea and dehydration in the sick calf were among the main clinical signs. Calf diarrhea caused by coronaviruses has been reported in calves aged 2–21 days. Usually, the authors point out that the epithelial cells of the small and large intestine are sensitive to these viruses [12]. In addition, the virus [36]. Usually, a coronavirus infection causes watery diarrhea, and blood clots may appear in the stool. In our studies, decreased appetite and loss of fluid and electrolytes, dehydration, metabolic acidosis, and hypoglycemia were the most frequently registered clinical symptoms in calves. Calves sick infected with the coronavirus developed complications in the form of pneumonia. Thus, rotaviruses were the most common viral cause of diarrhea in newborn calves, especially in the spring and winter. Clinical symptoms of rotavirus and coronavirus have been registered since the first 10 days of calf life, so it is important to keep both viruses under control.

## CONCLUSION

During the study, samples were taken in different seasons and analyzed by express testing. As a result of the study of clinical signs of seasonal diseases dynamics in calves caused by rotavirus and coronavirus infection, both rotaviruses and coronaviruses cause disease in calves belonging to Gilan Dairy Farms LLC, located in the north-west northwest of Azerbaijan. According to the tables, rotaviruses are accompanied by a greater number of infections than coronaviruses, but the mortality rate from them is relatively lower. The spread of rotaviruses and coronaviruses among calves on farms becomes widespread in the spring, autumn, and winter months of the year. A stressful change in environmental temperature can be a factor influencing the increase in the dynamics of the spread of diseases among animals.

## Ethical Approval:

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

## REFERENCES

1. Altizer S, Dobson A, Hosseini P, Hudson P, Pascual M, Pejman R. Seasonality and the dynamics of infectious diseases. *Ecology Letters*. 2006; 9: 467–484.

2. Steele AD, Geyer A, Gerdes GH. Rotavirus infections. In: Coetzer J.A.W., Tustin R.C., editors. Infectious diseases of Livestock. Southern Africa: *Oxford University Press*. 2004. 1256–1264.
3. Michael B, Franz-Ferdinand R, Beate C. Prevalence of Worldwide Neonatal Calf Diarrhoea Caused by Bovine Rotavirus in Combination with Bovine Coronavirus, Escherichia coli K99 and Cryptosporidium spp.: A Meta-Analysis. *MDPI Animals*. 11(4),2021; 1014.
4. Alkan F. Buzağı ishallerinde rotavirüs ve koronavirüslerin rolü. *Ankara Üniv. Vet. Fak. Derg.* 1998; 45. 29-37.
5. Atlı K, Yıldırım Y, Hasıcioğlu S, Bulut O, Avçı O. Buzağılarda ishale neden olan başlıca viral etkenler, *Göller Bölgesi Aylık Hakemli Ekonomi ve Kültür Dergisi Ayrıntı Cilt* 5: 61, 2018; 70.
- 6.
7. Michael B, Franz-Ferdinand R, Beate C. Prevalence of Worldwide Neonatal Calf Diarrhoea Caused by Bovine Rotavirus in Combination with Bovine Coronavirus, Escherichia coli K99 and Cryptosporidium spp.: A Meta-Analysis. *MDPI Animals*. 11(4),2021; 1014.
8. Saif LJ, Jung K. Comparative Pathogenesis of Bovine and Porcine Respiratory Coronaviruses in the Animal Host Species and SARS-CoV-2 in Humans. *J. Clin. Microbiol*; 2020; 58: e 01355-20.
9. Shahna KC, Alkan F. Sığırlarda Rotavirüs enfeksiyonunun epidemiyolojisinde gebeliğin rolü. *F.Ü. Sağlık Bil. Derg.* 2003; 17 (3), 203-209.
10. Malik Y S, Kumar N, Sharma K. Epidemiology and genetic diversity of rotavirus strains associated with acute gastroenteritis in bovine, porcine, poultry and human population of Madhya Pradesh, Central India 2004–2008. *Virus*, 2013; vol. 9.
11. Pesavento JB, Billingsley A M, Roberts E J, Ramig R F, Prasad VV. Structures of rotavirus reassortants demonstrate correlation of altered conformation of the VP4 spike and xpression of unexpected VP4-associated phenotypes. *Journal of Virology*. 2003; vol. 77, no. 5. 3291–3296.
12. Desselberger U, Gray J, Estes MK. Rotaviruses. In: Mahy Microbiology and Microbial infections. *USA: ASM press*; 2005; 946–958.
13. Yazıcı Z. Buzağılarda rotavirüs enfeksiyonlarının seroepidemiyolojisi ve ELISA testi ile rotavirüs antijenlerinin identifikasyonu. A.Ü. Sağlık Bilimleri Enstitüsü Doktora tezi.1992.
14. Afshari S, Mohammadi GR, Rad M, Naghibi A. A case-control study of association between diarrhea in newborn calves and infection with rotavirus and coronavirus in some indus-trial dairy herds of Mashhad Aarea, Iran in 2008. *Archives of Razi Institute*.2012; 67, 35–41.

15. Ghosh S, Varghese V, Sinha M, Kobayashi N, Naik TN. Evidence for interstate transmission and increase in prevalence of bovine group B rotavirus strains with a novel VP7 genotype among diarrhoeic calves in Eastern and Northern states of India. *Epidemiology of Infections*. 135: 2007; 1324–1330.
16. Mattijjnssens J, Ciarlet M, McDonald SM, Attoui H, Banyai K, Brister JR, *et al.*. Uniformity of rotavirus strain nomenclature proposed by the Rotavirus Classification Working Group (RCWG). *Arch Viro*. 2011; 156: 1397-1413.
17. Cho Y-II, Yoon K-JJ. An overview of calf diarrhea—Infectious etiology, diagnosis, and intervention. *J. Vet. Sci*. 2014; 15, 1–17.
18. Hakan A, Mehmet ÖT. Buzağı İshallerinde Koronavirüsün Nukleoprotein Gen ve Rotavirüsün VP7/VP4 Gen Bölgelerinin Kısmi Sekansı ve Filogenetik, Research 2018; Article: 72439
19. Abebe GG Review on the epidemiology of Bovine Rotavirus and its public health significance, *International Journal of Veterinary Science and Research*, 2022; 5-10. Prevalence of endemic enteropathogens of calves in New Zealand dairy farms. *N. Z. Vet. J*. 2015; 63, 147–152.
20. Nicola D, Mari V, Desario C. Severe outbreak of bovine coronavirus infection in dairy cattle during the warmer season. *Vet Microbiol*. 2008;126 (1–3): 30–39.
21. Samad L, Omid M, Mohammad RM, Mohammad RMD, David GW. Bovine coronavirus in neonatal calf diarrhoea in Iran, *Veterinary Medicine and Science*. 2020. Volume 6, Issue 4, 686-694.
22. Qinghe Zh, Bin L, Dongbo S. Advances in Bovine Coronavirus Epidemiology, *Viruses MDPI*, 2012; 14 (5): 1109.
23. Saif LJ. Bovine respiratory coronavirus. *Vet. Clin. N. Am. Food Anim. Pract*. 2010; 26:349–364.
24. Thomas JD, Simon FP. Rebhuns. Diseases of Dairy Cattle. second Edition Saunders ELSEVIER 2008. Mee JF. Newborn dairy calf management. Veterinary Clinics of North America: *Food Animal Practice*. 2008; 24(1):1–17.
25. Umer SG, Munera AU, Fufa DB. Rotavirus in Calves and Its Zoonotic Importance. *Vet Med Int*. 2021; 6639701.
26. Hasoksuz M, Armando EH, Loerch SC, Niesen WPR, Saif LJ. Detection of respiratory and enteric shedding of bovine koronaviruses in cattle in *an Ohio feedlot*. 2016; Article:12152810.
27. Windeyer MC, Leslie KE, Godden SM, Hodgins D, Lissemore K, LeBlanc SJ. Factors associated with morbidity, mortality, and growth of dairy heifer calves up to 3 months of age. *Prev. Vet. Med*. 113, 231–240.

28. Aydın H, Aktas O. Rotavirus genotypes in children with gastroenteritis in Erzurum: first detection of G12P [6] and G12P [8] genotypes in Turkey. *Gastroenterology Rev.* 2017 12, 122-127.
29. Al MJ, Grinberg A, Prattley D, Moffat J, French N. Prevalence of endemic enteropathogens of calves in New Zealand dairy farms. *N. Z. Vet. J.* 2015; 63, 147–152.
30. Bendali F, Bichet H, Schelcher F, Sanaa M. 61–74.
31. Reynolds D, Morgan J, Chanter N. Microbiology of calf diarrhea in Southern Britain. *Veterinary Record*, 1986; vol. 119: 2, 34–39.
32. Sue EC, Sasirekha R, Tate JE, Parashar UD, Svensson L. Rotavirus infection. *Nature reviews, disease primers* 3:2017. 17083.
33. Dhama K, Chauhan RS, Mahendran M, Malik SVS. Rotavirus diarrhea in bovines and other domestic animals. *Vet Res Commun.* 2009; 33(1): 1–23.
34. Abebe GG Review on the epidemiology of Bovine Rotavirus and its public health significance, *International Journal of Veterinary Science and Research*, 2022; 5-10.
35. Malmuthuge N, Griebel PJ, Guan LL. The Gut Microbiome and Its Potential Role in the Development and Function of Newborn Calf Gastrointestinal Tract. *Front. Vet. Sci.* 2015; 2, 36.
36. Sezgin Ş. Uzağların İç hastalıkları. Uludağ Üniversitesi, Veteriner Fakültesi, *İç Hastalıklar Anabilim Dalı II.* 2012.