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BOVINE RESPIRATORY DISEASE COMPLEX (BRDC): A REVIEW OF LUNG LESIONS AND REDUCING OF QUALITY OF CARCASSES

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Review paper

Abstract: Bovine respiratory disease complex (BRDC) is the biggest health problem of the cattle industry globally due to the high prevalence and economic consequences which arise due to numerous reasons. Huge economic losses are most often attributed to high morbidity and mortality, reduction of Average Daily Gain (ADG) and food utilization, weight loss, lower quality of carcasses and comprehensive measures of prophylaxis and therapy. BRDC commonly observed throughout the feedlot phase due to the stress factors. Predisposing factors divided didactic on environmental (inclement weather conditions, inadequate humidity and dust), host factors (age, sex, race, genetics, immune status) and stressful management practices (transportation, nutritional stress, metabolic disease, high density of animals, handling, castration, dehorning). In complex etiopathogenesis, in addition to the aforementioned predisposing factors, numerous viral and bacterial agents are involved. Gross lung lesions are most commonly observed in cattle slaughter or autopsies (visible to the naked eye) occur as a result of pneumonia. It is the result of an infection by the bovine respiratory syncytial virus (BRSV), parainfluenza virus type 3 (PI3V), bovine herpes virus type 1 (BoHV1) and bovine viral diarrhea virus (BVDV) alone or in combination with one another, as well the common bacterial pathogens *Mannheimia haemolytica, Pasteurella multocida, Histophilus somni and Micrococcus spp*. Numerous studies have pointed to the detrimental effects on performance and carcass characteristics.

Key words: Bovine Respiratory Disease Complex (BRDC), cattle, economic loss, lung lesions, carcass quality

Introduction

Bovine respiratory disease complex (BRDC) is among the most prevalent and damaging diseases which adversely affects cattle production globally *(Griffin, 1997; Prado et al., 2006; Kurćubić et al., 2018)*. Total annual costs to beef industry in the U.S. have been calculated to be approximately $4 billion, including animal and production losses, prevention and treatment costs *(Griffin, 1997)*. The annual loss of the US cattle breeding industry is estimated to be $ 1 billion. Cost of prevention and treatment is $ 3 billion a year *(Griffin, 2006, Snowder et al., 2007)*. The average cost of the individual treatment is estimated at $ 15.60. This cost increases to $ 92.30 when account is taken of indirect costs, such as reducing ADG and reduced carcasses value *(Schneider et al., 2009)*. BRDC covers 70 to 80% of total morbidity and 40 to 50% of total mortality in North American feedlots *(Edwards, 1996; USDA, 1999)*. In the European Union, production losses (excluding livestock deaths) are about 576 million euros on an annual basis *(Barrett, 2000)*. An estimated 1.9 million animals *(Nicholas, 2011)* are affected by BRDC each year in the UK cattle industry with costs calculated at around £60 million annually *(NADIS, 2007)*. On slaughter of feedlot cattle is a very common finding of lesions on the lungs, with the prevalence between 29.7 and 77% *(Wittum et al., 1996; Bryant et al., 1999; Thompson et al., 2006)*.

Pathogenesis and etiology of BRDC

The emergence of BRDC is most commonly caused by a primary viral infection. Infection of the respiratory tract of cattle causes pathological changes, which vary depending on the stage of infection. Bovine respiratory syncytial virus (BRSV) gives a major contribution to the emergence of BRDC *(Brodersen, 2010; Raaperi et al., 2012)*. *Kurćubić et al. (2013a)* confirmed above mentioned findings and determined the genome of the BRSV by Real-Time RT-PCR in all 20 examined samples of discharge from the nasal mucosa of the beef cattle diseased of BRDC. Damage to the upper parts of the respiratory tract and the mucocillary cleansing function make it possible that adhesion of bacteria to virus-infected cells is increased, growth and the formation of colonies. Damages extend to the epithelium of the tracheal mucosa, and then the bacteria open the passage to the deeper parts of the respiratory tract. Viruses damage the function of macrophages and neutrophil leukocytes, which depend on the immune functions of the host and the possibility of phagocytosis. In the final stage, viral causative agents also lead to impaired and depressed humoral immune responses with B cell effector and cellular immune response mediated by T cells *(Anderson and Rings, 2008; Rivera-Rivas et al., 2009)*.

Bacterial pneumonia often occurs after a viral infection or along with it. It often has a similar pathogenesis, which involves the formation of colonies in nasopharynx, the inhalation of aerosolized droplets containing pathogenic bacteria, bronchoalveolar colonization, the immune response of the host, and the elimination

of pathogens and impairment of the immune response of the host *(Frank et al., 1996)*. From the majority of the strong lesions observed on lungs when slaughtering cattle, which are characterized as acute fibrinous pleuropneumonia, *M. haemolytica* type 1 are the most commonly isolated agents. The primary isolate in many cases of bronchopneumonia is *P. multocida (Welsh et al., 2006)*. This has been confirmed in five-year study of *Kurćubić et al*. *(2000)*, who examined a total of 1,435 nasal swabs taken from beef cattle with the respiratory symptoms characteristic for BRDC. The most common bacterial isolates were *Pasteurella multocida* and *Pasteurella haemolytica* (62.78 and 40.20%), *Corynebacterium pyogenes* (53.44%), *Staphylococcus albus* (24.87%) and *Streptococcus viridans* (14.07%). *Kurćubić et al. (2013a, 2013b)* have found that the most commonly isolated bacterial pathogens in fattening cattle suffering from BRDC were *P. multocida*, *Aeromonas viridans* and *Corynebacterium bovis*, unlike most of the data from the literature on the highest prevalence of *M. haemolytica*. *M. haemolytica* is associated with numerous virulence factors which inevitably lead to structural changes in the lungs of cattle: leukotoxin, lipopolysaccharide (LPS), capsular components, outer membrane proteins, neuraminidases, and proteases *(Ackermann and Brogden, 2000; Jeyaseelan et al., 2002)*. Lung lesions caused by *M. haemolytica* is cascading, in 4 stages that can not be clearly separated: pre-pneumonia, pulmonary consolidation, localized inflammation and spread, and expansion of pneumonia *(Mosier, 2006)*. In the pre-pneumonic stage, *M. haemolytica* proliferates in the upper part of respiratory tract (initial step of pneumonia), and it appears the colonization of the bronchoalveoloar junction. The bacteria begin to produce the virulence factors in sufficient quantities to induce a localized inflammatory response which causes lobular bronchopneumonia, with firm and dark red lesion („liver-like“). As a result of the extensive damage, the entire affected area of pulmonary parenchyma turns from the normal healthy pink appearance to a dark red with a large amount of atelectasis. Subsequent abscessation may occur. Pleural adhesions may develop due to a formation of large amounts of fibrin and fibrinous fluid *(Mosier, 2006)*. The interlobular septa is inflated by yellow, gellatinous edema and fibrin *(Kurćubić et al., 2014)*. Gross findings include consolidated and/or collapsed lung parenchyma, focal or diffuse pleuritis, fibrinous adhesions, thoracic adhesions, abscesses, fibrosis, emphysema, and hemorrhage and are most frequently observed in the (right) cranial ventral lung lobes *(Bryant et al., 1999)*.

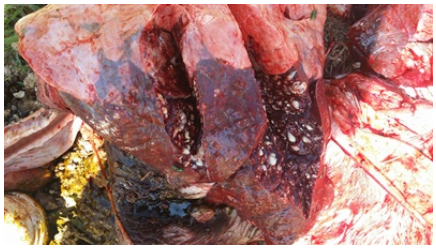

Figure 1. Suppurative bronchopneumonia, right lung, calf. Cranioventral parts are consolidated; bronchi are filled with purulent exudate.

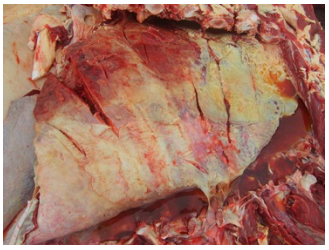

Figure 2. Fibrinous pleuropneumonia, right lung, heifer. The pleura is covered with a tick layer of fibrin.

In confirmation of the above results, Figures 1 and 2 show gross lesions in lungs in calves and heifers died with symptoms of BRDC *(Vasković et al., unpublished data)*. From the lung tissue shown in Figure 1, *Pasteurella multocida* was isolated, and the presence of the BRSV and BVDV genome was detected.

Mannheimia haemolytica was isolated from the lung tissue shown in Figure 2, and the presence of the BVDV genome was demonstrated. Examination was done in laboratories of the Veterinary Specialist Institute „Kraljevo", Serbia *(Vasković et al., unpublished data)*.

The presence of lung lesions did not greatly influence any of the traits considered within the research of *Schneider et al. (2009)*. They found that the greatest loss of production was in cattle that had active bronchial lymph nodes at slaughter. Such a result was somewhat different than other studies on the effects of lung lesions on performance and carcass traits. Utilizing lung lesions at harvest for BRDC diagnosis improves sensitivity and specificity to 77.4 and 89.7%, respectively *(White and Renter, 2009)*. Observation of lungs in cull cows for signs of pulmonary lesions at slaughter may provide useful information for veterinarians and other personnel who control management and health intervention strategies. Pulmonary lesions associated with BRDC were observed in 33.8% of all cattle (n=1461). Mild lesions (≤50% consolidation of any lung lobe) were the most common and were found in 23.5% of examined cattle. The high prevalence of lesions characteristic for BRDC and ruminal acidosis points to their significant levels which exist within the dairy cattle population *(Rezac et al., 2014)*.

Findings of the lesions on the lungs on the line of slaughtering of cattle

Numerous studies have shown the occurrence of lung lesions at slaughter in cattle. Generally, lung lesion prevalence of 72% with a total respiratory morbidity of 35% in a population of 469 steers was reported by *Wittum et al. (1996)*. Furthermore, 68% of the cattle not treated for BRDC during their lifetime displayed lung lesions at slaughter and 72% of those cattle treated for BRDC

during their lifetime displayed pulomonary lesions at slaughter, significantly associated with a 0.076 kg reduction in ADG.

Gardner et al. (1999) performed monitoring at slaughter of genetically similar Charolais steers (n=204) and concluded that 37% of steers never treated for BRDC during the finishing phase had lung lesions. Only 48% of those cattle treated for BRDC during the finishing phase had pulmonary lesions at slaughter. Cattle without pulmonary lesions at slaughter were observed to have an 11% greater ADG than cattle with lung lesions revealed at slaughter. Different influences of pulmonary lesions and BRD treatment were observed on other performance and carcass traits.

Bryant et al. (1999) observed the prevalence of all types of lung lesions from 33 to 77% in three populations (n=599) of commercially fed cattle.

Thompson et al. (2006) estimated the impact of respiratory disease on growth in 2,036 head of South African feedlot cattle from 2 different feedlots, during early and late finishing periods. Pulmonary lesions are noticeable in 38.5% of cattle never treated against BRDC, 55.4% of cattle treated once against BRDC, and 66.7% of cattle treated against BRDC twice or more.

Schneider et al. (2009) processed the data from 5,976 steers and heifers from Southwest Iowa registered in the Tri County Steer Carcass Futurity database to evaluate the associative effects of BRDC on performance and carcass traits. Observation of pulmonary lesions at slaughter was only collected on 1,665 head, of which, 61.9% had lesions present at slaughter. Among the cattle that have never been treated for BRDC, at 60.6% were observed lung lesions at slaughter with the most common score (26.9%) being mild in nature.

Other authors came in their researches to similar results and observations about the association of pulmonary lesions with treatments against BRDC *(Gardner et al., 1999; Thompson et al., 2006)*. A significant decrease in ADG (0.07 ± 0.01 kg), carcass weight (8.16 ± 1.38 kg), and marbling score (0.13 ± 0.04) indicated that it was caused by BRDC, whether cattle were treated against BRDC during a fattening period, or pulmonary lesions were observed in slaughtering cattle. The specific influence of pulmonary lesions at slaughter on carcass quality were not ascertained.

White and Renter (2009) have devised a way of calculating the diagnostic sensitivity and specificity of both customary, clinical scoring and pulmonary lesions at slaughter for diagnosing BRDC in beef cattle. The use of pulmonary lesions at slaughter, improved sensitivity to 77.4% and specificity to 89.7%, and indicate that exploiting pulmonary lesions at slaughter to monitor health and management programs of cattle or as an objective outcome to evaluate the effect of interventions and management techniques is incomparably more complete in relation to independent clinical observation.

Conclusion

Serious and continuous prevention and control of BRDC, which involves long-term planning and recording and evaluating lesions on the lungs and quality of the carcasses, can be a valuable tool for ensuring the sustainability of meat and milk production in cattle breeding. Monitoring and recording of the pulmonary lesions can be of great benefit in the investigations of the pathology of the respiratory tract of cattle in slaughterhouses in Serbia, especially in the light of the abundance of other evidence of the prevalence of BRDC in cattle herds in Serbia.

Kompleks respiratornog oboljenja goveda (BRDC): Pregled lezija pluća i smanjenog kvaliteta trupova

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Rezime

BRDC je najveći zdravstveni problem stočarske industrije na globalnom nivou zbog visoke prevalence i ekonomskih posledica koje nastaju zbog brojnih razloga. Ogromni ekonomski gubici najčešće se pripisuju visokom morbiditetu i mortalitetu, smanjenju prosečnog dnevnog prirasta (ADG) i iskorišćenju hrane, gubitku težine, nižem kvalitetu trupova i sveobuhvatnim merama profilakse i terapije. BRDC se obično posmatra kroz fazu punjenja tovilišta, zbog faktora stresa. Predisponirajući faktori podeljeni didaktički na ambijentalne (nepovoljnih vremenskih uslova, neadekvatne vlažnosti i prašine), faktora poreklom od domaćina (starost, pol, rasa, genetika, imunološki status) i prakse upravljanja stresom (prevoz, stres povezan sa ishranom, metaboličke bolesti, prenaseljenost životinja, rukovanje , kastracija, obezrožavanje). U kompleksnoj etiopatogenezi, pored navedenih predisponirajućih faktora, uključeni su i brojni virusni i bakterijski agensi. Velike lezije pluća se najčešće primećuju kod klanja goveda ili obdukcije (vidljive golim okom) i javljaju kao posledica upale pluća. To je rezultat infekcije govođim respiratornim sincicijalnim virusom (BRSV), virusom parainfluence tipa 3 (PI3V), virusom govođeg herpesa tipa 1 (BoHV1) i virusom govođe virusne dijareje (BVDV), samih ili u kombinaciji jedan s drugim. Uobičajeno su prisutni bakterijski patogeni *Mannheimia haemolitica, Pasteurella multocida, Histophilus somni i Micrococcus spp.* Brojne studije ukazuju na štetne efekte BRDC na performanse i karakteristike trupa goveda.

Ključne reči: kompleks respiratornog oboljenja goveda (BRDC), goveda, ekonomski gubici, plućne lezije, kvalitet trupova

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