Scientific Papers. Series D. Animal Science. Vol. LXIV, No. 1, 2021
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

# SIRE GENETIC EFFECTS ON HEALTH TRAITS IN UN-WEANED DAIRY CALVES-PRELIMINARY RESULTS

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***Abstract***

*The aim of the current study was to evaluate the effects that sire-bulls have on health traits of un-weaned dairy calves. The study was carried out at the Experimental Farm of the Research and Development Institute for Bovine, where health data was collected for two consecutive years, between November 2017 and October 2019, following a number of 119 purebred Romanian Black and White calves, managed under identical conditions. Calves were separated into 7 sire-groups, each one of the bulls having at least 10 descendants born and weaned, the maximum descendants from a sire were 35 calves. The incidence of colibacillosis was influenced by the sire of the calves as following: three calves groups did not developed this disease, one group showed a low susceptibility, one group presented an intermediary genetic predisposition, while two groups showed a significant susceptibility ($p \leq 0.10$). Health traits such as rickets, respiratory disease and haemorrhagic enteritis incidences in some sire-descendants groups showed low or lack of susceptibility. Current preliminary results suggest that paternal genetic effects could influence the health of un-weaned dairy calves.*

***Key words:*** *cattle, dairy calves, health, paternal genetic effects.*

## INTRODUCTION

It is well documented that maternal genetics in cattle can influence the health of animals and their offspring (Berry et al., 2011). Moreover, increased selection of dairy cows for higher milk yields has led to a significant decline in general fitness and health traits, this being observed particularly in high yielding breeds such as the Holstein-Friesians (Oltenacu and Broom, 2010; Parker Gaddis et al., 2014). For instance, breed discrepancies regarding the susceptibility to respiratory diseases have been confirmed by Snowder et al. (2005), studying 12 cattle breeds and reporting a pre-weaning respiratory disease resistance, heritability ranging between 0.00 and 0.26. Furthermore, Berry et al. (2011) reported maternal heritabilities ranging between 0.00 and 0.13 for health traits in dairy cattle, with no previous estimates for paternal genetic effects.

In the recent years, Nordic European Countries developed new breeding programs, which include traits such as survival of both calves and cows (Snowder et al., 2005). Limitations to include disease resistance into breeding schemes for dairy cattle are due to aspects such as lack of genetic variations in some breeds, interrelationships between different diseases, lack of reliable data for some diseases and the economic implications, as previously reported by Stear et al. (2001).

It is of utmost importance to include in the selection of artificial insemination (AI) breeding bulls with the health traits of their progeny, given that high estimated breeding value (EBV) bulls can sire over 200.000 descendants, which could lead to great economic losses if their descendants have high mortality rates or impaired health.

Furthermore, given the new genomic selection developments and the wide use of genotyping protocols, most European countries are using genotyped bulls for AI, considering the potential implications of some recessive genes.

For instance, bovine leukocyte adhesion deficiency (BLAD), which is autosomal recessive disease characterized by recurrent bacterial infections, delayed healing and reduced growth in calves, was found to have an incidence ranging between 4% and up to 18% in Holstein bulls (Nagahata, 2004). The aim of the current study was to evaluate the effects that genetics of sire-bulls have on health traits of un-weaned dairy calves.

## MATERIALS AND METHODS

*Animals and general management*

The study was carried out at the Experimental Farm of the Research and Development Institute for Bovine Balotesti Romania, where health data was collected for two consecutive years, between November 2017 and October 2019, following a number of 119 purebred Romanian Black and White (Holstein Friesian group) calves (57 males and 62 females, respectively), managed under identical conditions.

Immediately after birth, the calves were separated from their dams and were housed individually in a maternity compartment for the first 10 days of life. Colostrum was administrated in the first 4 hours after birth by an animal caretaker, using a bucket calf feeder. During their first 3 days of life, the calves received minimum 4 litres of colostrum per day, divided into two equal meals at intervals of 12 hours. The following 7 days, they received two meals per day consisting of 3 litres of milk per head. At the age of 10 days, the calves were moved to an outdoor individual hutch with straw bedding, where they were fed with milk replacement, 6 litres/day/head.

The calf diet was supplemented with *ad libitum* starter concentrates (18% crude protein) and alfalfa hay until the age of 3 months, when weaning occurred.

Anthrax vaccination was done at the age of two months and vitamin therapy was applied only to the underdeveloped and ill calves. The management and feeding of calves are similar with the data published in Irimia et al. (2020).

The research activities were performed according with the European Union's Directive for animal experimentation (Directive 2010/63/EU).

*Data collection and statistical analysis*

Calves were divided into 7 sire-groups, each one of the seven bulls having at least 10 descendants born and weaned within the farm, the maximum descendants from one sire were 35 calves (see Table 1).

Table 1. General experimental design and number of calves per sire-group

| Location | 44°36′46″N 26°4′43″E | Sire code | Group | Number of descendants |
|---|---|---|---|---|
| Altitude of site | 97 m | ROXX137 | I | 13 |
| Average rainfall | 555 mm | ROXX573 | II | 13 |
| Summer temperature | 22.3°C | ROXX953 | III | 11 |
| Winter temperature | -3.3°C | ROXX018 | IV | 10 |
| Weaning age | 90 ± 5 days | ROXX019 | V | 16 |
| Concentrates | 18% CP, *ad libitum* | ROXX147 | VI | 35 |
| Veterinary care | Anthrax vaccination | ROXX341 | VII | 19 |

Health trait data was recorded by the farm veterinarian and technicians, with the following health pathologies being reported in calves up to the age of weaning: colibacillosis, coccidiosis, rickets, neonatal calf enteritis, bovine respiratory disease, haemorrhagic diarrhea.

In order to assess the effect of the sire-group on health traits of their calves offspring, the MiniTab®18 software was used (computing average incidence ± standard error of the mean), with the differences between groups being calculated using the Mann-Whitney nonparametric test, with the statistical significance level set at values of $p \leq 0.10$.

## RESULTS AND DISCUSSIONS

Incidence of colibacillosis was influenced by the calves sire, with three calves groups out of the total seven not developing this disease (sire-groups I, II and VII), one group showed a low susceptibility to colibacillosis (VI), one group presented an intermediary genetic predisposition (III), while two groups showed a significant susceptibility (IV, V) of $p \leq 0.10$ and p≤0.05, respectively, when compared to the low susceptibility group (Table 2). Current results are in accordance with those previously reported by Bashahun and Amina (2017), who found a prevalence of up to 100% in some commercial dairy farms, outlining that 20% of the total death losses in un-weaned calves are caused by colibacillosis. Also, Irimia et al. (2020), found that year-factor influences significantly the colibacillosis incidence in un-weaned calves.

Coccidiosis incidence was not influenced (p>0.10) by the sire of calves (Table 2), although slight differences were observed among the calves groups, with incidences ranging from 23.1 ± 12.20 and 53.8 ± 14.40. Lack of statistical Considering that vitamin D was found to play an important role in the metabolism of Ca (calcium) and P (phosphorus), involved in the synthetisation of bones (Sahay and Sahay, 2012) and, also, that it has an important effect on immunity and cell differentiation (Nelson et al., 2012).

One of the most common causes of calf death is represented by neonatal enteritis, given the high prevalence of pathogenic agents such as rotavirus, coronavirus and *E. coli* bacteria in cattle farms (Abd-Elrahman, 2011). Over 50% of all neonatal enteritis cases appear during the first 7 days after birth, with less than 20% occurring after the 2nd week of life (Bendali et al., 1999), although, exceptionally, the highest prevalence of rotavirus is seen between 2nd and 4th weeks after birth (Nourmohammadzadeh et al., 2012). In our study, although slight differences were observed among the calves groups, neonatal enteritis incidence (p>0.10) ranged from 20.0 ± 13.30 to 37.5 ± 12.50 (Table 3).

Table 2. Mean ± SEM for colibacillosis, coccidiosis and rickets incidences among sire descendants

| Pathology | ROXX137 [I] | ROXX573 [II] | ROXX953 [III] | ROXX018 [IV] | ROXX019 [V] | ROXX147 [VI] | ROXX341 [VII] |
|---|---|---|---|---|---|---|---|
| Colibacillosis (%) | 0.0±0.00 | 0.0±0.00 | 18.2±12.20$^{a}$ | 30.0±15.30$^{b}$ | 31.3±12.00$^{b}$ | 8.57±0.48$^{a}$ | 0.0±0.00 |
| Coccidiosis (%) | 23.1±12.20$^{a}$ | 53.8±14.40$^{a}$ | 27.3±14.10$^{a}$ | 50.0±16.70$^{a}$ | 31.3±12.00$^{a}$ | 45.7±0.85$^{a}$ | 42.1±1.16$^{a}$ |
| Rickets (%) | 0.0±0.00 | 0.0±0.00 | 9.0±9.09$^{a}$ | 20.0±13.30$^{a}$ | 18.8±10.10$^{a}$ | 8.57±0.48$^{a}$ | 0.0±0.00 |

*Rows with different superscript differ significantly at p≤0.10*
*SEM Standard error of the mean*

significance could be attributed to the low number of calves within each sire group. Our results regarding the incidence of coccidiosis in un-weaned calves are similar with those previously published by Habtamu et al. (2020) for dairy claves reared in China.

Concerning rickets incidence (p>0.10), nevertheless, three of the calves sire groups did not develop rickets, two calves groups had a slight predisposition to develop rickets of 8.57 ± 0.48% and 9.0 ± 9.09%, while two sire groups had an incidence ranging between 18.8 ± 10.10% and 20.0 ± 13 (Table 2).

Unfortunately, there was no possibility to compare our results for the reason that no previously published data on rickets incidence in calves were found. Moreover, studies on factors that cause rickets in dairy calves are scarce, except general recommendations on dosage for vitamin D in their diets and sun exposure. One of the most common causes of calf death is represented by neonatal enteritis, given the high prevalence of pathogenic agents such as rotavirus, coronavirus and *E. coli* bacteria in cattle farms (Abd-Elrahman, 2011). Over 50% of all neonatal enteritis cases appear during the first 7 days after birth, with less than 20% occurring after the 2nd week of life (Bendali et al., 1999), although, exceptionally, the highest prevalence of rotavirus is seen between 2nd and 4th weeks after birth (Nourmohammadzadeh et al., 2012). In our study, although slight differences were observed among the calves groups, neonatal enteritis incidence (p>0.10) ranged from 20.0 ± 13.30 to 37.5 ± 12.50 (Table 3).

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Gulliksen et al. (2009) reported that diarrhea and respiratory diseases increase the risk of death in newborn dairy calves, causing 50% and 15% of the total calves losses, respectively.

Prior reports on the heritability of respiratory diseases susceptibility in both dairy and beef cattle showed low genetic additive effects, however, breed discrepancies have been outlined. For instance, Braunvieh cattle breed appears to be the most susceptible, while crossbred animals have highest resistance (Muggli-Cockett et al., 1992; Snowder et al., 2005). A study conducted in Australia comparing *Bos taurus* (European breeds) with *Bos indicus* (e.g. Santa Gertrudis and Santa Gertrudis crossbreds) cattle for bovine respiratory disease incidence concluded that *Bos taurus* have a greater risk for developing such pathologies compared to indicine cattle (Cusack et al., 2007).

Moreover, a study conducted by Muggli-Cockett et al. (1992) found that calves born from younger dams have a higher pre-weaning incidence of respiratory diseases, which the authors attributed to the lower antibody levels in colostrum of primiparous cows. The significance in maternal transfer of immune factors throughout colostrum was further supported by a trial of Ganaba et al. (1995) that found that throughout vaccination of the dams prior to calving, there is a decrease in respiratory disease incidence in pre-weaned calves.

Un-weaned calves diarrhea was found to be one of the most common diseases in young cattle, causing important economic and productivity losses to the bovine industry at a global level. Differences among prevalence rates between reports were attributed to geographical and animal-management variations (Cho and Yoon, 2014). Furthermore, bovine viral diarrhoea virus was demonstrated to play an important role, in terms of immunosuppression and synergistic effects with other pathogens, for instance having a primary interrelation with pneumo-pathogens. In recent years it was found that bovine coronavirus has a major role in bovine respiratory disease (Jared et al., 2010).

In our study respiratory disease and hemorrhagic enteritis were found exclusively among the descendants of a single sire (group VI), therefore statistical comparison was not possible to conduct (Table 3).

Table 3. Mean ± SEM for neonatal enteritis, respiratory disease and hemorrhagic enteritis incidences among sire descendants

| Pathology | ROXX137 [I] | ROXX573 [II] | ROXX953 [III] | ROXX018 [IV] | ROXX019 [V] | ROXX147 [VI] | ROXX341 [VII] |
|---|---|---|---|---|---|---|---|
| Neonatal Enteritis (%) | 30.8±13.30$^a$ | 23.1±12.20$^a$ | 0.0±0.00 | 20.0±13.30$^a$ | 37.5±12.50$^a$ | 31.4±7.96$^a$ | 36.8±11.4$^a$ |
| Respiratory Disease (%) | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 5.7±3.98 | 0.0±0.00 |
| Haemorrhagic Enteritis (%) | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 0.0±0.00 | 5.7±3.98 | 0.0±0.00 |

*Rows with different superscript differ significantly at p≤0.10*
*SEM Standard error of the mean*

Worth mentioning is the fact that sire group VI had the highest number of calves, accounting for 35 animals (Table 1), and therefore the reliability of our data is higher, compared to sire groups with lower number of descendants.

Diseases in un-weaned calves have multifactorial causes and represents the result of interactions among different factors that could influence to the build-up of infections, including immunological, nutritional, genetic and environmental factors. The study of un-weaned calves diseases is very important because general health represents a key issue of tackling and balancing diverse factors such as pathogens, the underdeveloped immune system of the young animals, environmental aspects and the rearing management practices.

## CONCLUSIONS

In the current study, the genetic component of the sire had a significant statistic influence on colibacillosis incidence and susceptibility in un-weaned dairy calves. Moreover, on health traits such as rickets, respiratory disease and hemorrhagic enteritis incidences some groups sire-descendants showed low or a lack of susceptibility.

The current research paper represents a preliminary study. Given the low number of calves for each sire-group available in the current study, which is far less than desired for statistical analyses, larger scale studies are required to include a greater number of bulls with higher number of descendants.

Current study suggest that paternal genetic effects could influence the health of un-weaned dairy calves, nevertheless this research paper gives us only preliminary results.

## ACKNOWLEDGEMENTS

This work was supported by a grant of the Romanian Ministry of Agriculture and Rural Development, project number ADER 8.1.5/2019.

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