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REVIEW ARTICLE

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ORTHOPEDIC DISEASES IN DAIRY CATTLE: CAUSES, EFFECTS, AND PREVENTIONS

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ABSTRACT

Locomotor diseases in cattle can have various causes, both infectious and non-infectious. Infectious agents, such as bacteria, mainly cause finger dermatitis and interdigital dermatitis. In turn, the non-infectious factors include deformation of the claws and the animal housing system, including the bedding material in the barn. Orthopedic disorders and diseases generate financial losses due to lower milk yield, extension of the calving period, or the need to implement treatment. Moreover, animals suffering from any hoof dysfunction suffer from reduced welfare, which results from the sensation of pain, discomfort, and stress associated with a hoof injury or deformation of the claw, or an infection developing on the bovine hoof. It is necessary to take measures to prevent the appearance of diseases and dysfunctions within the cow's hooves, and early detection of disorders is associated with faster implementation of treatment.

Key words: orthopedic diseases, locomotor disorders, lameness, dairy cattle

INTRODUCTION

In order to be profitable, dairy producers should reduce production costs and diseases and dysfunctions diagnoses in animals, which is the main goal in dairy farms [Ózsvári 2017]. It is estimated that 75% of dairy cows in Europe are affected by orthopedic diseases and disorders, indicating that all dairy farms could be affected by this problem. Cattle hoof diseases and disorders typically occur as subclinical disorders that are not readily apparent or directly related to lameness [Alvergnas et al. 2019]. The aim of this review was to summarize the causes, effects and prevention of locomotor disorders in cattle.

The causes of the disorder

Orthopedic diseases in dairy cattle can have various causes, including the environment in which the animals are kept [Alvergnas et al. 2019]. There are many infectious and non-infectious factors that influence the risk of lameness in cattle [Ózsvári 2017].

Infectious agents

Infectious agents include bacteria, viruses, or fungal infections [Ózsvári 2017]. Bacterial infections are responsible for digital dermatitis (DD), interdigital dermatitis (ID), and heel horn erosion (HHE) [Alvergnas et al. 2019]. These diseases are mainly caused by Treponema spp., F. necrophorum and D. nodosus, which penetrate the skin by trauma and cause infections. Bacterial infections are associated with pain experienced by animals and should be treated [Alvergnas et al. 2019].

Non-infectious agents

There are also non-infectious diseases of the claws, which include deformation of the claws as a result of mechani-

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cal trauma. There are asymmetric claws (AC), corkscrew claws (CC), interdigital claws (IC), and scissor claws (SC) [Alvergnas et al. 2019] (Fig. 1). Asymmetric claws are characterized by different height and length between the outer and inner claws. This deformation is not corrected by trimming. Other deformations are corkscrew claws- lateral ones twisted by the hypertrophy of the horn, such a shape of the claw forces the cow to transfer its body weight while walking on the outer side of the hooves. Interdigital hyperplasia, which is caused by an overgrowth of fibrous tissue in the interdigital part of the claw due to mechanical abnormalities. In turn, scissor claws result from the rotation of the inner phalanx axis with respect to the hoof axis, which causes the crossing of the cow's fingers [Alvergnas et al. 2019].

Other non-infectious factors include the housing system [Ózsvári 2017]. The housing system, including the floor and its material, is crucial when it comes to risk of orthopedic injuries and lameness. Barns should be free of stones and gravel that could damage the cows' hooves [Ózsvári 2017]. Animals that spend more time standing in the slurry have softer claws that are prone to lesions and plantar erosion, and bacterial infections that thrive in a humid environment. Moreover, a moist bedding material does not encourage cows to lie down, which shortens the chewing time and extends standing position time, which induces stress and puts pressure on the animals' hooves [Ózsvári 2017]. According to Ózsvári [2017] the risk of lameness increases in wet months. In turn, dry litter and dry months dry out the claws and hooves, which are at risk of cracking. Regular cleaning of barns is a crucial element in maintaining hoof health, as urea in the urine of animals softens the horns of the claw, making it vulnerable to infection and injury.

Metabolic diseases such as rumen acidosis also affect cows' hoof disorders. This disease results in non-infectious traumatic disorder – laminitis (LAM). Other diseases in this group are sole ulcer (SU), white line (WL), and horn fissure (HF) [Alvergnas et al. 2019]. The sole ulcer is a chronic and painful purulent disease. It ap-

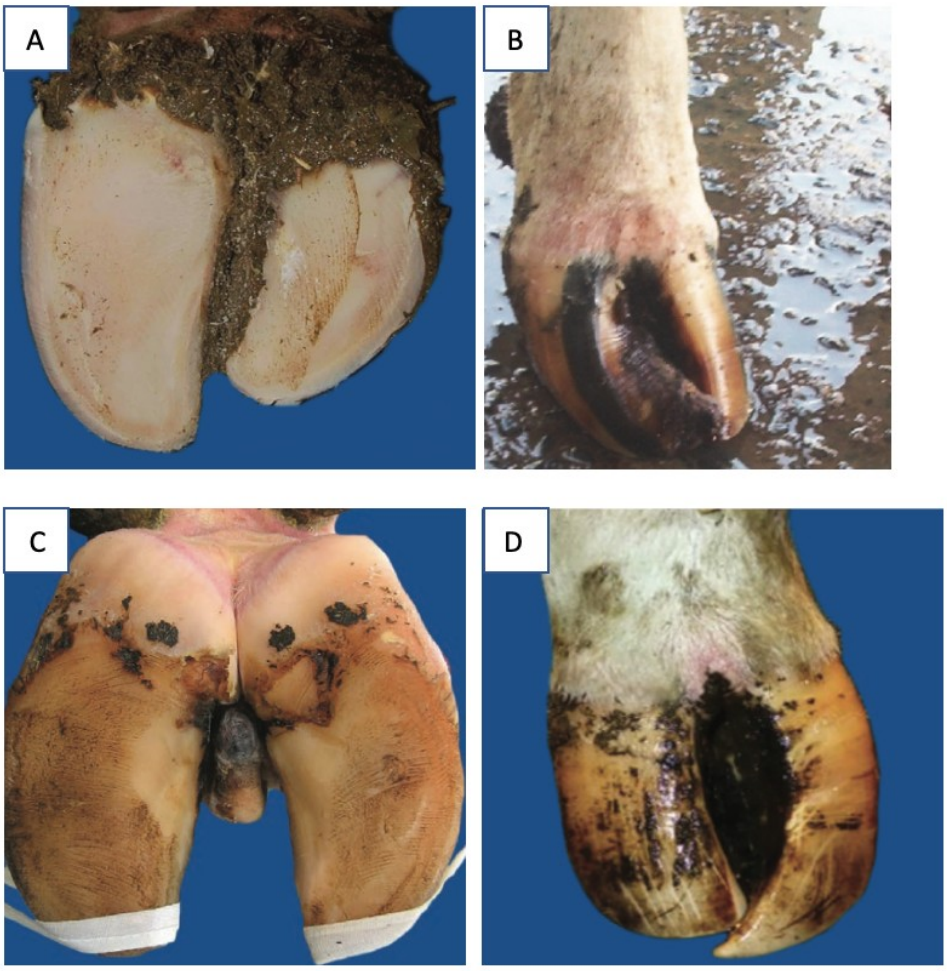

Fig. 1. Asymmetric claws (A), corkscrew claws (B), interdigital claws (C), and scissor claws (D)

Sources: ICAR [2020], Nguhiu-Mwangi et al. [2012]

pears with perforation of the stratum corneum and deep infection. A horn fissure is a fracture that can reach different depths and lengths in the outer wall. In turn, one of the most common disorders in dairy cattle is white line disease, which is caused by the accumulation of dead cells and blood during mechanical problems with the separation of different cell layers [Alvergnas et al. 2019].

According to Alvergnas et al. [2019], cows that have previously suffered from claw disease are more prone to other orthopedic dysfunctions.

Consequences of orthopedic disfunctions

Any orthopedic disorders affect animal welfare and can reduce the production and reproductive performance of animals [Alvergnas et al. 2019, Wrzecińska et al. 2021]. The most severe for animals are dermatitis of the fingers, lameness, and sole ulcer, which are painful for animals and are associated with the long duration of these disfunctions [Alvergnas et al. 2019, Sadiq et al. 2019]. Lame cows slow their walking speed and force the back to flex and tilt the head, which are a response to pain. Additionally, animals try to reduce the burden on the claw, which reduces the severity of the disease and causes greater hoof damage [Sadiq et al. 2019, O'Leary et al. 2020, Kang et al. 2021]. This causes pain, discomfort, and stress in animals, which contributes to animal welfare disorders [Sadiq et al. 2019]. Lameness is the result of painful hoof injuries, generating economic losses for farms due to the early culling of animals from herd, reduced milk yield, and also generates treatment costs [Ózsvári 2017, Alsaaod et al. 2019, Sadiq et al. 2019]. In terms of the economic losses, lameness is placed almost on a par with mastitis and reproductive disorders in cattle [Ózsvári 2017]. This dysfunction entails treatment costs, causes premature calving, extends the calving interval and reduces milk yield [Ózsvári 2017, Buisman et al. 2018].

Effect on milk production

Lame animals have been shown to spend more time lying down, which increases the risk of pressure ulcers and udder dysfunction. The pain also causes animals to consume less feed, which contributes to a negative energy balance (NEB) [Ózsvári 2017]. In turn, high-yield cows are much more prone to lameness than cows with lower milk yield. This may be related to the longer time spent standing while eating and to unfulfilled nutritional requirements [Alvergnas et al. 2019].

Any orthopedic disturbances in dairy cows result in a reduction of milk yield in cows [Alvergnas et al. 2019]. In studies carried out on Holstein-Friesian cows in Great Britain, proved that animals with lameness were characterized by a decrease in milk yield 4 months before and up to 5 months after the diagnosis of the disease. The reduction in yield was more than 350 kg per 305 days of lactation, during which the cows normally reached 5.500–7500 kg of milk during lactation [Alvergnas et al. 2019]. The reduction in milk production occurs as a result of the rejection of milk during antibiotic treatment of animals and as a result of a reduction in the milk yield of the animals. This decrease is due to the reduced feed consumption of cows, which then translates into the inability to maintain milk production. Is also associated with pain associated with lameness, which means stress that limits milk production and lower milk quality [Ózsvári 2017].

Effects on reproduction

Locomotion diseases, such as lameness, have a negative effect on the fertilization rate and delay conception [Wrzecińska et al. 2021]. Cows with lameness have longer periods of oestrus, and the time from calving to the next oestrus is longer [Ózsvári 2017, Wrzecińska et al. 2021]. According to [Ózsvári 2017], lameness increases the time between calving and conception by 9 days, while finger dermatitis increases this time by 20 days, and plantar ulceration by 40 days. In addition, lame animals experience stress that increases blood cortisol levels, which inhibits the secretion of reproductive hormones. This has a negative impact on oocytes and the expression of behavior during heat [Wrzecińska et al. 2021].

The effects of locomotor disturbances in cattle are shown in Fig. 2.

Diagnosing

Detection of lameness is mainly possible through the observation of animals [O'Leary et al. 2020, Kang et al. 2021]. Typically, three methods are used to diagnose lameness: Sprecher's five-point herd locomotion scoring system, routine claw trimming or ad hoc observation during e.g. grazing [O'Leary et al. 2020]. According to O'Leary et al. [2020], ad hoc detection is not effective in diagnosing mild or subclinical lameness. Currently, research on automation with the use of computer vision in the diagnosis of lameness is underway [Kang et al. 2021]. Automation of motion dysfunction detection can detect even mild or moderate lameness. This will shorten the time from diagnosis to treatment of animals and reduce the severity of symptoms, as well as improve welfare [O'Leary et al. 2020]. ALDS, or Automatic Lameness Detection Systems, provide the information necessary for the early and accurate detection of hoof pathology and lameness, further facilitate recovery from hoof treatments and help assess the impact of environmental conditions on animal movements [Alsaaod et al. 2019]. ALDS methods are based on three methods – kinematic gait analysis, kinetic gait analysis and indirect analysis [Alsaaod et

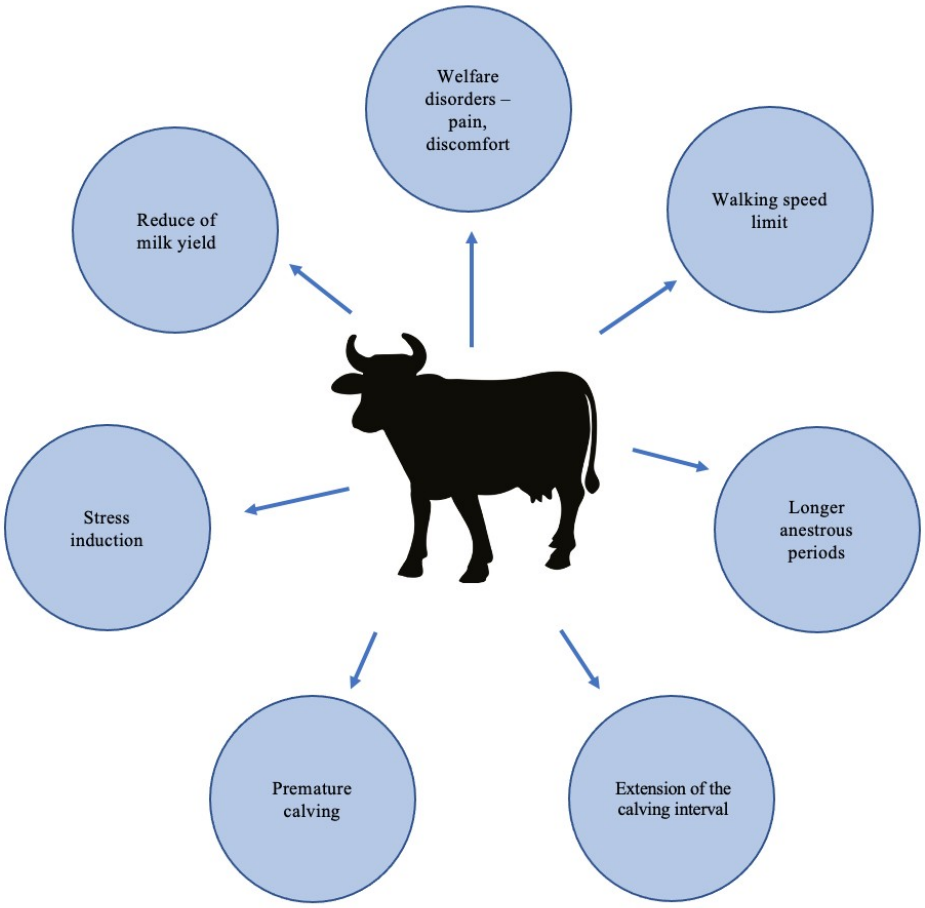

Fig. 2. Effects of locomotor disturbances in cattle

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al. 2019, Kang et al. 2021]. Kinetic methods are based on measuring the ground reaction force while walking, indirect methods detect the behavior and activities of cows, and kinematic methods measure the geometry of the movement without the acting forces. Due to automation, lame cows were found to be characterized by a shorter stride length, a longer stride duration, and a lower speed compared to cows without dysfunction [Kang et al. 2021].

Orthopedic problems in cattle result in an early culling of animals from herds [Ózsvári 2017].

Prevention of orthopedic disorders

Prevention of orthopedic diseases in cows begins with regular inspection and care of the cow's hooves, as well as trimming the claws. Claw trimming stimulated the tissue that are responsible for horn growth [Alvergnas et al. 2019]. This approach reduces the costs generated by hoof dysfunction [Ózsvári 2017, Buisman et al. 2018].

In preventing contagious hoof diseases in cattle, foot baths are important.The use of hoof baths on farms helps to maintain a high level of milk yield by reducing the occurrence of locomotor diseases [Cook 2017]. These treatments help to reduce the risk of these disorders, especially digital dermatitis (DD). According to research, the weekly use of 5% $CuSO_4$ for hoof bathing has a healing effect in digital dermatitis in cattle, because it has antibacterial properties [Alvergnas et al. 2019]. However, since 2006 in the European Union, due to the toxicity of this compound and its lack of biodegradability, the use of $CuSO_4$ has been prohibited [Cook 2017].

Diet is another important way to prevent locomotor dysfunction. According to Alvergnas et al. [2019], heifers fed with wet feed had a higher incidence of claws-related diseases than heifers fed with dry feed. It has been shown that a wet diet is associated with an increased risk of chemical erosion of heels and soles.

Proper hygiene of the barn floor, keeping the hooves clean and the proper bedding material in the barn are

also important to prevent hoof disease and dysfunction [Alvergnas et al. 2019]. Concrete floors in barns have been shown to increase the risk of lameness and claw dysfunction in cows. On the other hand, straw bedding in barns is considered to be the best material to reduce the risk of claw disease and claw dysfunctions [Alvergnas et al. 2019, Wrzecińska et al. 2021].

Early detection of hoof disorders in cows allows faster implementation of the treatment of a given disease [Alvergnas et al. 2019].

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SCHORZENIA ORTOPEDYCZNE U BYDŁA MLECZNEGO: PRZYCZYNY, SKUTKI I PROFILAKTYKA

STRESZCZENIE

Choroby lokomotoryczne u bydła mogą mieć różne podłoża zarówno infekcyjne, jak i nieinfekcyjne. Zakaźne czynniki, jak bakterie, powodują głownie zapalenie skóry palców oraz międzypalcowe zapalenie skóry. Z kolei do niezakaźnych czynników należą deformacje pazurów oraz system utrzymania zwierząt w tym materiał wyścielający oborę. Zaburzenia i choroby ortopedyczne generują straty finansowe spowodowane niższą wydajnością mleczną, wydłużeniem okresu międzywycieleniowego, czy koniecznością wdrożenia leczenia. Ponadto zwierzęta dotknięte wszelkimi dysfunkcjami ze strony racic charakteryzują się zmniejszeniem dobrostanu, co wynika z odczuwania bólu, doświadczania dyskomfortu oraz stresu związanego z urazem racicy bądź deformacją pazurów, czy też infekcją rozwijającą się na racicy bydła. Niezbędne jest podejmowanie środków zapobiegających pojawieniu się chorób i dysfunkcji w obrębie racic krów, a wczesne wykrycie zaburzeń wiąże się z szybszym wdrożeniem leczenia.

Słowa kluczowe: schorzenia ortopedyczne, zaburzenia lokomotoryczne, kulawizna, bydło mleczne

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