Scientific Papers. Series D. Animal Science. Vol. LXIII, No. 1, 2020
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

PRELIMINARY STUDY REGARDING THE ENVIRONMENTAL AND GENETIC FACTORS AFFECTING DAIRY CALVES HEALTH

Elena IRIMIA[1, 2], Daniela-Mihaela GRIGORE[1, 2], Ioana NICOLAE[1], Dinu GAVOJDIAN[1], Stelian BĂRĂITĂREANU[2], Livia VIDU[2]

[1]Research and Development Institute for Bovine Balotesti, Bucharest-Ploiesti, km 21, 077015, Ilfov, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: ela.irimia91@yahoo.com

Abstract

In order to study the influence of calves sex, dams age and year of calving, it is very important to evaluate at farm level, the incidences of colibacillosis, coccidiosis, rickets, neonatal enteritis, respiratory diseases (BRD) and haemorrhagic enteritis in un-weaned dairy calves. The study was carried out at the dairy cattle farm of the Research and Development Institute for Bovine Balotesti, Romania between January 2018 and December 2019, with health datasets from 176 Romanian Black Spotted calves. Colibacillosis and coccidiosis incidences were not influenced ($p>0.05$) by the sex of the calves, while rickets incidence was significantly influenced ($p\leq0.001$), with 2.20 ± 1.55% of the male calves being affected and 10.59 ± 3.36% of the females, respectively. Year of birth had significantly influenced ($p\leq0.05$) the incidence of colibacillosis and rickets and had no effects ($p>0.05$) on coccidiosis incidence. Neonatal enteritis, BRD and haemorrhagic enteritis incidences were not influenced ($p>0.05$) by factors such as calves sex, dams age and year of birth. Colibacillosis and rickets incidences were the only health problems influenced by factors such as calves sex and year of birth.

Key words*: animal health, calves welfare, dairy cattle, environmental factors.*

INTRODUCTION

The first 21 days of life in calves are very important because of the sensitivity and the higher risks of mortality (Gulliksen et al., 2009). In addition to these aspects, long-term consequences of diseases as well as the high degree of morbidity in unweaned calves determine a reducing of the genetic potential as adults (Swali and Wathes, 2006; Urie et al., 2018). The breeding environment and infancy period among domestic animals play an essential role for future harmonious development (Bornstein, 1989).

The most common causes for health disorders among young calves are of infectious nature such as diarrhea and bovine respiratory diseases (BRD) (Perez et al., 1990; Olsson et al., 1993; Sivula et al., 1996; Virtala et al., 1996a).

The performance of the animal at maturity is affected by the presence of diarrhea and / or BRD in the first three months of life and is associated with sub-fertility (Warnick et al., 1994; Svensson et al., 2003).

In general, animals have a native ability to adapt to the climatic influences, however, extreme climatic situations are difficult to overcome by immunosuppressed calves. Direct economic consequences were reported due to the inability of thermoregulation in young mammals, given the brown adipose tissue fast metabolization during severe cold thermal stress, a major negative impact on their welfare (Silanikove, 2000; Snowder et al., 2006; Roland et al., 2016).

Due to a high incidence of diseases in dairy calves, a series of economic and production negative repercussions have been described (Rossini et al., 2004; Stanton et al., 2012). For instance, the average costs owed to dairy calves respiratory and gastrointestinal treatments in North America are on average 33.46 $/calf and 14.71 $/calf, respectively (Kaneene and Hurd, 1990). The array of variation in mortality risks for calves younger than 12 months varies between 2.1% and 14%, under the influence of

year of birth and breed (Gulliksen et al., 2009). Other factors such as farm geography, farm size, colostrum management, housing and feeding strategy were found to have a significant influence as well (Waltner-Toews et al., 1986a; Lundborg et al., 2005; Gulliksen et al., 2009; Windeyer et al., 2014).

Another common disease of unweaned dairy calves is represented by rickets, which is a disorder of bone epiphyses growth, with the main cause being a deficient supply of vitamin D, phosphorus and especially the lack of calcium in the body (Pugh and Baird, 2012). The skin and digestive tract are involved in the synthesis and absorption of vitamin D, which influencing of calcium and phosphorus in the small intestine (Holick et al., 2006).

Exposure of animals to medium-wave ultraviolet (UVB) solar radiation at wavelengths between 290 and 320 nm generates the production of vitamin D in the skin (Nelson et al., 2012). Thus, the main natural method by which the animal's body can produce vitamin D, is the direct exposure to sun. The factors that influence the exposure to UVB solar radiation are season, skin pigmentation and also geographical location, with little up-to-date research focus on such aspects in cattle (Pickworth et al., 2012; Hymoller et al., 2012; Casas et al., 2015).

The aim of our study was to evaluate at farm level the incidences of colibacillosis, coccidiosis, rickets, neonatal enteritis, respiratory diseases (BRD) and haemorrhagic enteritis in un-weaned dairy calves, in order to assess the influence of factors such as calves sex, dams age and year of calving.

MATERIALS AND METHODS

Animals and general management

The study was carried out at the Research and Development Institute for Bovine Balotesti (44°36′46″N 26°4′43″E) Romania, were health data was collected for two consecutive years, between November 2017 and October 2019, from a number of 176 purebred Romanian Black and White (Holstein Friesian group) calves, managed under identical conditions (91 males and 85 females, 89 born in the 1th year of study and 72 in the 2nd year, respectively).

After birth, the calf was separated from the dam and housed in the maternity compartment until the age of 10 days. In the first 3 days of life, calves are fed with colostrum minimum 4 kg of colostrum per day, in two meals at 12 hours intervals. The following 7 days they receive two meals per day of 3 kg per head. After 10 days of age, the calves were moved to outdoor individual hutches with straw bedding. Where they were fed with milk replacement, 6 kg/day in two meals. The calves diet was supplemented with *ad libitum* solid diet of starter concentrates and alfalfa hay until the age of 3 months, when the waning took place, regardless of sex. The concentrates feed contained 18.5% crude protein, 9% fibre, 0.36% methionine, 0.9% lysine, 2.96% calcium, 0.69% phosphorus, 0.9% salt and 1.00% fats. With nonrestricted access to clean water.

Dehorning was carried out at the age of two months, only on female calves because they remain on the farm for replacement, while the male calves were sold for further fattening soon after weaning.

Veterinary care

As veterinary prevention, anthrax vaccination was used at the age of two months and vitamin therapy was applied only to the sensitive and sick calves. The main treatments were applied for symptomatic effects such as diarrhoea and lung diseases, these being the most common diseases in the studied calves. Neonatal enteritis causes diarrhoea and associated fluid and electrolyte losses. Thus, fluid therapy was an important part in enteritis management. The deworming procedures were made after the age of weaning and only if needed earlier. The research activities were performed in accordance with the European Union's Directive for animal experimentation (Directive 2010/63/EU).

Statistical analyses

In order to assess the effect of the age group on the above-mentioned health traits, the MiniTab®18 software was used, with the statistical significance level set at values of $p \leq 0.05$.

RESULTS AND DISCUSSIONS

Results concerning colibacillosis, coccidiosis and rickets incidence in 0-3 months of age calves, based on calves sex, dams age and year of study are shown in Table 1. Our data showed that colibacillosis and coccidiosis incidences were not influenced ($p>0.05$) by the sex of the calves, while rickets incidence was significantly influenced ($p\leq0.001$), with 2.20 ± 1.55% of the male calves and 10.59 ± 3.36% of the females being affected, respectively. No supporting previously published data for comparison was available, concerning the influence of sex related factors on rickets incidence. This aspect, regarding the higher susceptibility of female calves to rickets is of outmost importance, given that in the dairy cattle industry only females are being kept for replacement reasons, males being most often sent for fattening or slaughter at an early age. Moreover, rickets impairs growth and future development of calves and negatively affects the immune functions (Adams et al., 2010; Nelson et al., 2012).

Dams age had no influence ($p>0.05$) on colibacillosis, coccidiosis and rickets incidences in un-weaned calves.

Year of birth significantly influenced ($p\leq0.05$) the incidence of colibacillosis with 14.71 ± 0.43% of the calves being affected in the first year of study and 5.38 ± 2.35% in the second year of study. Colibacillosis prevalence in commercial farms is strongly influenced by the bedding and fed hygiene, and also by heat and humidity conditions. These differences were observed in other commercial farms (Dubey and Rao, 1997; Tikoo et al., 2009; Shekhar et al., 2017). Coccidiosis incidence, however, was not influenced ($p>0.05$) by this factor.

Results relating to neonatal enteritis, respiratory diseases (BRD) and haemorrhagic enteritis incidences in 0-3 months of age calves, based on calves sex, dams age and year of study are shown in Table 2.

Neonatal enteritis, BRD and haemorrhagic enteritis incidences were not influenced ($p>0.05$) by factors such as calves sex, dams age and year of birth.

However, a sex related sensitivity could be observed for BRD, with an average incidence of 5.49 ± 0.24% in male calves and 2.35 ± 1.65% in females, respectively. This might be attributed to the higher growth rates of male calves, compared to females (Phyllis and Moss, 1986), with in return might lead to a prioritization of the nutrients towards the growth process, rather than allocating nutrients to support the immune system.

According to previous studies, total morbidity incidence in calves up to 3 months old was of 35% (Waltner-Toews et al., 1986b) and the highest risk was identified for neonatal diarrhoeas and bovine respiratory disease (BRD), with 29% and 39%, respectively (Van Donkersgoed et al., 1993; Donovan et al., 1998a; Windeyer et al., 2014). Conversely, current results shown the incidence for BRD to be significantly lower, of 3.98 ± 1.48%, while the incidence neonatal diarrhoea was similar as previously reported, of 29.55 ± 0.34%. Differences in BRD incidences could be attributed to different geographical and climatic conditions in which the calves were raised, previously published data concerned dairy calves raised in North America, especially in Canada, where severity of cold weather is much more prominent compared to temperate European climate.

Windeyer et al. (2014) found that BRD has a minimal impact on body weight loss in calves, while neonatal diarrhoea causes weight losses of 1.10 kg. In the same study, it was reported that BRD prevention strategies for un-weaned calves is much more complex and does not just refer to the general management of colostrum feeding, which is the first essential step, vaccination programs and antimicrobial administration represent major tools for the disease prevalence to be reduced. Calves with passive immunity transfer deficiencies (FTPI) had 1.6 times higher likelihood to develop BRD (Windeyer et al., 2017).

Our hypothesis, that age of the dam could influence calves health was not supported by current results. Although, in the literature there are mentions that multiparous cows produce a higher concentration of immunoglobulins in the colostrum and also the incidence of dystocia is much lower, compared to first calving cows, such aspects did not seem to have an influence on the overall health status of the resulting calves (Neamt et al., 2017).

In an extensive study Urie et al. (2018) reported a 5.0% mortality rate, also describing death causes, which were 32.0% of digestive related problems, 14.1% of respiratory nature, 7.0% a combined digestive and respiratory causes, while 13.3% of deaths were caused by infectious agents, various injuries or unknown causes. Given the relative low number of calves included in our study, for the future we plan to include more farms and a higher number of calves, following mortality losses and mortality causes.

The total morbidity incidence for calves studied was of 88.54%. None of the diseases has lead to mortality of calves included in our study. Conversely, other authors report a mortality rate in dairy calves between 5-6% (Seppa-Lassila et al., 2016) and 7.8% (Santman-Berends et al., 2019).

Table 1. Mean (± SEM) for colibacillosis, coccidiosis and rickets incidence in 0-3 months of age calves, based on calves sex, dams age and year of study

Factors/Disease	Colibacillosis (%)	Coccidiosis (%)	Rickets (%)
Cohort	8.52±2.11	39.20±0.36	6.25±1.83
Male calves	7.69±2.81	41.76±0.52	2.20±1.55
Female calves	9.41±3.19	36.47±0.52	10.59±3.36
Differences males vs. females (p value)	NS (0.686)	NS (0.475)	***(0.000)
Primiparous dams	11.36±4.84	43.18±0.75	4.55±3.18
Multiparous dams	8.42±2.86	45.26±0.51	7.37±2.69
Differences for dams age	NS (0.583)	NS (0.821)	NS (0.534)
1th year of study	14.71±0.43	36.76±0.58	11.76±0.39
2nd year of study	5.38±2.35	45.16±0.51	3.23±1.84
Differences year 1 vs. year 2	*(0.045)	NS (0.288)	*(0.034)

Table 2. Mean (± SEM) for neonatal enteritis, respiratory diseases and haemorrhagic enteritis incidence in 0-3 months of age calves, based on calves sex, dams age and year of study

Factors/Disease	Neonatal enteritis (%)	Respiratory diseases (%)	Haemorrhagic enteritis (%)
Cohort	29.55±0.34	3.98±1.48	1.13±8.01
Male calves	30.77±0.48	5.49±0.24	1.10±11.00
Female calves	28.24±0.49	2.35±1.65	1.18±11.80
Differences males vs. females (p value)	*NS (0.714)*	*NS (0.289)*	*NS (0.967)*
Primiparous dams	3.63±0.73	6.82±3.84	2.27±2.27
Multiparous dams	3.15±0.47	4.21±2.07	1.05±1.05
Differences for dams age (p value)	*NS (0.580)*	*NS (0.518)*	*NS (0.574)*
1th year of study	32.35±0.57	2.94±2.06	2.94±2.06
2nd year of study	29.03±0.47	5.38±2.35	n.a.
Differences year 1 vs. year 2	*NS (0.653)*	*NS (0.458)*	*n.a.*

CONCLUSIONS

Understanding the factors associated with calves morbidity is an essential part for improving calf health, welfare and performance.

We found that female calves have an overall susceptibility to rickets, when compared to male counterparts, which could translate in adapting future diets based on calves sex, e.g. diets with higher macroelements and vitamin D content, in order to promote better growth rates and health.

Coccidiosis and neonatal enteritis were the most prevalent health disorders found in our study, affecting altogether over 60% of the investigated calves.

Our initial hypothesis that dams age constitutes an influencing factor for overall calves health was not supported by the results. For our future studies, we plan to involve factors such as colostrum quality and calving year, in order to

better evaluate and differentiate between the innate and acquired organic resistance of dairy calves.

REFERENCES

Adams, J. S., Hewison, M. (2010). Update in vitamin D. *Journal of Clinical Endocrinology and Metabolism*, 95(2), 471–478.

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968–1987. *Psychological Bull*etin, 106, 265–289.

Casas, E., Lippolis, J. D., Kuehn, L. A, Reinhardt, T. A. (2015). Seasonal variation in vitamin D status of beef cattle reared in the central United States. *Domestic Animal Endocrinology*, 52, 71–74.

Centers for Epidemiology and Animal Health USDA (1994). Dairy heifer morbidity, mortality and health management focusing on preweaned heifers, Retrieved January 10, 2020, from https://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/ndhep/NDHEP_dr_Report.pdf

Donovan, G. A., Dohoo, I. R., Montgomery, D. M. (1998a). Association between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. *Preventive Veterinary Medicine,* 34, 31–46.

Dubey, R. D., Rao, K. N. P. (1997). Some observations on neonatal diarrhoea in buffaloes. *Indian Veterinary Journal*, 74, 677–679.

Gavrila, M.I., Marginean, G.E., Vidu, L. (2015). Study on the interrelation between animal welfare and production in dairy cattle. *Scientific Papers: Series D, Animal Science,* LVIII, 278–283.

Gulliksen, S., Lie, K., Loken, T., Osteras, O. (2009). Calf mortality in Norwegian dairy herds. *J.ournal of Dairy Science*, 92, 2782–2795.

Holick, M. F. (2006). Resurrection of vitamin D deficiency and rickets. *Journal of Clinical Investigation*, 116(8), 2062–207.

Hymoller, L., Jensen, S. K. (2012). 25-Hydroxycholecalciferol status in plasma is linearly correlated to daily summer pasture time in cattle at 56 degrees. *British Journal of Nutrition*, 108, 666–71.

Kaneene, J. B., Hurd, H. S. (1990). The National Animal Health Monitoring System in Michigan III. Cost estimates of selected dairy cattle diseases. *Preventive Veterinary Medicine,* 8, 127–140.

Lundborg, G. K., Svensson, E. C., Oltenacu, P. A. (2005). Herd-level risk factorsfor infectious diseases in Swedish dairy calves aged 0–90 days. *Preventive Veterinary Medicine,* 68, 123–143.

Neamt, R. I., Gavojdian, D., Neciu, F. C., Cziszter, L. T., Ilie, D. E. (2017). Effects of some factors on calves viability and growth. *Proceedings of the 7th International Conference on the Assessment of Animal Welfare at the Farm and Group Level, 5*3.

Nelson, C. D., Reinhardt, T. A., Lippolis, J. D., Sacco, R. E., Nonnecke, B. J. (2012). Vitamin D signaling in the bovine immune system: a model for understanding human vitamin D requirements. *Nutrients,* 4, 181–96.

Olsson, S. O., Viring, S., Emanuelson, U., Jacobsson, S.O. (1993). Calf diseases and mortality in Swedish dairy herds. *Acta Veterinaria Scandinavica*, 34, 263–269.

Perez, E., Noordhuizen, J. P. T. M., Van Wuijkhuise, L. A., Stassen, E. N. (1990). Management factors related to calf morbidity and mortality rates. *Livestock Production Science,* 25, 79–93.

Phyllis, C. Lee, Moss, C. J. (1986). Early maternal investment in male and female African elephant calves. *Behavioral Ecology and Sociobiology,* 18, 353–361.

Pickworth, C. L, Loerch, S. C., Fluharty, F. L. (2012). Restriction of vitamin A and D in beef cattle finishing diets on feedlot performance and adipose accretion. *Journal of Animal Science*, 90, 1866–78.

Pugh, D. G, Baird, A. N. (2012). Diseases of the neurologic system. 2nd ed. *Sheep and goat medicine*. Elsevier. St. Louis, Mo.

Roland, L., Drillich, M., Klein-Jöbst, D., Iwersen, M. (2016). *Invited review:* Influence of climatic conditions on the development, performance and health of calves. *Journal dairy science*, 99, 2438–2452.

Rossini, K. L., McGillard, M., James, R., Pearson, R., Swecker, W. (2004). Effects of calfhood respiratory and digestive disease on calfhood morbidity and first lactation production and surivival rates. *Virginia Polytechnic Institute and State University, Blacksburg, Virginia (Unpublished master's thesis).*

Santman-Berends, I. M. G. A., Schukken, Y. H., Van Schaik, G. (2019). Quantifying calf mortality on dairy farms: Challenges and solutions. *Journal of Dairy Science,* 102, 6404–6417.

Seppa-Lassila, L., Sarjokari K, Hovinen, M., T. Soveri, T., Norring M. (2016). Management factors associated with mortality of dairy calves in Finland: A cross sectional study. *The Veterinary Journal*, 216, 164–167.

Shekhar, S., Ranjan, R., Singh, C. V., Kumar P. (2017). Prevalence, Clinicohaemato-Biochemical Alterations in Colibacillosis in Neonatal Calves. *International Journal of Current Microbiology and Applied Sciences,* 6(9), 3192–3198.

Silanikove, N. (2000). Effects of heat stress on the welfare of extensively managed domestic ruminants. *Livestock Production Science,* 67, 1–18.

Snowder, G. D., Van Vleck, L. D., Cundiff, L. V., Bennett, G. L. (2006). Bovine respiratory disease in feedlot cattle: Environmental, genetic, and economic factors. *Journal of Animal Science,* 84, 1999–2008.

Stanton, A. L., Kelton, D. F., LeBlanc, S. J., Wormuth, J., Leslie, K. E. (2012). The effect of respiratory disease and a preventative antibiotic treatment on growth, survival, age at first calving, and milk production of dairy heifers. *Journal of Dairy Science*, 95, 4950–4960.

Svensson, C., Lundborg, K., Ulf Emanuelson, U., Olsson, S. O. (2003). Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. *Preventive Veterinary Medicine*, 58, 179–197.

Swali, A., Wathes, D. C. (2006). Influence of the dam and sire on size at birth and subsequent growth, milk production and fertility in dairy heifers. *Theriogenology,* 66, 1173–1184.

Tikoo, A., Singh, R., Agrawal, R. (2009). Occurrence of cases of calf diarrhoea in Jammu. Indian. *Journal of Veterinary Medicine,* 29(1), 53-45.

Urie, N. J. (2018). Preweaned heifer management on US dairy operations: Part V. Factors associated with morbidity and mortality in preweaned dairy heifer calves. *Journal of Dairy Science,* 101, 1–16.

Van Donkersgoed, J., Ribble, C. S., Boyer, L. G., Townsend, H. G. (1993). Epidemiological study of enzootic pneumonia in dairy calves in Saskatchewan. *Canadian Journal of Veterinary Research*, 57, 247–254.

Virtala, A. M., Mechor, G. D., Gröhn, Y. T., Erb, H. N. (1996a). Morbidity from nonrespiratory diseases and mortality in dairy heifers during the first three months of life. *Journal of the American Veterinary Medical Association,* 208, 2043–2046.

Waltner-Toews, D., Martin S. W., Meek, A. H. (1986a). Dairy calf management, morbidity and mortality in Ontario Holstein herds. II. Age and seasonal patterns. *Preventive Veterinary Medicine*, 4, 125–135.

Waltner-Toews, D., Martin, S. W., Meek, A. H. (1986b). Dairy calf man-agement, morbidity and mortality in Ontario Holstein herds. IV: association of management with mortality. *Preventive Veterinary Medicine, 4*, 159–171.

Windeyer, M. C., Lesliea, K. E., Godden, S. M., Hodginsc, D. C., Lissemorea, K. D., LeBlanc, S. J. (2014). Factors associated with morbidity, mortality, and growth ofdairy heifer calves up to 3 months of age. *Preventive Veterinary Medicine*, 113, 231–240.

Windeyer, M. C., Timsit, E., Barkema, H. (2017). Bovine respiratory disease in pre-weaned dairy calves: Are current preventative strategies good enough? *The Veterinary Journal*, 224, 16–17.