

Dairy farming in Kars district, Turkey: III. Neonatal calf health*

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Abstract: The study was designed to determine the health status of neonatal calves on dairy farms in Kars district. It involved retrospective questioning (2001 calving season) and prospective follow up (2002 calving season). The localities and farms were selected from a list using a 2-stage stratified random sampling method. Farms were weekly visited by authors during the 2002 calving season for clinical problems. A total of 624 calves, born on 45 farms from 7 different localities, were followed up in the 2002 calving season. On the same farms data were collected regarding 582 neonatal calves in the 2001 calving season by questionnaire. The overall morbidity in 2002 and 2001 was 51.1% and 36.3%, respectively. The morbidity of diarrhoea, omphalitis, pneumonia, premature birth, omphalitis-enteritis complex, and pneumonia-enteritis complex were 24.4%, 13%, 3.4%, 2.4%, 2.4%, and 1% in 2002, and 17.4%, 1.4%, 6.2%, 0%, 2.7%, and 6% in the 2001 calving season, respectively. Clinical problems of trauma, umbilical hernia, complicated hernia, and an unknown reason were also diagnosed at low proportion. The overall mortality determined in 2001 and 2002 was 10.5% and 6.7%, respectively. The most common causes of mortality were diarrhoea (2.2%), premature birth (2.1%), and trauma (0.8%) in 2002 while diarrhoea (7.7%), pneumonia (0.7%), and Foot and Mouth Disease (1.4%) were most common in 2001. Additionally, deaths due to pneumonia, omphalitis, congenital deformation, and an unknown reason were also experienced. Age distribution of cases revealed that diarrhoea and omphalitis were common in the first 2 weeks of life while pneumonia was more frequent in the 4th week of neonatal life. A positive association between group size and disease existence was determined. Of the cases examined, 12.9% (12/93) had the failure of passive transfer while all controls had adequate colostrums (0/45).

The study revealed that a considerable proportion of calves suffer from at least 1 clinical problem during neonatal life and around 1 in tenth die, resulting in detrimental effects on farm profitability.

Key Words: Neonatal calves, morbidity, mortality

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Kars yöresi süt sığırcılığı: III. Neonatal buzağı sağlığı

Özet: Bu çalışma, Kars ilindeki sütçü sığır işletmelerindeki neonatal buzağı sağlığını araştırmak için yapıldı. Çalışma anket (2001 buzağılama sezonu) ve buzağuların takibini (2002 buzağılama sezonu) kapsadı. Çalışmadaki odaklar ve çiftlikler iki aşamalı tesadüfi kota örneklemeyle belirlendi. Çiftlikler 2002 doğum sezonu boyunca herhangi bir klinik sorunu belirlemek için haftalık olarak araştırmacılar tarafından ziyaret edildi. Çalışmada 7 odak ve 45 çiftlikte toplam 624 neonatal buzağı 2002 doğum sezonu boyunca takip edildi. Aynı çiftliklerde anket ile 2001 doğum sezonunda doğan 582 neonatal buzağı sağlığı ile ilgili veri toplandı. Toplam morbidite 2002 ve 2001'de sırasıyla % 51,1 ve % 36,3 olarak belirlendi. Diyare, omphalitis, pnömoni, prematüre doğum, omfalit-enteritis ve pnömo-enteritis 2002 ve 2001 morbidite oranları sırasıyla % 24,4, % 13, % 3,4, % 2,4, % 2,4 ve % 1 olarak ve % 17,4, % 1,4, % 6,2, % 0, % 2,7 ve % 6 olarak tespit edildi. Düşük oranlarda da olsa travma, umbilical hernia, komplike hernia, pnömo-enteritis ve sebebi belli olmayan hastalıklar da teşhis edildi. Toplam mortalite oranı 2001 ve 2002 sezonlarında sırasıyla % 10,5 ve % 6,7 olarak belirlendi. Çalışmada 2002 sezonunda en önemli mortalite sebepleri diyare (% 2,2), prematüre doğum (% 2,1) ve travma (% 0,8) olurken, 2001 sezonunda diyare (7,7%), pnömoni (0,7%) ve Şap (1,4%) daha yaygındı. Ayrıca pnömoni, omfalitis, konjenital anomaliler ve bilinmeyen sebeplerden de ölümler gerçekleşti. Yaş dağılımı, ishal ve omphalitis vakalarının yaşamın ilk 2 haftasında daha sık buna karşın pnömoni vakalarının yaşamın 4. haftasından sonra ortaya çıktığını göstermektedir. Buzağı sayısı ile hastalıkların görülme sıklığı arasında pozitif bir ilişki belirlendi. İncelenen olguların % 12,9 (12/93)'unda pasif transfer yetmezliği belirlenirken kontrol buzağuların tamamının yeteri kadar kolostrum aldığı belirlendi (0/45).

Çalışma buzağuların önemli bir oranının neonatal dönemde en az bir klinik probleme maruz kaldığını ve bunlardan yaklaşık onda birinin öldüğünü, bu durumun çiftlik kârlılığını, hayvan sağlığı ve refahını olumsuz yönde etkilediğini ortaya koymuştur.

Anahtar Sözcükler: Neonatal buzağı, morbidite, mortalite

Introduction

Neonatal period (0-28 days) is of critical importance because most of the deaths occur within the first 2 weeks of life (1,2). Calf death inflicts enormous economical losses to cattle farmers all over the world (3). Economical losses are not only associated with death but also with loss of genetic material, intervention cost, loss of performance, and productivity later in life (1,3). Studies on calf health covered a period of 0-3 months or even longer depending on the study and revealed that morbidity ranged from 20% to 52.9% (1,4-7) while mortality was between 2% and 35% (1,4-8). Common causes of calf diseases and deaths were diarrhoea, pneumonia, joint problems, umbilical diseases, trauma, congenital abnormalities, nutritional deficiencies, dystocia, and other infections (1,4-7).

Aetiological investigations of, and risk factors associated with the mortality and morbidity of calves were also extensively studied (2,4,9-15). However, these studies covered either perinatal period or postnatal period of up to 3 months, even longer although included neonatal period and disease data were collected either by farmers or a veterinarian but at longer intervals. To the best of our knowledge, there

is only 1 study addressing calf health in Kars district where cattle farming is the key economical activity (16). However, this study evaluated only pneumonia, diarrhoea, and retarded growth in calf up to 1 year of age and no other disease condition and epidemiological data were provided.

There is scarcity of information on neonatal calf health in the district as well as the rest of Turkey. This part of the study therefore investigated neonatal calf health in Kars district.

Materials and Methods

Study design

Details of the farm selection and study design were given elsewhere (17). Briefly, a 2-stage stratified random sampling strategy was employed to first select localities and then farms from a list of dairy farmers provided by the District Office of the Ministry of Agriculture and Rural Affairs. Forty five farms from 7 localities were randomly (simple lottery) selected within the central Kars (17). Localities were Başgedikler, Boğazköy, Çağlayan, Çakmak, Dikme, Kümbetli, and Central Kars. For privacy purposes, the localities were labelled with letters in the text.

The longitudinal survey of calves was carried out between October 2001 and June 2002 (referred as 2002 calving season in the text), involving an interview with the farmers using pre-tested structured questionnaire inquiring neonatal calf health in the previous calving season (between October 2000 and June 2001, referred as 2001 calving season in the text) and farm management practices, and regular weekly visits to determine any health problems during the neonatal period. Visits were made by the authors; calves were examined by internists (HME, VG, MC). Clinical conditions were diagnosed based on presenting clinical signs. Causes of specific diseases were also investigated and reported elsewhere (18-21). Serum samples collected from calves were evaluated for failure of passive transfer using the glutaraldehyde test (22)

Data analyses

Data collected by questionnaire and longitudinal survey were numerically coded and entered to a database (Microsoft Access 2000) and analysed using Epi info 6. Frequencies of diseases in 2001 and 2002 calving seasons were determined at farm level (proportion of farms affected = number of farms with disease / number of farms studied) then the mortality, morbidity, and case fatality rates were determined for each disease (23,24). In calculating morbidity and mortality, number of cases or deaths was divided by number of live births monitored during the neonatal period of the calving season of interest (16). Abortions and stillbirths were excluded from the analyses. Simple frequency distributions were run to estimate proportions. Yate's corrected chi squared test was used to compare the differences between proportions. Kruskal-Wallis test was used to compare the differences between median values (23). Age of the diseased calves were categorised as 0-7, 8-14, 15-21, and 22-30 and X^2 for trends was used to evaluate the effect of age. Proportion of calves treated in 2001 and 2002 calving seasons were also determined. Significance level was set at $P < 0.05$.

Results

The longitudinal survey included a total of 624 calves and the retrospective study included 582 calves on 45 farms excluding the abortions and stillbirths.

The overall proportion of farms having at least 1 ill calf and 1 fatal case in the 2002 calving season was 95.5% (43/45) and 40% (18/45), respectively. The proportion of farms with cases of diarrhoea, omphalitis, omphalitis-enteritis complex, respiratory problems, and premature birth were 91.1% (41/45), 71.1% (32/45), 22.2%, (10/45), 20% (9/45), and 20% (9/45), respectively. Of the calves examined, 51.1% (321/624) had at least 1 health problem. The proportion of calves with diarrhoea, omphalitis, pneumonia, premature birth, and omphalitis-enteritis complex were 24.4% (152/624), 13% (81/624), 3.4% (21/624), 2.4% (15/624), and 2.4% (15/624), respectively. The overall mortality was 6.7% (42/624). The most common cause of mortality was diarrhoea (2.2%, 14/624), premature birth (2.1%, 13/624), and trauma (0.8%, 5/624). Additionally, deaths due to pneumonia, omphalitis, and congenital deformation and an unknown reason were also experienced (Table 1).

Retrospective questioning of the calving season of 2001 revealed that the proportion of farms having at least 1 case and 1 death was 88% (37/42) and 53.3% (24/45), respectively. The proportion of farms experiencing diarrhoea, pneumonia, pneumonia-diarrhoea complex, omphalitis, and omphalitis-enteritis complex was 73.3% (33/45), 20% (9/45), 13.3% (6/45), 11.1% (5/45), and 8.9% (4/45), respectively. Of the calves born in the 2001 season, the morbidity was 36.3% (211/582). The most common reasons for morbidity were diarrhoea (17.4%, 101/582), pneumonia (6.2%, 36/582), pneumonia-diarrhoea complex (6%, 35/582), and omphalitis-enteritis complex (2.7%, 16/582). The overall mortality was 10.5% (61/582). The most common causes of mortality were diarrhoea (7.7%, 45/582), pneumonia (0.7%, 4/582), and Foot and Mouth Disease (FMD) (1.4, 8/582) (Table 1).

Trauma, congenital deformation, hernia umbilicalis, and complicated hernia were diagnosed only in the 2002 calving season. On the other hand, FMD and joint problems were only reported in the 2001 calving season (Table 1).

Farm prevalence of neonatal diseases did not significantly differ between the 2 seasons apart from omphalitis (71.1% in 2002; 11.1% in 2001) ($P < 0.001$). Overall morbidity ($P < 0.001$), neonatal diarrhoea ($P = 0.03$), and omphalitis ($P < 0.001$) were significantly

Table 1. Calf health in 2001 (582 calves) and 2002 (624 calves) seasons on 45 dairy farms.

Diseases	Farm prevalence (%)		Morbidity (%)		Mortality (%)		CFR (%)	
	2001 N = 45	2002 N = 45	2001 n = 211	2002 n = 321	2001 m = 61	2002 m = 42	2001	2002
Diarrhoea	73.3	91.1	17.4	24.4	7.7	2.2	44.6	9.2
Omphalitis	11.1	71.1	1.4	13	0	0.16	0	1.2
Pneumonia	20	20	6.2	3.4	0.7	0.16	11.1	4.8
Omphalitis-enteritis	8.9	22.2	2.7	2.4	0	0	0	0
Pneumoenteritis	13.3	11.1	6	1	0.3	0	5.7	0
Premature birth	0	20	0	2.4	0	2.1	0	86.7
Trauma	0	11.1	0	0.8	0	0.8	0	100
Unknown	0	6.7	0	1	0	1	0	100
Abnormality	0	4.4	0	0.3	0	0.3	0	100
Umbilical hernia	0	13.3	0	1.4	0	0	0	0
Hernia-enteritis	0	11.1	0	0.8	0	0	0	0
Hernia-omphalitis	0	6.7	0	0.6	0	0	0	0
Joint problem	4.4	0	1.2	0	0	0	0	0
FMD	2.2	0	1.4	0	1.4	0	100	0
Overall	88	95.5	36.3	51.1	10.5	6.7	28.9	13.1

N: number of farms, n: number of diseased calves, m: number of death

higher in the 2002 season when compared to those of 2001 season while the morbidity of pneumonia ($P = 0.02$) and pneumonia-enteritis ($P < 0.001$) were significantly lower. On the other hand, the overall mortality ($P = 0.02$) and mortality due to diarrhoea ($P < 0.001$) were significantly lower in the 2002 calving season. Similarly, case fatality rates of overall

diseases and diarrhoea were significantly lower in the 2002 season (Table 1).

The survey involved 7 localities and found that morbidity significantly differed between the localities. The lowest overall morbidity determined was in locality F (27.7%) while the highest was in locality B (62.7%) (Table 2).

Table 2. Distribution of neonatal diseases in the 2002 season with respect to localities.

	A (%) n = 112	B (%) n = 67	C (%) n = 73	D (%) n = 110	E (%) n = 84	F (%) n = 61	G (%) n = 117	P
Diarrhoea	30.3	38.8	27.4	17.3	21.4	13.1	23.1	0.006
Omphalitis	14.3	11.9	6.8	18.2	10.7	9.8	14.5	0.03
Pneumonia	0	0	0	3.6	7.1	0	9.4	<0.001
Omphalitis-enteritis	3.6	1.5	1.4	3.6	2.4	1.6	1.7	0.8
Premature birth	6.3	1.5	0	0	4.8	1.6	1.7	0.03
Unknown	0	0	0	0	0	1.6	4.3	0.006
Abnormality	0	1.5	1.4	0	0	0	0	0.005
Umbilical hernia	5.4	3	0	0	0	0	0.9	0.005
Trauma	0.9	3	0	0.9	0	0	0.9	0.4
Hernia-enteritis	0.9	0	1.4	2.7	0	0	0	0.2
Hernia-omphalitis	0	1.5	0	1.8	0	0	0.8	0.5
Pneumoenteritis	0	0	2.7	1.8	2.4	0	0	0.2
Overall	61.6	62.7	41.1	50	48.8	27.7	57.3	<0.001

n: number of calves examined

Overall recovery rate (92.4%, 279/302) and recovery rate of calves with diarrhoea in the 2002 season (90.8%, 138/152) were significantly higher than those of the 2001 season (67.8%, 150/221 and 60.2%, 56/93) ($P < 0.001$) (Table 3).

Categorisation of the age of cases (0-7, 8-14, 15-21, and 22-28 days) revealed that the risk of diarrhoea and omphalitis was high in the first 2 weeks while the

risk of pneumonia was high in the 4th week of life (Table 4).

Clinical conditions were more likely to occur in crowded groups. Mean size of the calf group where diarrhoea, omphalitis, and pneumonia were diagnosed was 14.7 (range 4-39), 16.3 (4-39), and 18.8 (8-39), respectively (Table 5).

Table 3. Treatment of neonatal cases recorded in the 2001 and 2002 seasons.

	Treated		Recovered		Died	
	2001 (%)	2002 (%)	2001 (%)	2002 (%)	2001 (%)	2002 (%)
Diarrhoea	92.1 (93/101)	100 (152/152)	60.2* (56/93)	90.8 (138/152)	39.7* (37/93)	9.2 (14/152)
Pneumonia	100 (36/36)	100 (15/15)	88.9 (32/36)	95.2 (20/21)	11.1 (4/36)	4.8 (1/21)
Omphalitis	100 (8/8)	100 (81/81)	100 (8/8)	98.8 (80/81)	0	1.2 (1/81)
Overall	91.5 (193/211)	94.1 (302/321)	71.1* (150/211)	92.4 (279/302)	22.3* (43/193)	7.6 (23/302)

* $P < 0.001$

Table 4. Age distribution of diseased calves.

Age	Diarrhoea		Omphalitis		Pneumonia	
	n = 150 (%)	OR	n = 84 (%)	OR	n = 20 (%)	OR
0-7	79 (52.4)	1.00	23 (27.4)	1.00	2 (10)	1.00
8-15	36 (24)	0.28	41 (48.8)	2.53	2 (10)	1.00
16-21	16 (10.7)	0.11	12 (14.3)	0.44	2 (10)	1.00
22-28	19 (12.7)	0.13	8 (9.5)	0.28	14 (70)	21.00
Statistics	$X^2 = 70.9$,	$P < 0.001$	$X^2 = 17.3$,	$P < 0.001$	$X^2 = 17.1$,	$P < 0.001$

n: number of calves included in analyses, OR: Odds Ratio, X^2 : chi square, * $P < 0.001$

Table 5. Association between group size and neonatal diseases.

Diseases		Mean	Median	IQ	Range	Statistic
Diarrhoea	+	14.7	12	8-18	4-39	$X^2 = 5.7$
	-	5.8	6	3.5-8	1-10	$P = 0.01$
Omphalitis	+	16.3	15	10-20	4-39	$X^2 = 12.8$
	-	7.8	8	6-10	1-12	$P < 0.001$
Pneumonia	+	18.8	18	10-22	8-39	$X^2 = 3.4$
	-	12.7	11	7-15	1-37	$P = 0.06$
Overall	+	14.4	12	9-18	4-39	$X^2 = 4.6$
	-	3.5	3.5	1-6	1-6	$P = 0.03$

IQ: Interquartile range

A total of 138 sera (93 from diseased and 45 from healthy controls) were evaluated for failure of passive colostral transfer (FPT) using glutaraldehyde turbidity test. Of the cases, 12.9% (12/93) were determined to have FPT while all controls had received adequate colostrums (0/45). This difference was statistically significant ($X^2 = 4.8$, $P = 0.03$). Of the diarrhoeic calves whose IgG status were evaluated (68 calves), only 10 (14.7%) had FPT. Similarly, only 28.6% of the pneumonic calves tested (2/7) had FPT.

Discussion

Longitudinal survey disclosed an overall morbidity of 51.1% in neonatal calves in the 2002 calving season. This figure corresponds well with that of a previous study (52.9%) (7), but was higher than the figures (between 20%-30%) reported from other parts of the world (1,4-7). This difference might be related to the nature of the study as visits were made weekly and animals were examined by a veterinarian, which resulted in better detection of diseases. As previous studies covered a period of up to 3 months or even longer, our figure becomes more important. Although the overall mortality rate of 6.7% found in the present study is similar to the results (5%-6.3%) of some previous studies (1,6,7), it is lower than that (11.8%-35%) of some others (5,8,10,15). The low proportion might be related to the duration of the studies as our study was shorter than those reporting higher rates. Clinical conditions determined in this study were in agreement with the previous studies (1,4-7).

The morbidity of diarrhoea was within the range of 10.3%-28.8% as reported from other parts of the world (1,4,5,7) and similar to that (29%) reported previously in this district (16). As previously reported, diarrhoea was the main clinical condition of the first 2 weeks of life (1,7,15) and the risk of diseases was high in crowded calf groups (1,15). The mortality due to diarrhoea was lower compared to previous studies (4-6,10), but it was similar to the one previously reported in this district (16). The lower figure may be explained by the short duration of our study as other studies covered a longer period. The low figure may also be attributed to frequent visits made during the study where farmers were informed about the treatment process, which might have resulted in lower

mortality as previously reported frequent veterinary visits resulted in improvements of calf health (4,15).

Morbidity of omphalitis was comparable to that reported for calves between 0-3 months old (7,10). However, this figure reaches up to 16% when complicated omphalitis cases were accounted. As reported previously, the time when omphalitis diagnosed was in the first 2 weeks of life (7). Analyses also revealed that calves in crowded groups were more likely to develop omphalitis.

The morbidity of respiratory diseases was markedly lower than the ones reported elsewhere [25.6% (9), 8.4% (5), 9.4% (1), and 7.2% (4)]. Similarly mortality was also lower than previous reports (1,5,9). This difference may be explained by the shorter period of our study. Previous studies reported that respiratory tract disorders were commonly diagnosed after the first month of life as was the case in this study (5,9) where the cases of the respiratory tract disorders were common at the last week of the neonatal period. Another possible explanation may be that bacterial agents involved in the respiratory tract infection were absent on bacteriological examination and calves had sufficient antibodies to common viral agents when all calves were evaluated (21), which might have resulted in lower mortality.

Calf health studies mainly focused on diarrhoea and respiratory tract diseases, only a few studies addressed other clinical conditions such as premature birth, hernia umbilicalis, trauma, and congenital abnormality. Frequency of hernia umbilicalis, trauma, and congenital abnormality was similar to previous reports (4,7). Surprisingly, a considerable number of premature births were determined. Factor(s) involved were not inquired but a further detailed study is needed in this district.

Results of retrospective questioning and the follow up study well correlated with few exceptions in terms of common clinical problems (diarrhoea and respiratory diseases) and their frequencies. However, higher morbidity of illnesses, especially omphalitis, hernia, premature birth, trauma, and congenital abnormality diagnosed in the 2002 calving season, but not in the previous season, may be attributed to the nature of the study where calves were under regular observation and the visits were made by a

veterinarian, which consequently resulted in better detection of diseases (4,5,15). This better surveillance may also explain the lower mortality rates as the recovery from diarrhoea, respiratory problems, and omphalitis was higher following the treatment recommended by the authors though it may also yielded an underestimation of mortality.

The proportion of calves lacking colostral immunity was lower than the figures (around 36%) reported previously (5,9,10). The low FPT figure seemed to have little effect on morbidity as the morbidity was notably high in spite of considerable number of calves with colostral immunity (9,10). The higher colostral immunity may also explain the lower mortality. Disease process may have been less severe in these cases, which accordingly resulted in low

mortality as earlier studies found a strong positive association between the failure of passive transfer and higher mortality rates (4,10).

Difference in the distribution of diseases with respect to localities was evident in this study. This might have been due to different management practices exercised. Further analytical studies are required to disclose differences at calf, herd, and farm management level.

This descriptive epidemiological study was the first to illustrate a picture of on-farm events in the district of Kars. Although the study made many numerical descriptions available, further detailed epidemiological studies addressing each clinical condition are needed to improve health and welfare of dairy cattle as well as farm profitability.

References

1. Wells, S.J., Garber, L.P., Hill, G.W.: Health status of preweaned dairy heifers in the United States. *Prev. Vet. Med.*, 1997; 29: 185-199.
2. Brenner, J., Ungar-Waron, H.: Environmental and managerial risk factors affecting morbidity and mortality of young calves. *Israel J. Vet. Med.*, 1996; 51: 3-8.
3. Lundborg, K.: Housing, Management and Health in Swedish Dairy Calves. PhD Thesis, Swedish University of Agricultural Sciences, Skara, Sweden, 2004.
4. Svensson, C., Lundborg, K., Emanuelson, U., Olsson S.O.: Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. *Prev. Vet. Med.*, 2003; 58: 179-197.
5. Sivula, N.J., Ames, T.R., Marsh, W.E., Werdin, R.E.: Descriptive epidemiology of morbidity and mortality in Minnesota dairy heifer calves. *Prev. Vet. Med.*, 1996; 27: 155-171.
6. Dutil, L., Fecteau, G., Bouchard, E., Dutremblay, D., Paré, J.: A questionnaire on the health, management, and performance of cow-calf herds in Québec. *Can. Vet. J.*, 1999; 40: 649-656.
7. Virtala, A.M., Mechor, G.D., Gröhn, Y.T., Erb, H.N.: Morbidity from nonrespiratory diseases and mortality in dairy heifers during the first three months of life. *J. Am. Vet. Med. Assoc.*, 1996; 208: 2043-2046.
8. French, N.P., Tyrer, J., Hirst, W.M.: Smallholder dairy farming in the Chikwaka communal land, Zimbabwe: birth, death and demographic trends. *Prev. Vet. Med.*, 2001; 48: 101-112.
9. Virtala, A.M., Mechor, G.D., Gröhn, Y.T., Erb, H.N., Dubovi, E.J.: Epidemiologic and pathologic characteristics of respiratory tract disease in dairy heifers during the first three months of life. *J. Am. Vet. Med. Assoc.*, 1996; 208: 2035-2042.
10. Donovan, G.A., Dohoo, I.R., Montgomery, D.M., Bennett, F.L.: Associations between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. *Prev. Vet. Med.*, 1998; 34: 31-46.
11. Wells, S.J., Dargatz, D.A., Ott, S.L.: Factors associated with mortality to 21 days of life in dairy heifers in the United States. *Prev. Vet. Med.*, 1996; 29: 9-19.
12. Aydın, F., Umur, Ş., Gökçe G., Genç, O., Güler, M.A.: The isolation and identification of bacteria and parasites from diarrhoeic calves in Kars district. *Kafkas Üniv. Vet. Fak. Derg.*, 2001; 7: 7-14. (article in Turkish with an abstract in English)
13. García, A., Ruiz-Santa-Quiteria, J.A., Orden, J.A., Cid, D., Sanz, R., Gómez-Bautista, M., de la Fuente, R.: Rotavirus and concurrent infections with other enteropathogens in neonatal diarrhoeic dairy calves in Spain. *Comp. Immunol. Microbiol. Infect. Dis.*, 2000; 23: 175-183.
14. Sivula, N.J., Ames, T.R., Marsh, W.E.: Management practices and risk factors for morbidity and mortality in Minnesota dairy heifer calves. *Prev. Vet. Med.*, 1996; 27: 173-182.
15. Frank, N.A., Kaneene, J.B.: Management risk factors associated with calf diarrhoea in Michigan dairy herds. *J. Dairy Sci.*, 1993; 76: 1313-1323.
16. Özkan, Ö., Bulu, A.A., Dörterler, R., Hoştürk, F.: An epidemiological investigation on the important outbreaks and diseases with defined syndroms in animals in Kars and vicinity. *Etlik Vet. Mikrobiol. Derg.*, 1993; 7: 115-125. (article in Turkish, no abstract in English is available)
17. Erdoğan, H.M., Çitil, M., Güneş, V., Saatci, M.: Dairy cattle farming in Kars district, Turkey: I. Characteristics and production. *Turk. J. Vet. Anim. Sci.*, 2004; 28: 735-743.

18. Erdoğan, H.M., Ünver, A., Güneş, V., Çitil, M.: Frequency of Rotavirus and Coronavirus in neonatal calves in Kars district. Kafkas Üniv. Vet. Fak. Derg., 2003; 9: 65-68.
19. Güneş, V., Ünver, A., Çitil, M., Erdoğan, H.M.: The prevalence of *Eschericia coli* O157 serotype and *Clostridium perfringens* type A toxin in neonatal diarrhoeic calves in Kars district. Kafkas Üniv. Vet. Fak. Derg., 2004; 10: 41-45. (article in Turkish with an abstract in English)
20. Çitil, M, Arslan, M.Ö., Güneş, V., Erdoğan, H.M.: The role of Cryptosporidium and Eimeria infections in diarrhoea of neonatal calves. Kafkas Üniv. Vet. Fak. Derg., 2004; 10: 59-64. (article in Turkish with an abstract in English)
21. Erdoğan, H.M., Ünver, A., Çitil, M., Güneş, V.: Respiratory System Problems in Neonatal Calves. Symposium of Bovine Respiratory System Diseases, 14-16 April 2006, Bursa. (article in Turkish with an abstract in English)
22. Turgut, K.: Veteriner Klinik Laboratuvar Teşhis. Özel Basım, Konya.: 1995; 438-440.
23. Kirkwood, B.R.: Essentials of Medical Statistics. Blackwell Scientific Publications, London. 1988; 106-117.
24. Thrusfield, M.: Veterinary Epidemiology. 2nd edn. Blackwell Science, London. 1996; 37-59.