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Mortalidade de bovinos de corte em diferentes sistemas de confinamento

Pablo Estima Silva

Pelotas, 2020

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Mortalidade de bovinos de corte em diferentes sistemas de confinamento

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Resumo

ESTIMA-SILVA, Pablo. **Mortalidade de bovinos de corte em diferentes sistemas de confinamento.** 2020. 41f. Tese (Doutorado em Ciências) - Programa de Pós-Graduação em Veterinária, Faculdade de Veterinária, Universidade Federal de Pelotas, Pelotas, 2020.

Tendo em vista o aumento da demanda em diagnóstico de enfermidades em bovinos mantidos em diferentes sistemas de confinamento na área de influência do Laboratório Regional de Diagnóstico, da Faculdade de Veterinária, da Universidade Federal de Pelotas (LRD/UFPel) esta tese buscou determinar as principais causas de morte de bovinos confinados nesta região, estabelecendo sua prevalência e formas de controle. Para isso foi realizado um estudo retrospectivo das enfermidades diagnosticadas em confinamentos de bovinos de corte na área de influência do LRD/UFPel. Foi realizada pesquisa nos protocolos de necropsia do laboratório de janeiro de 2000 a dezembro de 2017. Foi realizado, ainda, um estudo prospectivo, entre janeiro de 2018 e agosto de 2019 em confinamentos de bovinos de corte na região. Práticas de manejo sanitário, alimentar e categoria de bovinos utilizadas em cada um deles foram verificadas. Este estudo abrangeu confinamentos dedicados à exportação de bovinos vivos e terminação para abate. Com base nos resultados pode-se observar que acidose ruminal, timpanismo, pneumonia e tristeza parasitária bovina (TPB) foram as principais causas de morte em bovinos confinados na região estudada. A mortalidade foi significativamente maior em confinamentos para terminação do que para exportação. A adaptação dos bovinos a dieta rica em carboidratos altamente fermentáveis oferecida nos confinamentos, de modo geral, foi eficiente para evitar mortes por acidose e timpanismo. Em relação à TPB, a quimioprofilaxia mostrou-se eficiente para o controle de surtos da doença em confinamentos. Nesta tese foi incluída, ainda, uma breve revisão de literatura sobre as principais causas de morte em bovinos de corte mantidos em diferentes sistemas de confinamento. Descreveram-se as perdas econômicas decorrentes destas enfermidades e a forma de controle das mesmas. Doenças associadas aos sistemas respiratório e digestivo foram as mais frequentemente observadas. Além da TPB, descrita na região Sul do Rio Grande do Sul, foram descritos surtos pontuais de botulismo e enterite necrótica que mesmo eventuais causaram prejuízos econômicos consideráveis quando ocorreram. Concluiu-se que a assistência técnica e um bom manejo sanitário e alimentar podem fazer a diferença no melhor desempenho e produtividade em criações de bovinos em confinamento, independente de sua finalidade.

Palavras-chave: confinamento; mortalidade; acidose; timpanismo; doenças respiratórias; tristeza parasitária

Abstract

ESTIMA-SILVA, Pablo. **Beef cattle mortality in different feedlot systems.** 2020. 41f. Thesis (Doctor degree in Sciences) - Programa de Pós-Graduação em Veterinária, Faculdade de Veterinária, Universidade Federal de Pelotas, Pelotas, 2020.

In view of the increased demand for diagnosis of diseases in cattle kept in different feedlot systems in the area of influence of the Laboratório Regional de Diagnóstico, da Faculdade de Veterinária, da Universidade Federal de Pelotas (LRD/UFPel) this thesis sought to determine the main causes of death of feedlot cattle in this region, establishing its prevalence and forms of control. For this, a retrospective study of diseases diagnosed in feedlots in the LRD / UFPel area of influence was carried out. This study was based on a survey of laboratory necropsy protocols from January 2000 to December 2017. A prospective study between January 2018 and August 2019, following up the beef cattle feedlot in the region also was conducted. Practices of sanitary management, feeding management and category of cattle used in each one of them were verified. This study included live cattle exports feedlots and finishing feedlots. Based on the results it can be observed that ruminal acidosis, bloat, pneumonia and cattle tick fever were the main causes of death in beef cattle feedlot in the studied region. Mortality was significantly higher in feedlots to finishing than feedlots to export live cattle. Adaptation of cattle to the highly fermentable carbohydrate-rich diet offered in feedlots was generally effective in preventing deaths from acidosis and bloating. The chemoprophylaxis was efficient to control outbreaks of cattle tick fevet in feedlots. This thesis also included a brief literature review on the main causes of death that occur in beef cattle kept in different feedlot forms. The economic losses resulting from these diseases and their control were also described. Diseases associated with the respiratory and digestive systems were the most frequently observed. In addition to cattle tick fevet, described in the Southern region of Rio Grande do Sul, it has been described occasional outbreaks of botulism and necrotic enteritis that caused considerable economic damage when they occured. It was concluded that technical assistance and good sanitary and food management can make the difference in better performance and productivity in feedlot cattle, regardless of its purpose.

Keywords: feedlot; mortality; acidosis; bloat; respiratory diseases; cattle tick fever

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1 Introdução

Nos últimos anos tem sido observado um aumento da demanda em diagnóstico de enfermidades em bovinos na área de influência do Laboratório Regional de Diagnóstico, da Faculdade de Veterinária, da Universidade Federal de Pelotas (LRD/UFPel), especialmente em bovinos de corte mantidos em diferentes sistemas de confinamento. Estes sistemas tratam-se basicamente da criação de bovinos em áreas restritas, com alimentação de um número elevado de animais em cochos com rações comerciais ou produzidas nos próprios estabelecimentos (REZENDE, 2010). O principal objetivo desses sistemas de criação é a obtenção de animais terminados para abate durante o ano todo, dependendo o mínimo possível de grandes extensões de campo, pastagens e condições climáticas favoráveis. Outra finalidade dos confinamentos é estoque e quarentena prévia à exportação de bovinos vivos (BAILONE, 2019), que tem tido aumento expressivo nos últimos anos na região. Outro objetivo de confinamento é a produção de touros para reprodução (MALAFAIA et al., 2016).

Nos Estados Unidos, a terminação de bovinos é majoritariamente realizada em confinamentos (EDWARDS, 2010), sendo que mais de 75% dos bezerros, destinados a produção de carne, é criada nesse sistema (GRANDIN, 2016). Na Austrália, a indústria do confinamento mantém-se em expansão constante, tendo aumentado de 750 mil cabeças confinadas nos anos 1990 para 2,8 milhões em 2015 (MAYBERRY et al., 2019). No Brasil, em 2018, 2,6% do rebanho bovino brasileiro, correspondente a 214,69 milhões de cabeças, foi terminado em confinamentos, ou seja, 12,6% das 44,23 milhões de cabeças abatidas oficialmente em todo o país (ABIEC, 2019). Na região Sul do Rio Grande do Sul tradicionalmente a pecuária de corte esteve sempre associada a grandes extensões de terra, com a criação dos animais em campo nativo, pastagens cultivadas e em restevas de plantações de arroz ou soja, entretanto, nos últimos anos os confinamentos, com diferentes propósitos, têm aumentado na região.

Acompanhando esse aumento da indústria do confinamento, tem sido observado o aumento da frequência de enfermidades ligadas a estes sistemas de produção animal, comprometendo a produtividade e causando prejuízos econômicos aos estabelecimentos nos quais este sistema de criação é utilizado. Kelly e Jansen (1986) relatam taxas de morbidade de até 69% em bovinos de corte confinados na América do Norte, com a maioria dos relatos entre 15% e 45%. Com relação à mortalidade no mesmo período a taxa chegou a 15%, com a maior parte dos relatos mencionando 1% a 5% de mortalidade. No Brasil, são relatadas taxas de morbidade de 7,05% e mortalidade de 0,64% em um estudo de taxas de morbidade e mortalidade de animais confinados na região Sudeste do Brasil (BAPTISTA et al., 2016). Em Minas Gerais, Martins (2016) observou morbidade de 7,76% e mortalidade de 1,5%.

Em relação às causas de morte, as doenças respiratórias são as principais com altas taxas de morbidade e mortalidade em confinamentos nos Estados Unidos. Edwards (2010) relata que 70%-80% das taxas de morbidade geral dos confinamentos nos Estados Unidos são representadas pelas doenças respiratórias. Em relação às taxas de mortalidade, esse número é de 40%-50%. No Brasil, além das pneumonias, os transtornos digestórios são citados, também, como importantes enfermidades diagnosticadas em confinamentos (MALAFAIA et al. 2016). Há, ainda, relatos de surtos pontuais acompanhados de expressivas taxas de mortalidade por outras enfermidades afetando bovinos nestes sistemas de criação com prejuízos consideráveis, como botulismo no Rio Grande do Sul (MABONI et al., 2010) e na região Centro-Oeste (SOARES et al., 2018). É, portanto, fundamental o conhecimento das principais causas de morte em bovinos de corte confinados para determinar formas de controle, que possam evitar prejuízos econômicos importantes para estabelecimentos que utilizam esse sistema de criação na região Sul do Rio Grande do Sul.

2 Artigos

2.1 Artigo 1

Causes of death of beef cattle raised in feedlots

Pablo Estima-Silva; Plínio Aguiar de Oliveira; Fábio Raphael Pascoti Bruhn; Haide Valeska Scheid; Lucas dos Santos Marques; Luiza Soares Ribeiro; Ana Lucia Schild

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Causes of death of beef cattle raised in feedlots [1]

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ABSTRACT.- Estima-Silva P, Oliveira P.A., Scheid H.V., Marques L.S., Ribeiro L.S. & Schild A.L. 2019. [**Causes of death of beef cattle raised in feedlots in Southern Brazil.**] *Pesquisa Veterinária Brasileira* 00(0):00-00. Laboratório Regional de Diagnóstico, Faculdade de Veterinária, Universidade Federal de Pelotas, Campus Universitário s/n, Pelotas, RS 96010-900, Brazil. E-mail: alschild@terra.com.br

The causes of death of cattle kept in pre-export feedlots (PEFs) and in feedlot for finishing for slaughter are described. Two studies were conducted: a retrospective study of mortality cases in feedlots between 2000 and 2017 registered at the Laboratório Regional de Diagnóstico of the Faculdade de Veterinária of the Universidade Federal de Pelotas; and a prospective study between January 2018 and August 2019, following up 22 feedlots for finishing and six PEFs for the export of live cattle. Between January 2000 and August 2019 samples of 150 cases of diseases that affected feedlot cattle were received from 22 feedlots for finishing and 115 of the six PEFs followed. Mortality considering all diagnosed diseases was significantly higher in feedlots for finishing ($p<0.05$), than in PEFs for the export of live cattle, of 1% and 0.12%, respectively. Diseases of the digestive system were the most important causes of death in feedlots regardless of its purpose. Acidosis presented the highest mortality rates both in feedlot for finishing (3.33%) as in PEFs for export (0.95%). In all cases the disease occurred due to failure in the adaptation of animals to the ingestion of concentrated foods. Bovine tick fever and pneumonias presented mortality rates of 0.13% and 0.09%, respectively in PEFs. In the feedlot for finishing seneciosis was the second cause of death due to cattle coming from areas with high infestation by the plant. In the present study, it was possible to identify the main diseases that occur in cattle feedlots for finishing or for the export of live animals in the southern region of Rio Grande do Sul. These diseases are known in other systems of cattle breeding and can be prevented or controlled through management, chemoprophylaxis or vaccination, minimizing losses due to mortality.

INDEX TERMS: Feedlot, pre-export feedlots, acidosis, bloat, respiratory diseases, tick fever.

RESUMO. **–** [**Causas de morte de bovinos de corte criados em confinamentos na região Sul do Brasil.**] Descrevem-se as causas de morte de bovinos mantidos confinados em estabelecimentos pré-embarque (EPFs) para exportação de animais vivos e em estabelecimentos de terminação para abate. Foram realizados dois estudos: um retrospectivo dos casos de mortalidade em confinamentos entre 2000 e 2017 registrados no Laboratório Regional de Diagnóstico da Faculdade de Veterinária da Universidade Federal de Pelotas; e um estudo prospectivo entre janeiro de 2018 e agosto de 2019, acompanhando-se 22 confinamentos de terminação e seis EPFs para exportação de bovinos vivos. No total, entre janeiro de 2000 e agosto de 2019 foram recebidos no LRD/UFPel amostras de 150 casos de enfermidades que afetaram bovinos confinados, 35 provenientes de 22 confinamentos de terminação e 115 dos seis EPEs acompanhados. A mortalidade considerando-se todas as enfermidades diagnosticadas foi significativamente maior nos confinamentos para terminação ($p<0,05$), do que nos EPEs para exportação de bovinos vivos, de 1% e 0,12% respectivamente. As doenças do sistema digestivo foram as causas de morte mais importante nos confinamentos, independente da finalidade. Acidose apresentou as maiores taxas de mortalidade tanto nos confinamentos para terminação (3,33%) como nos EPEs para exportação (0,95%). Em todos os casos a doença ocorreu devido a falha na adaptação dos animais à ingestão de alimentos concentrados. Tristeza parasitária bovina e pneumonias apresentaram taxas de mortalidade de 0,13% e 0,09 respectivamente em EPEs de exportação. Nos confinamentos para terminação a seneciose foi a segunda causa de morte devido aos bovinos serem provenientes de áreas com alta infestação pela planta. Este estudo permitiu identificar as principais enfermidades diagnosticadas em confinamentos para terminação de bovinos ou para exportação de bovinos vivos na região Sul do Rio Grande do Sul. Observou-se que são doenças que ocorrem em outros sistemas de criação de bovinos e que podem ser prevenidas ou controladas por meio de manejo, quimioprofilaxia ou vacinação, minimizando prejuízos por mortalidade de animais.

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TERMOS DE INDEXAÇÃO: Confinamento, estabelecimento pré-embarque, acidose, timpanismo, doenças respiratórias, tristeza parasitária.

INTRODUCTION

In recent years, there has been an increase in the demand for the diagnosis of diseases in cattle in the area of influence of the Laboratório Regional de Diagnóstico, of the Faculdade de Veterinária, of the Universidade Federal de Pelotas (LRD/UFPel), especially in feedlot cattle. The main purpose of feedlots in Brazil is cattle finishing, i.e., to produce animals ready for slaughter (Malafaia et al. 2016). In 2014, 2.4% of the Brazilian cattle herd (198.7 million heads) was finished in feedlots, representing 10.8% of the 43.3 million heads officially slaughtered across the country. This livestock rearing system has expanded due to the appreciation of the dollar and consequently, the increased export of live cattle (Bailone 2019). These animals are maintained in pre-export feedlots (PEFs) for periods predetermined by the importing countries. Despite this increase in feedlot cattle, little is known about the diseases affect cattle that occur in this rearing system in southern Brazil, as well as their impacts on animal health, production and costs (Malafaia et al. 2016).

Respiratory diseases are the main causes of morbidity and mortality in cattle feedlots in the United States, despite advances in operational management and health protocols in this sector. The cumulative incidence of these diseases is estimated at 16.2% (Avra et al. 2017), impacting the profitability of farms that use this system for cattle finishing (Cernicchiaro et al. 2013). It has been mentioned that approximately 75% of morbidity and 50% of mortality in cattle feedlots in the United States is caused by respiratory diseases (Kelly & Jansen 1989, Edwards 2010). In Brazil, in addition to pneumonia, digestive disorders are also cited as important diseases diagnosed in feedlot cattle (Malafaia et al. 2016). In the area of influence of LRD/UFPel, which corresponds to the southern region of Rio Grande do Sul, surveys and previous retrospective studies have shown that diseases of the respiratory tract are important causes of death in calves, mainly of dairy breeds, up to one year of age raised in feedlots (Assis-Brasil et al. 2013). However, little is known about the causes of death in cattle reared in feedlots for finishing or exportation. It is, therefore, fundamental to know the main causes of death in this breeding system to identify control strategies, which could prevent economic damage to beef cattle ranching in the region.

The goal of this paper was to determine the main diseases that cause mortality in feedlot cattle in the area of influence of the LRD/UFPel, verify their prevalence and develop control strategies according to the current reality of this breeding system.

MATERIAL AND METHODS

A retrospective study of diagnosed diseases in feedlot cattle in the area of influence of the LRD/UFPel was carried out, and the mortality rates and epidemiological characteristics of each disease were verified. For this study, a survey of necropsy reports from the LRD/UFPel from January 2000 to December 2017 was conducted.

A prospective study was also carried out on feedlot cattle farms in the southern region of Rio Grande do Sul state. The feedlots were visited to identify the sanitary condition, food management practices and the age of the cattle on each farm since protocols differ and depend on the ultimate goal of each farm. This study was conducted in feedlot cattle intended for export to Turkey and Venezuela as well as feedlots dedicated to slaughtering.

Necropsies were performed at the feedlots or at the laboratory to diagnose the diseases that caused the death of the cattle. The organs of the cattle subjected to necropsy by the veterinarians responsible for the feedlots were also sent to the LRD/UFPel. Complementary analyses (histopathological, bacteriological, parasitological) were performed when necessary to confirm the diagnosis. Outbreaks were considered when several animals with similar clinical signs reported by the responsible veterinarians died within a short period of time. As many necropsies as possible were performed for each outbreak.

Export to Turkey

The cattle destined for export to Turkey remained in quarantine after the number of animals to be exported was reached (minimum 8000 heads). After the entry of all cattle in PEF, which could take up to 15-20 days due to the significant number of cattle, quarantine conditions were initiated by Ministério da Agricultura Pecuária e Abastecimento (MAPA). During this period (40 days), the entry or exit of animals was prohibited (MAPA 2018). The total duration of stay in the PEFs could reach 60 days. Cattle were submitted to an incoming sanitary protocol involving endectocidal drugs, vaccines against infectious bovine rinotracheitis (IBR), bovine viral diarrhea (BVD), bovine respiratory syncytial virus (BRSV), bovine parainfluenza (PI), *Pasteurella multocida* and *Mannheimia haemolytica*, and clostridiosis, in addition to a dose of oxytetracycline. In these operations, chemoprophylaxis for bovine tick fever was performed with imidocarb (1,2 mg/kg of body weight) or oxytetracycline (6,7 mg/kg of body weight) and diminazene diaceturate (1.17 mg/kg of body weight). Animals intended for export were noncastrated males aged up to 18 months old, of European breed standard, and with a maximum body weight of 285 kg. During the quarantine period, blood was collected from all the cattle; the blood samples were required to be negative for IBR, BVD, paratuberculosis and leukosis. Animals positive for any of these diseases were isolated and considered unfit for export but released into domestic trade after the

embarkation of the others. In the same period, the animals were also tested for tuberculosis and brucellosis. If they were positive for either of these diseases, they were isolated and referred for sanitary slaughter after the end of quarantine and the boarding of the other animals.

Export to Venezuela

For those intended for export to Venezuela, the quarantine period, also supervised by MAPA, was 24 hours; however, cattle could remain on site for approximately 15 days to complete the lot to be exported. Cattle in this case had to be males, and there were no requirements for age or breed pattern or sanitary protocols because slaughtering was performed shortly after arrival at the destination. Body weights above 400 kg were required. In these operations, chemoprophylaxis for bovine tick fever was performed only in cattle from Santa Vitória do Palmar/RS due to the absence of the tick (*Rhipicephalus microplus)*, which is the only vector of babesiosis and the main vector of anaplasmosis, in that region.

Finishing feedlots

In the finishing feedlots, only cattle aged over 12 months were included. These animals were reared in pastures before arriving at the feedlots. Vaccinations were not required, although owner generally administered preventive vaccinations for clostridiosis and performed endectocidal treatments and preventive chemoprophylaxis for bovine tick fever. The animals remained in the feedlot for approximately 90-120 days.

Statistical analysis

The program OpenEpi was used for all the statistical analyses (Dean et al 2006), and a minimum confidence of 95% was considered ($p<0,05$). Comparisons of the specific mortality rates (%) of the different diseases observed within and between each feedlot system were made using Fisher's exact tests or chi-square tests. Fisher's exact test was performed when there were less than five observations in the contingency table for the test. The mortality rate was calculated considering the number of dead cattle as a result of each disease during each feedlot cycle. The quantification of the risk of occurrence of diseases was performed by calculating the relative risk with a confidence interval of 95%.

RESULTS

Between January 2000 and August 2019, 150 materials were received at the LRD/UFPel for the diagnosis of diseases that affected feedlot cattle, including cadavers for necropsies and refrigerated or formalized organs. Six PEFs located in the municipalities of Capão do Leão, Rio Grande, Turuçu, Cristal and Eldorado do Sul that exported cattle lots to Turkey and/or Venezuela were followed. Out of the 150 materials received, 35 came from 22 feedlots for finishing cattle, and 115 came from the six PEFs.

Diseases diagnosed in PEFs for cattle intended for export to Turkey and in feedlots for finishing are presented in Tables 1 and 2, respectively. In a population of 8,000 at-risk animals in a PEF for export to Venezuela, five animals died of bovine tick fever, and 3 died of trauma. The mortality rates in this case were 0.063% and 0.038%, respectively. The comparison of mortality rates of all the diseases diagnosed in PEFs intended for Turkey and in feedlots for finishing is presented in Table 3. The mortality rate was significantly higher ($p<0.05$) in feedlots for finishing than in feedlots for export.

The number of cattle that died by acidosis was 105. Deaths occurred in both PEF and finishing feedlot. This disease presented the highest mortality rates both in feedlots for finishing (3.33%) and in PEFs for export to Turkey (0.95%). Acidosis occurred in two PEFs and in a feedlot for finishing. In one PEF, cattle were fed concentrate in a quantity equivalent to 3% of their body weight to increase bulk. In the other, the cattle received a commercial mixture of oatmeal with concentrate. In the finishing feedlot, cattle received corn silage and concentrate, and there was no prior adaptation of the animals to the food. In these cases, anorexia, dehydration, ruminal atony and recumbency were observed. The necropsies showed that the ruminal content was liquified, yellow-green in color and acidic. Histologically, the rumen showed increased papillae and the vacuolization of epithelial cells, forming vesicles. There was also multifocal neutrophil infiltrate in the mucosa and rumen submucosa, forming small pustules.

Bloat caused the death of 92 animals in 2 PEFs and in a feedlot for finishing (Tables 1 and 2). In a PEF, the diet contained concentrate (30%) and corn silage (70%), and a consumption rate of 0.5% of the body weight of the animals was calculated. There was gradual adaptation of the cattle to the food until a proportion of 50% concentrate with consumption of 2% to 2.2% of their body weight was achieved. The outbreak in this case occurred in cattle that arrived at the feedlot after the beginning of adaptation and, therefore, did not participate in the adaptation process. In another PEF, cattle were maintained for a period without a diet of concentrate plus oats. The manufacturer indicated that diet should be provided daily *ad libitum* in covered troughs. The feed was removed after consumption and administered again at variable intervals up to 10 hours later due to the absence of coverage in the troughs. In an single feedlot for finishing, the protocol indicated by the manufacturer was followed. This protocol consisted of feeding the animals the diet in the trough alternated with feeding in the pasture, which was gradually decreased until only concentrated feed was administered on the basis of 2% of their body weight. In one outbreak, there was no history of adaptation of cattle to food or the composition of the diet.

In cases of bloat, clinical signs were characterized by marked rumen distension, respiratory difficulty, salivation and protrusion of the tongue. During the necropsies, ruminal dilation, tongue and rectum protrusion and the presence of foam mixed with ruminal content were observed. In the cadavers, congestion of the musculature and organs in the thoracic cavity and pallor of the tissues in the caudal portion was also observed. This difference was eventually observed in a marked line in the caudal third of the esophagus, called the bloat line.

Bovine tick fever was diagnosed on 58 occasions in four PEFs and in four feedlots for finishing, and the disease manifested in both isolated cases and outbreaks. Table 4 shows cases of bovine tick fever according to the etiological agent. Five outbreaks of bovine tick fever diagnosed in feedlots for finishing occurred, with mortality reaching 2.5% in feedlots that did not administer chemoprophylaxis for the disease. In a PEF in which two export operations to Venezuela took place, cattle from Santa Vitória do Palmar did not get sick. In PEFs in which all animals were submitted to chemoprophylaxis for bovine tick fever, the mortality rate was 0.1%.

Anaplasmosis was clinically characterized by jaundice or anemia and fever. In cases of cerebral babesiosis, incoordination and eventual aggression were observed. The necropsies revealed that the liver was yellowish and enlarged, and the biliary vesicle was distended with lumpy contents. Splenomegaly with protrusion of red pulp was observed, and the kidneys appeared dark. In cases of cerebral babesiosis, the cerebral cortex presented cherry-red coloration. In two cases of cerebral babesiosis, no clinical signs were observed. The diagnosis confirmation was made by observation of Giemsa-stained organ smears in which f parasitic structures within the red blood cells compatible with *Anaplasma marginale*, *Babesia bigemina* and/or *Babesia bovis* were identified.

Pneumonias occurred in three PEFs and in two feedlots for finishing, affecting a total of 40 cattle, all under 18 months of age. In PEFs for export to Turkey, a vaccination against the respiratory diseases IBR, BVD, bovine respiratory syncytial virus, bovine parainfluenza, *Pasteurella multocida* and *Mannheimia haemolytica* from different manufacturers was administered at the time of entry of the animals into the feedlot.

Cattle diagnosed with respiratory diseases presented dyspnea, sialorrhea and, eventually, uni- or bilateral purulent nasal discharge. Gross lesions ranged from mild anteroventral consolidation accompanied by edema and pulmonary emphysema to irregular areas of atelectasis with pulmonary hepatization and fibrin deposition, according to the gravity of the case. Histologically, edema, congestion and hemorrhage, inflammatory infiltrate of mononuclear cells, necrosis of alveolar walls and syncytial cells that sometimes presented necrosis were observed. There were also mixed inflammatory infiltrates in the bronchi, bronchioli and alveoli as well as hyperplasia due to type II pneumocytes and marked edema in the interlobular septa and alveoli in addition to oat grain cells. There was growth of *Mannheimia haemolytica* in bacterial culture performed from lung samples collected at necropsy in two cases and *Pasteurella multocida* in three cases.

Cases of bovine tick fever, pneumonia and bloat also occurred without obvious clinical signs.

Thirty cases of *Senecio* spp. poisoning were diagnosed, two of which occurred in animals less than 18 months old who were confined to two PEFs. The other 28 cases occurred in five different feedlots for finishing, and the animals were over 18 months of age. The clinical signs included progressive weight loss and diarrhea. The liver was firm, whitish, with nodules on the surface. There was also edema of the vesicle wall, ascites and edema in the mucosa of the abomasum. Histologically, fibrosis, megalocytosis and proliferation of the bile ducts was observed.

The other diseases occurred sporadically, with low mortality (Tables 1 and 2).

DISCUSSION

The results of the present study showed that cattle mortality was significantly higher in feedlots for finishing than in PEFs for the export of live cattle. Cattle destined for export receive greater care in feedlots due to the requirements of the importing countries; this care does not occur in animals in feedlots for finishing. Other factors, such as cattle age and time of stay in the feedlot, could also influence the mortality of animals on these farms.

In the present study, the diagnosis of diseases that caused mortality in feedlots in the southern region of Rio Grande do Sul was performed with relative ease. Although many clinical signs of diagnosed diseases are nonspecific, diagnosis was possible by examining macroscopic and histological lesions to confirm the clinical suspicion of each disease. Death without obvious clinical signs in cases of ruminal bloat, pneumonia and cerebral babesiosis in confined cattle described in this study has also been reported by other authors (Glock & DeGroot, 1998). Cerebral babesiosis is described as one of the leading causes of death without obvious clinical signs in cattle in the region (Estima-Silva et al. 2016).

Diseases of the digestive system, mainly acidosis, caused the highest mortality in feedlot cattle in the southern region of Rio Grande do Sul between 2000 and 2019. This is not surprising since when cattle reach the feedlot, regardless of the system, they start ingesting carbohydrate-rich rations, often without prior adaptation or with insufficient adaptation. In the present study, it was observed that all cases of acidosis occurred in export and termination feedlots, in which cattle were not adapted to the new feed or the adaptation was inadequate or late. Cattle fed excessive amounts of highly fermentable carbohydrates associated with inadequate amounts of fiber can lead to ruminal acidosis (Valente et al. 2017). A gradual adaptation to this type of food can be effective in preventing the condition (Snyder & Credille, 2017).

Additionally, with regard to diseases affecting the digestive system, bloat is as an important disease in feedlots, regardless of their purpose for finishing or export. This disease occurs in cattle fed diets rich in grains

and is related to factors such as the physical form of the diet and changes in the populations of ruminal bacteria and protozoa and their fermentation products (Meyer & Bryant 2017). In an outbreak described in this paper, the lack of adaptation to food was identified as a cause of the outbreak. In another outbreak, the cattle were fasted for up to 10 hours, which predisposes them to the occurrence of bloat due to the eagerness with which animals begin to feed when they have access to food again. This has been described by other authors who noted that hunger led to the ingestion of excessive amounts of food after a period of fasting (Abdisa 2018). The individual case observed in a feedlot for finishing demonstrated that previous adaptation is effective in avoiding the disease, since in this feedlot, the animals were adapted, and only one case occurred, probably due to individual susceptibility of the animal.

Another disease of importance in the feedlots in the region during the study period was bovine tick fever. There was no significant difference between the occurrence of anaplasmosis and babesiosis in both types of feedlots. In an epidemiological study on bovine tick fever in the southern region of the state, approximately 60% of the diagnosed cases were babesiosis (Almeida et al. 2006). In feedlots in general, there is no favorable environment for the tick to complete its cycle; therefore, in the case of babesiosis, which is transmitted exclusively by this ectoparasite, cattle probably entered in feedlot during the incubation period of the disease. On the other hand, babesiosis can occur be due to imbalance between the inoculum and the immune state of the animal that may decrease due to stress. This fact would explain the occurrence of the disease throughout the feedlot stay (Gonçalves 2000). Another important fact is that most animals reared in feedlots for finishing or export are less than 24 months old and are therefore included in the age group most susceptible to bovine tick fever in the southern region of the Rio Grande do Sul (Almeida et al. 2006). In addition, European breed of cattle, which are most susceptible to bovine tick fever, are in demand for export feedlots and are predominant in feedlots for finishing in certain regions.

Cattle tick fever prophylaxis was efficient in preventing the occurrence of the disease in feedlots in this study. It has been shown that animals receiving chemoprophylaxis are nine times less likely to die as a result of this disease than those who don't receive chemoporphylaxis. In addition, it should be noted that PEF cattle from Santa Vitória do Palmar that were treated did not get sick. This region of RS, which is located south of parallel 32, is free from the vector ticks and therefore cattle are more susceptible to bovine tick fever (Almeida et al. 2006). This suggests that the use of anaplasmicides and babesicides can be used to control these diseases in feedlot cattle. It has been shown that in addition to preventing the disease, these drugs also increase weight gain (Silva et al. 2015).

Pneumonia was also a significant cause of death among feedlot cattle, especially in those in finishing feedlots. Respiratory disorders have been identified as the leading causes of death in cattle in Brazil (Malafaia et al. 2016) and in other countries (Avra et al. 2017). All cases of pneumonia occurred in cattle under 18 months of age. The age of cattle is a risk factor for the occurrence of pneumonia (Avra et al. 2017). The disease was the leading cause of death in calves under one year in a retrospective study of mortality in young animals conducted in the area of influence of the LRD/UFPel (Assis-Brasil et al. 2013). The results of this study showed that unvaccinated finishing feedlot cattle were approximately 12 times more likely to die than vaccinated cattle. In PEFs for export to Turkey, cattle were vaccinated against respiratory diseases, and mortality was significantly lower than mortality due to these diseases in finishing cattle. This indicates that the practice is effective in preventing deaths from this disease. Other studies have reported that the vaccine is effective, especially if administered before the animals enter the feedlot (Magalhães, 2017). Another fact that should be mentioned is that even with epidemiological conditions favorable for the occurrence of disease in PEFs, such as age and stress, mortality due to this disease was lower in these feedlots, which also reinforces the idea that vaccination is effective in the control of this disease.

Senecio spp. poisoning was the second cause of death in feedlots for finishing. Intoxication by this species is one of the most important causes of death in cattle reared in the field in the southern region of Rio Grande do Sul and mainly affects animals older than 18 months (Grecco et al. 2010, Panziera et al. 2018). In the feedlots for finishing, cattle were older than 18 months and came from this region; thus, cases of intoxication were expected. It should be noted that this is not a disease that occurs as a result of the feedlot itself or its management. The acquisition of cattle for feedlots from areas where there is no *Senecio* spp. or where the plant is controlled is the only way to prevent deaths from intoxication during the feedlot period. In PEFs exporting to Turkey, the chances of intoxication are substantially decreased. This is probably because the cattle in these feedlots are usually newly weaned calves that go straight to the feedlot without sufficient contact with the plant.

Other diseases that caused deaths in feedlot cattle include abomasum ulcer, which has been previously reported as a disease that generates economic losses in feedlots. This disease has a multifactorial etiology, including stress and changes in feeding characteristics (Marshall 2009), factors observed in the studied feedlots. However, in the feedlots in this study, mortality from this disease was low. Starvation and trauma also had little importance as a cause of death. In general, starvation occurs due to a lack of adaptation to the feed due to temperament, which prevents it from feeding from the trough (Macitelli et al 2018). Trauma occurs due to sodomy and is very frequent when intact male cattle are kept in agglomerations (Mascitelli et al 2018), which was observed in this study. Rabies was diagnosed in a bovine in a feedlot for finishing; it was likely that the affected bovine was already in the incubation period of the disease when it reached the feedlot. Attention should be drawn to the

possibility of outbreaks when the disease is diagnosed in places near confinement areas where there is crowding of animals, which is a risk factor for the spread of the disease. Other diseases, such as pericarditis, peritonitis, meningitis, listeriosis, tetanus and coenurosis, occurred sporadically and did not greatly affect the mortality rate.

In the present study, it was possible to demonstrate the main diseases that occur in cattle feedlots for finishing or for the export of live animals in the southern region of Rio Grande do Sul. These diseases are known in other systems of cattle breeding and can be prevented or controlled through management, chemoprophylaxis or vaccination, minimizing losses due to mortality.

CONCLUSIONS

Based on the results obtained, it can be concluded that:

- Cattle mortality is significantly higher in feedlots for finishing than for export in the southern region of Rio Grande do Sul.
- Ruminal acidosis, bloat, pneumonia and bovine tick fever were the main causes of death in cattle feedlot both for export and finishing in the southern region of Rio Grande do Sul.
- The gradual introduction of high fermentable carbohydrate-rich diet to feedlot cattle, in general, is efficient to prevent deaths from acidosis and bloat.
- Cattle over 18 months old, when originating from Senecio spp. areas can enter feedlots already intoxicated by the plant.
- Chemoprophylaxis for bovine tick fever proved to be efficient for the control of outbreaks of the disease in feedlots.

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Table 1. Diseases diagnosed in beef cattle kept in feedlot for export to Turkey, population at risk and specific mortality rate in the southern region of Rio Grande do Sul, between January 2000 and August 2019.

Diagnosis	No of death	Population at risk	Mortality rate (%)[1]
Acidosis	95	10000	0,95a
Bloat	70	36000	0,19b
Cattle tick fever	30	24000	0,13c
Pneumonia	27	30000	0,09c
Starvation	4	16000	0,03d
Trauma	3	16000	0,02d
Abomasum ulcer	3	16000	0,02d
Senecio spp. poisoning	2	16000	0,01d
Pericarditis	2	16000	0,01d
Peritonitis	2	16000	0,01d
Keratoconjunctivitis	1	8000	0,01d
Coenurosis	1	8000	0,01d
Meningitis	1	8000	0,01d

[1] Different letters in the column indicate statistical difference (p <0.05) by the chi-square test.

Table 2. Diseases diagnosed in beef cattle kept in feedlot to finishing, population at risk and specific mortality rate in the southern region of Rio Grande do Sul, between January 2000 and August 2019.

Diagnosis	No of deaths	Population at risk	Mortality rate (%)[1]
Acidosis	10	300	3,33a
Senecio spp. poisoning	28	1170	2,39ab
Pneumonia	13	870	1,49bc
Bloat	22	1600	1,38c
Cattle tick fever	23	2000	1,15c
Abomasum ulcer	1	348	0,29cd
Tetanus	5	2500	0,20d
Rabies	1	1200	0,08d

[1] Different letters in the column indicate statistical difference (p <0.05) by the chi-square test.

Table 3. Mortality rate comparison and disease risk quantification between finishing feedlot and PEF Turkey.

Diagnosis	Finishing[1]	PEF Turkey[1]	RR[2]	CI 95%[3]
Acidosis	3,33a	0,95b	3,51	1,85 – 6,66
Senecio spp. poisoning	2,39a	0,01b	191,50	45,67 – 802,60
Pneumonia	1,49a	0,09b	11,95	6,26 – 22,84
Bloat	1,38a	0,19b	7,07	4,39 – 11,39
Cattle tick fever	1,15a	0,13b	9,20	5,36 – 15,81
Abomasum ulcer	0,29a	0,02b	15,33	1,60 – 146,90
All diseases	1,00a	0,12b	8,69	7,01- 10,770

[1]Different letters on the line indicate statistical difference (p <0.05) by the chi-square test.;
[2]RR = relative risk; [3]CI= 95% confidence interval

Table 4. Number of cases of cattle tick fever according to etiological agent in beef cattle feedlot in the southern region of Rio Grande do Sul, between January 2000 and August 2019.

Etiological agent	No of deaths	Population at risk	Mortality rate[1]
Anaplasma marginale	20	34000	0,06a
Babesia bovis	13	34000	0,04ab
Mixed infection	6	34000	0,02b
Babesia bigemina	5	34000	0,02b

[1]Different letters on the column indicate statistical difference ($p < 0.05$) by the chi-square test

2.2 Artigo 2

Causes of death in feedlot beef cattle and their control: a brief review

Pablo Estima-Silva; Haide Valeska Scheid; Ana Lucia Schild

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Causes of death in feedlot beef cattle and their control: a brief review[1]

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ABSTRACT. - Estima-Silva P., Scheid H.V. & Schild A.L. 2020. [**Causes of death in feedlot beef cattle and their control: a brief review.**] *Pesquisa Veterinária Brasileira* 00(0):00-00. Laboratório Regional de Diagnóstico, Faculdade de Veterinária, Universidade Federal de Pelotas, Campus Universitário s/n, Pelotas, RS 96010-900, Brazil. E-mail: alschild@terra.com.br

This review reports the leading causes of death in feedlot beef cattle. It describes economic losses resulting from these deaths and suggests control alternatives. Diseases associated with the respiratory and digestive systems were the most frequently observed. In different geographical areas, the importance of each one might vary. Outbreaks of diseases such as botulism occur occasionally and can cause important economic losses. Cattle tick fever can cause significant losses in zones of enzootic tick instability. Technical assistance sound sanitary and food management are critical for the best productivity in feedlot cattle.

INDEX TERMS: Feedlot, cattle, morbidity, mortality, pneumonia, acidosis, bloat.

RESUMO.- [**Causas de morte em bovinos de corte confinados e seu controle: uma breve revisão.**] Esta revisão discute as principais causas de morte em bovinos de corte em confinamento. Descreve as perdas econômicas resultantes dessas mortes e sugere alternativas de controle. As doenças associadas aos sistemas respiratório e digestivo foram as mais frequentemente observadas. Em diferentes áreas geográficas, a importância de cada uma pode variar. Surtos de doenças como o botulismo ocorrem ocasionalmente e podem causar importantes perdas econômicas. A tristeza parasitária bovina pode causar perdas significativas em zonas de instabilidade enzoótica do carrapato. A assistência técnica e um bom gerenciamento sanitário e alimentar são essenciais para a melhor produtividade em bovinos de corte confinados.

TERMOS DE INDEXAÇÃO: Confinamento, bovinos, morbidade, mortalidade, pneumonia, acidose, timpanismo.

INTRODUCTION

A feedlot is a system for raising a significant number of cattle with high-cost control in restricted areas, feeding them with commercial rations or rations produced in the premises (Barbiere et al. 2016). The main objective of the feedlot is to obtain finished cattle for slaughter throughout the year, including those periods of forage scarcity, and depending to a minimum on pastures and favorable climatic conditions. Besides, feedlots are used for stock and quarantine beef cattle before the export of livestock (Bailone 2019), and for raise and hold breeding bulls (Malafaia et al. 2016).

The first feedlot on record dates from 1876 in the United States, when a large number of cattle were fed simultaneously on grain in a crop farm close to slaughterhouses. Thee feedlot practice was then an alternative to extensive livestock farming, which would be too distant from slaughterhouses and, thus, too expensive (Hubbs 2010). Subsequently, in the 1950s and 1960s, feedlots emerged as a result of new technologies and improved grain production with more productive crops (Hubbs 2010). Currently, most of the finishing of cattle for slaughter in the United States occurs in feedlots (Edwards 2010) since farmers raise more than 75% of calves for meat production in this system (Grandin 2016). In Australia, the feedlot industry started in the 1960s and has kept on expanding until today, having increased from 750,000 feedlots (comprising 3.4% of the country's total cattle herd) in the 1990s to 2.8 million (12%) in 2015 (Mayberry et al. 2019).

In Brazil, the first known beef cattle feedlot to exist was created in 1961 in the city of Ourinhos, state of São Paulo, as an alternative for finishing cattle during the dry season (USP-ESALQ 2019). Since the 1970s, there has been an exponential increase in the Brazilian bovine population. In the same period, there was also an expansion of agricultural areas facilitated by new technologies that allowed plowing and sowing of large plots of land in a short period. This took over extensive areas for crops leaving increasingly lesser space for livestock. The search for an alternative resulted win a steep increase in the number of cattle raised in the feedlot system (Rezende, 2010), and since 1980, feedlots became a real alternative to cattle raising (Malafaia et al. 2016). In 2018, 12.6% of the 44.23 million cattle officially slaughtered across the country were finished at feedlots (ABIEC 2019).

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Traditionally, in the State of Rio Grande do Sul (RS), in the southern region of Brazil, cattle ranching has always been associated with large extensions of land. Cattle were raised grazing on native or cultivated pastures or rice or soybean crop leftovers. However, in recent years, the number of feedlots with different purposes has increased in the region (Estima-Silva et al. 2020).

With the advancement of feedlot systems in the world, cattle diseases became an increasing concern for producers and veterinarians. A review (Kelly & Janzen 1986) on diseases of feedlot cattle has shown that cattle morbidity in these systems can reach 69%, ranging from 15-45%. Regarding mortality, the rate reached up to 15%, with most reports mentioning 1-5% mortality. The same authors observed that the peak of disease occurred in the first three weeks of admission to the feedlots, and the leading conditions were those affecting the respiratory system (Kelly & Janzen 1986). In Brazil, in a feedlot in the Southeast region, morbidity rates of 7.05% and mortality of 0.64% have been reported (Baptista et al. 2017). In Minas Gerais, the morbidity of 7.76% and mortality of 1.5% were observed (Martins 2016). In the southern region of RS, mortality rates of 0.11% and 1.33% were found in feedlots for the export of live animals and for finishing cattle, respectively (Estima-Silva et al. 2020).

This paper aimed to review the leading causes of death of feedlot beef cattle. It was also our intention to demonstrate the economic impact that they cause in the livestock industry and how to assist veterinary practitioners and farmers, offering solutions to reduce financial losses in their farming systems.

Potential causes of mortality in feedlot beef cattle

Feedlot cattle are more susceptible to infections respiratory diseases such as pneumonia and non-communicable diseases of the alimentary tract such as lactic acidosis and bloat (Smith 1998, Borges & Afonso 2007). There are reports of occasional outbreaks of other conditions affecting cattle in feedlots with significant losses, such as botulism in RS (Maboni et al. 2010) and the Midwest (Soares et al. 2018, Guizelini et al. 2019) regions and tick fever in RS (Estima-Silva et al. 2020).

Pneumonias

Respiratory diseases (Fig.1) are the leading morbid conditions in feedlot cattle in the United States (Sanderson et al. 2008, Edwards 2010, Wilson et al. 2017), Australia (Cusack 2004), Canada (Church & Radostits 1981, Smith 1998), and Brazil (Malafaia et al. 2016, Baptista et al. 2017). These diseases impact the meat industry, with direct losses due to deaths, treatment, and human resources and indirect losses associated with low animal development, increased permanence of cattle in the feedlot, and lower carcass yield (Smith 1998, Wilson et al. 2017). Despite advances in management and new treatment protocols and vaccines, the cumulative incidence of bovine respiratory disease (BRD) in feedlot cattle has not decreased over the past 30-40 years (Edwards 2010).

The causes of BRD are complex and associated with several viruses, namely bovine respiratory syncytial virus (BRSV), bovine herpesvirus-1 (IBR), bovine viral diarrhea virus (BVDV) and parainfluenza virus type 3 (PIV-3). Such viruses establish a favorable environment for the colonization and replication of pathogenic bacteria such as *Pasteurella multocida*, *Mannheimia haemolytica*, *Streptococcus pneumoniae*, *Mycoplasma bovis*, and *Histophilus somni*, resulting in pneumonia (Urban-Chmiel & Grooms 2012). These diseases represent 45% of the causes of death in feedlot cattle in the United States (Edwards 2010, Cernicchiaro et a.l. 2012, Avra et al. 2017) and approximately 75% of the total morbidity (Edwards 2010). In Australia, the mortality rate reaches 50% (Hay et al. 2016). In one study the Midwest region of Brazil (Malafaia et al. 2016), 45% of the diagnoses of diseases in feedlot cattle were BRD, and in one feedlot in the Southeast (Baptista et al. 2017), 87% of the total diagnoses were pneumonia and mortality from this disease was 20%. In the Southern region of RS, over 20 years, BRD represented 11% of all illnesses that causing death in cattle from several different feedlot systems (Estima-Silva et al. 2020).

The economic impact of pneumonia on feedlot cattle

Costs associated with respiratory diseases in feedlot beef cattle in the United States is estimated at 4 billion dollars a year, including, in addition to deaths, costs of treatment, prevention, and loss of productivity (Cernicchiaro et al. 2012). In the USA, in a study on treatment failure of these diseases (Avra et al. 2017), the authors describe an increase of approximately 85% in treatment costs over 12 years, that is, it was US $ 12.59 per bovine in 1999 and $ US 23.60 in 2011. In a study carried out in Brazil (Malafaia et al. 2016), the economic impact with treatment for BRD was, on average, $ US 21.70 per cattle with losses on average of 13.4 kg body weight per animal. In another study in cattle feedlots in the Southeast region of Brazil (Baptista et al. 2017), treatment costs were US $ 26.62 per animal and losses due to mortality were US $ 682.40 per animal; the calculation included the treatment, and the human resources cost added to the value of the animal. The relevance of respiratory diseases and their economic impact on the management of feedlot cattle has led to the development of programs seeking to minimize the costs in these types of cattle raising systems (Edwards 2010).

Control alternatives for pneumonia in feedlot cattle

The first 45 days of arrival at the feedlot are critical to the occurrence of BRD since this is a period of stress caused by weaning, the shipment of cattle to the feedlot, nutritional changes, and handling of animals shortly after arrival (Smith 1998, Edwards 2010). To reduce the losses, the administration of antibiotics to cattle on arrival at feedlots (metaphylaxis) have been advised, regardless of whether these animals show any clinical signs of illness

(Catry et al. 2008, Edwards 2010, Nickell & White 2010, Rezende 2010). This way of preventing pneumonia in feedlot cattle is deemed efficient considering the drop in rates of morbidity and mortality due to BRD and the increase in weight gain of treated animals, which makes the practice economically viable (Catry et al. 2008, Edwards 2010, Nickell & White 2010, Rezende 2010). The use of a metaphylaxis program shortly after the arrival of cattle to the feedlot reduced the occurrence of BRD by 50% and the mortality from this disease by 25% (Urban – Chmiel & Grooms 2012). Rezende (2010), in an experiment performed in feedlots in the Midwest region of Brazil, observed that a single application of florfenicol to a group of cattle at their entrance to the feedlot was effective in reducing BRD morbidity by 54%. Also, an increase in weight gain occurred, indicating this treatment as economically viable when BRD morbidity rates are higher than 2.7%. However, the use of antibiotics is not free of secondary problems. Antibiotic residues in the meat and inducement of resistance to the active ingredient are threats that linger on (Moreno & Lanusse 2017).

Vaccines can be used to minimize the occurrence of BRD in feedlot cattle. Currently, vaccines against the different viral and bacterial agents involved in BRD are widely available in Brazil. Proper use of these vaccines reduces the risk of disease (Urban-Chmiel & Grooms 2012). In a study on BRD mortality in feedlot cattle, those who were not vaccinated were 11.95 times more likely to die from BRD than those who were (Estima-Silva et al. 2020). Mortality was significantly higher in non-vaccinated finishing feedlot cattle in comparison to in younger, more susceptible animals vaccinated at arrival at the feedlot (Estima-Silva et al. 2020). However, the stress experienced by cattle during the first days at the feedlot can compromise the efficiency of the immune response to the vaccine (Urban-Chmiel & Grooms 2012, Edwards 2010). Two vaccinations performed 60 and 30 days before the entrance to the feedlot is more efficient than a single dose vaccination on arrival at the feedlot. In the latter case, cattle were 2.5 times more likely to die from BRD than those of animals on the arrival at the feedlot or 14 days after the entry did not significantly influence the occurrence of the disease (Richeson et al. 2008). In general, vaccine protocols show controversial results concerning BRD morbidity and mortality in confined cattle (Edwards 2010).

The increase in the efficiency of the BRD vaccine has been evident when it is performed during pre-conditioning programs. This pre-conditioning consists in performing surgical procedures, such as dehorning and castration, treating the animals with anthelmintics, and adapting them to feed in troughs and drinking fountains approximately 30-45 days before entering the feedlot. This is a strategy used in the United States that aims to reduce the stress of cattle due to the sudden change of feed and surgical procedures necessary on arrival at the feedlot. These animals have greater sale values, but, at the end, they are more profitable since the morbidity and mortality due to BRD and other diseases decrease (Urban-Chmiel & Groons 2012).

BRD is a multifactorial disease complex of great importance in feedlot systems in general. Several viral and bacterial agents are involved in the pathogenesis of BRD. Consequently, BRD requires the use of different strategies for its proper control and reduction of economic losses. Several studies report the optimal time for vaccination or the use of metaphylaxis, or even adopting pre-conditioning programs that can make a difference in the morbidity and mortality rates for BRD. This pre-conditioning can also be significant for animal welfare, since the cattle to a new feeding system in the period before confinement, can avoid the stress produced by all these practices on arrival at the feedlot (Mota & Marçal 2019).

Digestive tract disorders

Acidosis is one of the most common gastrointestinal disorders of feedlot cattle since grain feeding became a widespread practice (Nagaraja & Lechtenberg 2007, Snyder & Credille 2017). In Brazilian feedlot cattle, ruminal acidosis is second only to pneumonia as the leading cause of morbidity and mortality (Malafaia et al. 2016). In one study, done in feedlot cattle for finishing or export, acidosis was the leading cause of death, surpassing pneumonia (Estima-Silva et al. 2020).

Ruminal acidosis results from the consumption of high amounts of rapidly fermentable carbohydrates (CH). (Galyean & Rivera 2003, Nagaraja & Lechtenberg 2007). Ruminal bacteria respond to the increased availability of fermentable substrates by increasing growth rates and fermentative activities, that is, the introduction of this highly fermentable CH in the diet leads to a reduction in fibrolytic bacteria, the rapid growth of amylolytic bacteria and a decrease in ruminal pH (Bevans et al. 2005). Although many ruminal bacteria can use starch, the explosive growth of *Streptococcus bovis*, in response to the availability of fermentable CH, is observed only in situations where the ruminant is not adapted to the grain or during the period of intensification of feeding (Nagaraja & Lichtenberg 2007). Acute acidosis (Fig. 2), which causes mortality, is due to excessive CH intake when animals are not adapted to such a diet, when there is a change of diet after fasting or when an already adapted bovine abruptly ingests high amounts of highly fermentable carbohydrate (Borges & Afonso 2007). In acute acidosis lactate and volatile fatty acids accumulate, resulting in an increased osmotically ruminal content. Lactate also causes damage to the epithelial lining of ruminal mucosa. Those changes together lead to extensive extravasation of liquid into the rumen resulting in marked dehydration that may be fatal (Owens et al. 1988). Ruminal acidosis can, therefore, be defined as a ruminal fermentation disorder characterized by below the normal ruminal pH, reflecting an imbalance between microbial production, microbial utilization, and ruminal absorption of volatile fatty acids (Hernández et al. 2014).

Another frequent digestive disorder in intensively bred cattle is frothy bloat (Fig.3) resulting from the fermentation of grain feed, with excessive production of gases, mainly carbon dioxide and methane that mix with the rumen content forming the foam (Meyer & Bryant 2017, Abdisa 2018). Physiologically, these gases are produced by the action of bacteria and rumen protozoa on fermentable foods. The gases are expelled by absorption through the rumen wall, passing to the next stomach compartment or by eructation through the esophagus, which is the main route of expulsion (Meyer & Bryant 2017, Abdisa 2018). The foam pathologically accumulated in bloat is due to a bacterial mucopolysaccharide that originates in the bacterial wall or in its cytoplasm. The increased production of this mucopolysaccharide, due to the increase in ruminal bacteria, turns the ruminal fluid thick and viscous, making it difficult to separate it from the gas in the rumen content resulting in foam (Borges & Afonso 2007).

Reports on morbidity and mortality rates of digestive disorders in feedlots cattle are variable. In the USA, it is estimated that approximately 4.4% of feedlot cattle are diagnosed with digestive disorders (USDA 2011). The same report states that 14-42% of deaths in feedlot cattle are due to these problems, making digestive disorders (Smith 1998, Nagaraja & Lechtenberg 2007, Snyder & Credille 2017, which would make these disorders the second most important cause of mortality in feedlot cattle. Others report mortality rates from digestive disorders as 19.5%-28.4% of all diseases diagnosed in American feedlot cattle (Meyer & Bryant 2017). These latter authors found 96.3% of cases of bloat and 3.7% of cases of ruminal acidosis.

In Brazil, rates of 31%-32.7% were found among all observed diseases in feedlot finishing cattle and breeding bulls (Malafaia et al. 2016). In the South of Rio Grande do Sul, digestive diseases represented 57.3% among all diseases that caused the death of cattle in different feedlot systems over 20 years. Of those deaths, 52.2% resulted from acidosis and 45.8% from bloat (Estima-Silva et al. 2020).

Control alternatives to digestive disorders

The acute course of digestive disorders is challenging to timely diagnosis and treatment (Meyer & Bryant 2017). Ruminal acidosis and bloat are complex and overlapping disorders, which makes it virtually impossible to establish a single management practice in their control (Cheng et al. 1998, Meyer & Bryant 2017). The control of acidosis clearly depends on proper nutritional management and adaptation of animals to a high CH diet; the disorder can, however, occur even when cattle are gradually adapted to a grain diet (Bevans et al. 2005). The adaptation consists of decreasing the concentration of roughage and gradually increasing the concentrate in the diet. To carry out the adjustment, the history of the animals, whenever available, should be considered. Cattle previously raised on pasture with no exposure to concentrated feed are more susceptible to changes in ruminal pH and, therefore, more vulnerable to acidosis and bloat. Adaptation to the concentrate should last a minimum of 3-4 weeks; s cattle adapted for shorter periods remain more susceptible to digestive disorders (Nagaraja & Lechtenberg 2007, Hernández et al. 2014, Meyer & Bryant 2017).

Basically, the percentage of fiber in the feed at the beginning of the adaptation is 45% to 55% (Meyer & Bryant 2017). Studies have shown that the provision of highly concentrated diets *ad libitum* during the first weeks of adaptation results in a drastic reduction in food intake (Schwartzkopf-Genswein et al. 2003, Brown et al. 2006, Meyer & Bryant 2017). A comparative study between rapid versus gradual adaptation of feedlot heifers to a diet that increased from 40% to 90% in concentrate is reported (Bevans et al. 2005). In both types of adaptation, concentration went from 40% to 905% of dry matter. In fast adaptation, the percentage of concentrate went from 40 to 90% in 3 days with an intermediate phase of 65% of concentrate for three days. In the gradual transition, the concentrate levels increased by 48.3%, 56.7%, 65.0%, 73.3%, and 81.7% every five days until reaching 90%. The authors concluded that the majority of heifers were able to adapt quickly, requiring few steps of gradual increase in the diet. However, ideal adaptation should favor those most vulnerable individuals to prevent outbreaks.

The association of concentrate with roughage is therefore essential to avoid morbidity from digestive diseases in feedlot cattle since fiber is necessary to stimulate ruminal movements and promote saliva production. Roughage dietetic levels decreased over the past few years due to the difficulty in storage, handling, and mixing with the concentrate. Currently, roughage corresponds to a maximum of 8% of dry matter, less than that 10%-15 % used 20 years ago (Nagaraja & Lechtenberg 2007). In many cases, despite the use of roughage associated with the concentrate, digestive disorders are still a significant cause of death in feedlots operations in RS (Estima-Silva et al. 2020).in feedlots operations in RS (Estima-Silva et al. 2020).

The strategy to decrease the morbidity rates of bloat in feedlot operations includes, besides the association of concentrate with roughage, the choice of the cereal to be fed. Wheat has a higher fermentation rate than corn, sorghum, and barley; thus, bloat tends to be more frequent in feedlot cattle fed wheat-based diets (Cheng et al. 1998).

The processing of cereal entering the diet of feedlot cattle also plays a part in the occurrence of both acidosis and bloat. The more finely ground the starch, the more facilitate its digestion by microbial enzymes, leading o accelerated production of organic acids and mucopolysaccharides, consequently lowering the pH and increased viscosity of rumen content (Cheng et al. 1998, Meyer & Bryant 2017).

There is a parameter called “stool score”, which consists of evaluating the stool on a scale of 1-5. Score 1 represents diarrheic stools indicating excess protein or starch; score 5 indicates dry stools denoting inadequate

digestion of forage by ruminal microrganisms and scarcity of degradable protein in the diet (Fig. 4). This parameter aids in assessing the balance of concentrate and roughage administered to cattle maintaining the weight gain and minimizing the occurrence of digestive disorders. The ideal score is 3 (Schwartzkopf-Genswein et al. 2003, Ferreira et al. 2013, Meyer & Bryant 2017).

Trough management asseses the consumption of an ideal amount of the diet administered to animals (Schwartzkopf-Genswein et al. 2003, Meyer & Bryant 2017). This practice takes it account the daily leftover of feed in the troughs daily, observed at the same period of the day, namely Feedbunk Scoring System (Table 1). Scores correspond to 0, for a clean trough and 4 for an intact trough. Score 1 denotes the ideal diet that will avoid acidosis and maintain weight gain (Meyer & Bryant 2017).

Another popular practice of controlling digestive disorders in feedlot cattle is the use of food additives such as ionophores, mainly monensin. Those substances will affect lactic acid-producing gram-negative bacteria are effective in controlling acute acidosis and promoting significant food efficiency (Meyer & Bryant 2017). Ionophores also prevent the occurrence of bloat. Cases of bloat in feedlot cattle were decreased by 64% and 92% respectively by monensin and lasalocid (Bartley et al. 1983).

Other additives have been suggested to prevent digestive diseases in feedlot cattle, such as baking soda, mineral oil, and probiotics whose, but their results are controversial (Meyer & Bryant 2017). Some authors, however, consider these additives to be good tools to control the digestive diseases of feedlot cattle (Hernández et al. 2014, Valente et al. 2017).

Other precautions are suggested to prevent digestive diseases that cause death in feedlot cattle. Weight of livestock entering the feedlot should be uniform as possible to avoid the dominance of larger animals and monitoring animals to observe behavior and early clinical signs that might suggest bloat. When more than 3% of the animals in the flock have ruminal distension, action must be taken immediately to prevent an outbreak of bloat (Hernández et al. 2007).

Other diseases that cause mortality in feedlot cattle

In feedlot beef cattle, conditions such as botulism (Maboni 2010, Soares et al. 2018, Guizelini et al. 2019, Le Maréchal et al. 2019) occasionally cause economic losses in feedlot beef cattle operations. The study of an outbreak of botulism in the Midwest region with morbidity and mortality of 0.4% and a financial loss of more than US $ 13,000.00 is described (Cursi et al. 2013). In another outbreak in the same region (Guizelini et al. 2019), a total of 1090 out of 1700 feedlot steers died due to the ingestion of corn silage contaminated with *Clostridium botulinum* neurotoxin type C (Fig.5). Vaccine can be effective. Still, vaccinating cattle after the outbreak started, it is not the best practice (Cursi et al. 2013).

The elimination of the source of contamination of the botulinic toxin is an adequate measure (Soares et al. 2018). The storage and periodic cleaning of the food and water storage place and troughs minimize the risks of botulism outbreaks and are also part of animal welfare (Mota & Marçal 2019).

Bovine tick fever is observed mainly in feedlot cattle, the southern region of Rio Grande do Sul with mortality of up to 2.5% (Estima-Silva et al. 2020). The disease is especially important in areas of enzootic instability for the tick that results in outbreaks with considerable losses (Farias 2007). Although the feedlot environment is not ideal for the vector, many cattle arrive as during the incubation period of the disease (Estima-Silva et al. 2020). In these cases, chemoprophylaxis with anaplasmicidal and babesicidal drugs should be considered, which, in addition to demonstrating efficiency in controlling the disease (Estima-Silva et al. 2020), increase the weight gain of confined cattle (Silva et al. 2015).

CONCLUSIONS

The primary diseases affecting feedlot cattle are those associated with the respiratory and the digestive systems. Technical assistance and proper sanitary and food management are critical in raising cattle in confinement for meat production, the export of live animals, or breeding. Also, practitioners should consider endemic diseases in each region when facing mortality outbreaks in feedlots.

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Legend for the figures

Fig.1. Thorax cavity from a feedlot steer that died from pneumonia. There are dark areas of consolidation affecting all pulmonary lobes. Adjacent areas show checkers pattern with intercalated dark and pale areas.

Fig.2. Rumen from a feedlot steer that died from acute ruminal lactic acidosis. The ruminal content is abundant, liquid, and yellow-green.

Fig.3. Rumen from a feedlot steer that died from frothy bloat resulting from grain overload. Ruminal content is yellow and frothy.

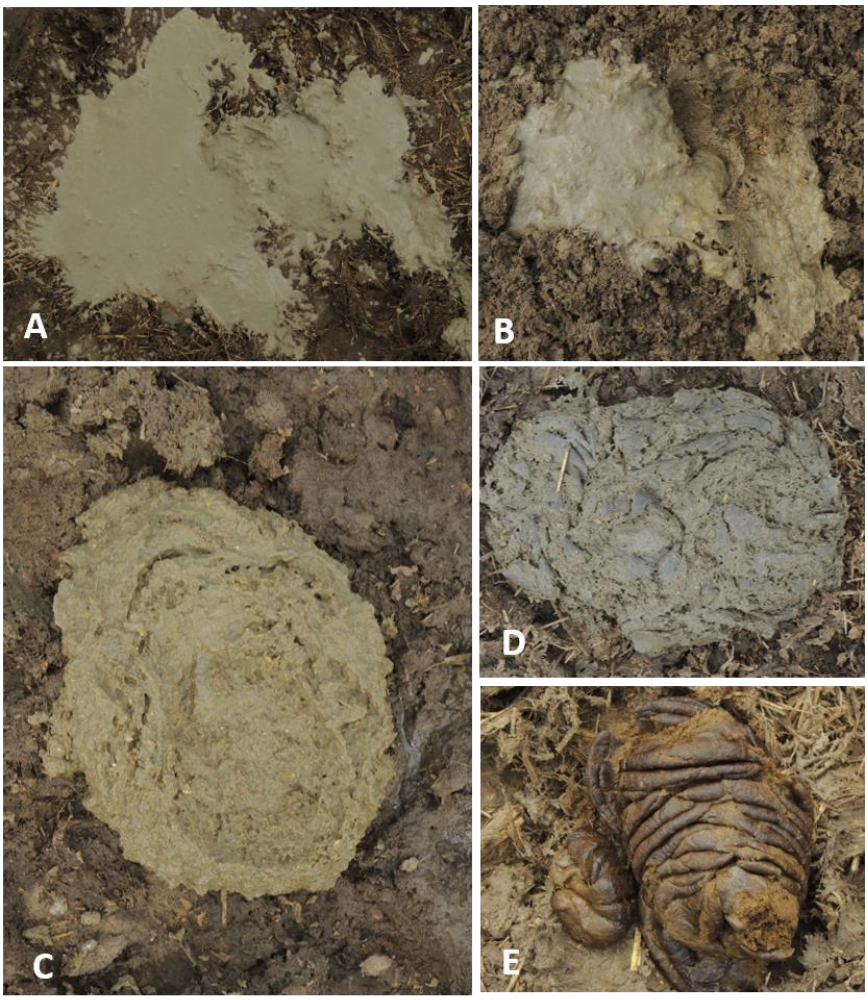

Fig.4 Stool score indicating the balance between concentrate and roughage in the diet of feedlot cattle. The score ranges from 1 (excess protein or starch) to 5 (poor digestion of forage. Score 3 represents the balance in the composition of the diet (Adapted from Vigne et al. 2019) A. Score 1: Liquid stools; diarrheic. B. Score 2: semi-liquid stools. C. Score 3: Pasty stools. D. Score 4: Light and moderately dry stools, with concentric rings and 3-4 cm layers. E. Score 5: Dry and hard stools.

Fig.5 Botulism. Several feedlot steers are affected in a massive outbreak in Mato Grosso do Sul. A total of 1090 out of 1700 feedlot steers died due to the ingestion of corn silage contaminated with *Clostridium botulinum* neurotoxin type C (Courtesy of Dr. Tessie Möck, Ulmer Straße 14 89180 Berghülen, Germany).

Table 1. Feedbunk Scoring System

Score	Description
0	No feed remaining in bunk
0.5	Scattered feed remaining. Most of the bottom of the bunk exposed
1	Thin, uniform layer of feed remaining. About one corn kernel deep
2	25 to 50% of feed remaining
3	More than 50% of feed remaining. Crown is thoroughly disturbed
4	Feed is virtually untouched. Crown of feed still noticeable

Fonte: Pritchard R.H. 1993. Bunk Management. Proceedings. Land O'Lakes. Delivering the Difference Conference. Minnesota, USA

3 Considerações Finais

Os resultados desta tese permitiram demonstrar que as principais enfermidades que ocorrem em bovinos de corte criados em confinamento, na região Sul do Rio Grande do Sul, estão associadas ao sistema digestivo como acidose ruminal e timpanismo espumoso e também ao sistema respiratório como as pneumonias. Estes resultados podem ser comparados aos resultados obtidos por outros autores em outras regiões do Brasil, no entanto observou-se que em diferentes regiões podem ocorrer surtos de doenças, muitas vezes endêmicas e que o conhecimento da prevalência dessas enfermidades é fundamental em cada região específica. Na região do presente estudo observou-se que a tristeza parasitária bovina é importante nos confinamentos tanto quanto em bovinos criados em sistemas extensivos. Surtos pontuais de enfermidade causadas por clostridios podem, também, afetar os confinamentos e causar elevados prejuízos devido a alta morbidade e mortalidade dessas enfermidades. Observou-se, ainda, que a mortalidade é significativamente maior criação de bovinos confinados para abate do que para exportação.

A assistência técnica e um bom manejo sanitário e alimentar podem fazer a diferença na criação de bovinos em confinamento. Além disso, enfermidades endêmicas de cada região devem ser consideradas, também, quando há mortalidade em estabelecimentos que utilizam este tipo de sistema de criação.

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