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Review Article

Actinomycosis in cattle: A review

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Abstract

Actinomycosis (lumpy jaw) in cattle is a chronic, suppurative, and granulomatous infection primarily affecting the mandible and maxilla. It is caused by Actinomyces bovis, an opportunistic bacterium occasionally isolated from lesions in other domestic animals. The disease is of considerable veterinary importance due to its progressive nature, limited treatment response, and resultant economic losses. This review aims to summarize current evidence on the etiology, epidemiology, clinical features, diagnostic approaches, treatment options, and prevention of bovine actinomycosis. Infection typically follows mucosal trauma or periodontal disease, leading to rarefying osteomyelitis and firm, immovable swellings with sinus tracts exuding seropurulent material containing characteristic granules. Although cases occur sporadically, the condition remains a challenge in cattle production systems. Diagnosis relies on clinical examination supported by cytology, microbiological culture, and imaging, while management includes surgical debridement and antimicrobial therapy, particularly iodides. Preventive measures focus on reducing oral injuries, improving feed quality, and culling severely affected animals. This review provides an updated synthesis of knowledge on bovine actinomycosis to support enhanced awareness, timely diagnosis, and effective control in livestock populations.

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INTRODUCTION

Actinomycosis in bovines, also called "lumpy jaw," is a persistent bacterial infection that mostly affects calves. Actinomyces bovis, a filamentous, Gram-positive bacterium that is normally present in ruminants' oral cavities, is the cause of this illness (Rao et al., 2011). The causative agent of cow lumpy jaw is A. bovis. Additionally, it has been identified from nodular abscesses in cattle lungs and, rarely, from infections in dogs, sheep, pigs, and other mammals, such as chronic poll evil in horses and chronic fistulous withers in sheep (Neja & Gari, 2020). Lumpy jaw is a condition that usually affects the mandible, maxillae, or other bony tissues in the head. It is a localized, chronic, progressive, granulomatous abscess that can cause pain and swelling over time. Eventually, it can cause bone lysis and deformation (Gajdács *et al*., 2019).

Actinomycosis is characterized by the presence of "sulfur granules," which are clumps of bacteria or phagocytized bacteria (González-Martín et al., 2021). The bacterium can enter deeper tissues and produce granulomatous lesions when the mucosal barrier is disrupted, which is part of the pathogenesis of bovine actinomycosis (Könönen & Wade, 2015). One of the main risk factors is frequent oral trauma, which can be caused by sharp objects or harsh feeding (Boyanova et al., 2015). Treatment involves long-term antimicrobial medication combined with

surgical intervention in severe cases; the diagnosis is usually established on clinical symptoms, radiography, and microbiological culture (Könönen & Wade, 2015).

The disease's traumatic pathophysiology in cattle usually begins with a breach in the gingival mucosa as a result of the vegetable bodies' small, hard penetration. Periostitis and, most of the time, osteomyelitis resulting from periodontitis are caused by the infection (Van Den Wollenberg et al., 2023). When bacteriological studies come up negative, fine-needle aspiration biopsy (FNAB), a less invasive technique than histology biopsy, may help identify bacteria and sulfur granules (Van Den Wollenberg et al., 2023).

Disease develops when *A. bovis* enters underlying soft tissue through oral mucosal lesions caused by sticks, wire, or coarse hay (Gajdács *et al*., 2019); when nearby bone becomes involved, it often causes facial deformation, loose teeth that make biting difficult, and dyspnea due to swelling into the nasal cavity (Rao et al., 2011). The oral cavity and nasopharynx are A. bovis's natural habitats, and it is believed that the bacteria enter through dental alveoli or wounds in the buccal mucosa. *Actinomyces bovis,* a Gram-positive filamentous anaerobe, is the causal organism of lumpy jaw. When teeth emerge or sharp things break the mucosa, the organism is able to enter the soft tissues. After infection, there is a proliferation of connective tissue, leucocyte infiltration, and the creation of a walled tumor-like mass. The granuloma then spreads to the mandibular or, rarely, maxillary bones (Gajdács *et al*., 2019).

Furthermore, the complex interactions between environmental factors, nutritional deficiencies, and animal husbandry practices in Ethiopia create an environment conducive to the spread of bovine actinomycosis (Habte et al., 2025). Many smallholder farmers lack access to effective veterinary care and are often unaware of the signs and symptoms of the disease, leading to delayed diagnosis and treatment (Gizaw et al., 2021). Bovine actinomycosis remains a notable health concern in cattle production systems in Ethiopia due to its detrimental effects on animal welfare, productivity, and economic performance. Limited farmer awareness, insufficient veterinary service delivery, and difficulties in early diagnosis often result in delayed treatment and increased disease severity. This situation underscores the urgent need for enhanced farmer education and improved veterinary infrastructure to reduce the burden of bovine actinomyosis. Therefore, the objective of this review is to synthesize current knowledge on bovine actinomycosis, focusing on its etiology, epidemiology, clinical presentation, diagnosis, treatment, and prevention in cattle.

Etiology of Actinomycosis

The principal cause is *Actinomyces bovis*; severe lesions may contain other bacteria, such as *Actinomyces spp.,* which is not bovis (Rao et al., 2011). Actinomycosis should be addressed in patients with resistant infection following a standard course of antibiotics, sinus tract formation that may heal and recur, and persistent disease progression across tissue planes that occasionally resemble masses (Rao et al., 2011).

Characteristics of Actinomycesis bovis

Actinomyces bovis is characterized by branching, filamentous, Gram-positive bacilli that are embedded in purulent and granulomatous inflammatory exudates. These bacilli frequently form sulfur-granule-like clumps, which are easily visible with Gram staining and histochemical methods (Masand *et al.,* 2015; Kumar & Kundu, 2025). The disease is characterized by an anaerobic to microaerophilic bacterium that typically lives in the oral cavity of cattle. However, it becomes opportunistically pathogenic after mucosal disruption brought on by rough feed, erupting teeth, or oral trauma, allowing invasion into deeper tissues and the development of the chronic pyogranulomatous infection that characterizes bovine actinomycosis (also known as "lumpy jaw") (González-Martín et al., 2021; Cunha et al., 2022; Habte et al., 2025).

Despite its slow-growing and picky character, which makes regular isolation difficult? (Narayanan et al., 1998), and clinically, infection shows up as

persistent granulomatous and suppurative lesions with abscessation, fibrosis, draining fistulae, and progressive osteomyelitis of the mandible or maxilla, which causes the distinctive solid swellings associated with "lumpy jaw" in cattle. Rare human cases, frequently associated with immunocompromise, show up as localized or disseminated actinomycosis that responds to long-term beta-lactam therapy (Cunha et al., 2022).

Geographical Distribution

Although bovine actinomycosis is found all over the world, it is more commonly documented in areas where cattle husbandry is intense and rough, and fibrous feed is a staple of the diet (Jacob, 2022). In well-managed herds, prevalence is typically low, but it may rise in regions with subpar feed quality and health care.

Risk factors for the occurrence of the diseases

The main occerance cases of bovine actinomycosis is primary associated with trauma to the oral mucosa and jaw tissues**,** which allows the opportunistic bacterium *Actinomyces bovis*, a normal inhabitant of the oral cavity, to invade deeper tissues and establish infection; such trauma commonly results from the ingestion of course, stemmy, or poorly processed feeds, including straw, rough hay, and thorny plant materials, as well as from sharp foreign bodies such as sticks, wire, or stones present in feed, while dental abnormalities including erupting, fractured, or diseased teeth further increase susceptibility by creating entry points for the pathogen, and these risks are exacerbated under poor management and husbandry conditions, including inadequate feed inspection, rough grazing environments, nutritional deficiencies that compromise mucosal integrity, concurrent systemic illness or immunosuppression, and physical injuries to the head or jaw arising from handling or animal interactions(Kumar & Kundu, 2025).

Pathogenesis

Bovine actinomycosis, caused mostly by *Actinomyces bovis*, is a chronic, pyogranulomatous illness that most usually affects the bones and soft tissues of the head, notably the mandible and maxilla. Through mucosal abrasions or penetrating wounds, *A. bovis*, a typical commensal of the bovine oral cavity, gains access to deeper tissues, initiating the pathogenesis. The mucosal barrier is frequently disrupted by things like harsh feeding, foreign objects, or oral injuries, which provides the bacteria a site of entrance (Madrigali et al., 2020). Once within, *A. bovis* triggers a powerful inflammatory reaction that results in the formation of pyogranulomas, which are defined by a core mass of bacterial colonies encircled by fibrous connective tissue, neutrophils, and macrophages. Osteomyelitis, characterized by hard, immobile swellings on the afflicted jawbones, is the result of the infection spreading over time into neighboring bone structures (González-Martín et al., 2021). As the illness worsens, the osteolytic lesions may form fistulous tracts that leak purulent material that includes aggregates of *A. bovis* filaments encircled by immune cells, which have a yellowish sulfur granule appearance (Madrigali et al., 2020). These granulomatous-like tumors cause abnormal bone architecture, which results in mastication difficulties and facial abnormalities. According to Könönen and Wade (2015), if the infection is not treated, there may be significant bone loss, pain during chewing, and decreased nutrient intake. Early intervention is essential for optimal therapy and to prevent consequences like secondary infections or significant bone involvement, as the condition often progresses slowly and does not resolve on its own (González-Martín et al., 2021).

Several infectious and parasitic diseases other than actinomycosis cause major production losses in cattle and warrant routine consideration: Foot-and-mouth disease (FMD) is an acute, highly contagious viral disease producing fever and vesicular lesions of the mouth, feet and teats with rapid herd-level impacts on production and trade (Zewdie et al., 2023); bovine tuberculosis**,** caused principally by *Mycobacterium bovis*, leads to chronic granulomatous lesions of lungs and lymph nodes and is a persistent zoonotic and herd-management challenge (Gutema et al., 2020);brucellosis due to *Brucella abortus* produces late-term abortion, retained membranes and infertility with significant

public-health consequences (Khurana et al., 2020);bovine mastitis, particularly *Staphylococcus aureus*–associated mastitis, causes both clinical and economically important subclinical infections that reduce milk yield and complicate antimicrobial use (Touaitia et al., 2025); acute clostridial infections such as blackleg (*Clostridium chauvoei*) produce often-fatal myonecrosis in young cattle and are preventable by vaccination (De Jesus Sousa et al., 2024); and parasitic diseases fasciolosis (liver fluke) and gastrointestinal nematodiasis impair nutrient absorption, cause liver condemnation and weight loss, and produce substantial economic losses in endemic areas(Nyirenda et al., 2019).

Clinical Manifestations

Bovine actinomycosis, also referred to as "lumpy jaw," is characterized by the formation of hard, immovable swellings on the maxilla or mandible that are the result of osteomyelitis and chronic granulomatous inflammation brought on by Actinomyces bovis. When the disease advances, affected animals usually exhibit firm, painless swellings that enlarge over weeks to months and finally become painful (Cunha et al., 2022). In more difficult situations, fistulous tracts may develop and release a viscous, purulent discharge that is known to contain sulfur granules, which are yellowish clusters of bacteria encircled by immune cells. Additional clinical indicators include hypersalivation, trouble masticating food, weight loss, and displacement or loosening of teeth. These symptoms can make feeding difficult and seriously harm the animal's nutritional status (Cunha et al., 2022). Infections can cause significant bone loss, deformities, and subsequent consequences, such as sinusitis or septicemia, if they are not treated quickly as well.

Diagnosis and Clinical Pathology

Actinomycosis diagnosis is greatly aided by the pathology of infected tissue and pus Gram staining, which is typically more sensitive than culture, which is sterile in over 50% of cases. After Actinomyces species have infected a tissue, they create a persistent granulomatous infection that is typified by the production of microscopic clusters that are known as sulfur granules due to their yellow hue. A protein-polysaccharide combination stabilizes these 0.1-1 mm in diameter formations, which are made up of an interior tangle of mycelial fragments and a rosette of peripheral clubs. This process is thought to act as a defense mechanism against host defenses by preventing phagocytosis (Van Den Wollenberg et al., 2023; Habte et al., 2025).

A presumptive clinical diagnosis is formulated, and *Actinomyces bovis* is verified through cytological assessment and microbiological isolation from purulent material, respiratory secretions, or tissue samples, preferably obtained through endoscopic retrieval. Depending on the results, imaging tests (such as thoracic or abdominal CT or chest x-rays) are frequently performed (Madrigali et al., 2020). The microorganism is visible in pus or tissue as the characteristic sulfur granules or as tangled masses of pus cells, debris, and branched and unbranched wavy bacterial filaments. An outer zone of radiating, club-shaped, hyaline, and refractive filaments surrounds the microorganism and shows positive results for Gram stain but negative results for hematoxylin-eosin in tissue (Sasaki et al., 2013).

Other microorganisms are frequently involved in actinomycotic lesions. Unfortunately, the primary isolation of Actinomyces is complicated by the existence of numerous bacterial species (Habte et al., 2025). Gram stain-stained smears of the pus discharged offer a quick and easy way to confirm the diagnosis. The centers of the crushed granules are where the organism's gram-positive filaments are most easily located (Jacob, 2022).

Differential Diagnosis

Carcinoid, as is frequently the case, actinomycosis-like signs and symptoms can be found in a number of illnesses and ailments. As a result, incorrect diagnoses can happen. As an illustration, consider abscesses brought on by grass seeds, woody tongue, bottle jaw, growths, and discomfort. When spiky grass-awns are consumed, abscesses of the cheek muscles and throat area are frequently observed. As opposed to the immobility of an actinomycotic

lesion, they are distinguished by their mobility and placement in soft tissues. (Gajdács et al., 2019).

Necropsy Findings

It is typical to have loculi and sinuses filled with thin, whey-like pus that has tiny, gritty granules in addition to rarefaction of the bone. A broad fibrous tissue reaction around the lesion is persistent, and there may be contiguous spread to neighboring soft tissues. The disease is characterized by the appearance of 'club' colonies containing the usual, thread-like bacteria. These forms can be observed histologically on a slice or microscopically on smears created from crushed granules in pus (Gajdács et al., 2019). The lower esophagus, the front wall of the reticulum, and the esophageal groove can all have granulomatous lesions with pockets of pus within them. Results of the postmortem examination:(1) Damage to the maxilla or mandible (lumpy jaw); (2) Granulomatous lesions in the anterior or lower part of the reticulum or oesophagus; (3) Localized peritonitis; (4) Mild enteritis and abomasitis (Yar et al., 2023).

Antimicrobial susceptibility and management of the disease

Actinomyces infections in cattle are generally susceptible to β-lactam antimicrobials, with penicillin and amoxicillin remaining the drugs of choice due to consistently low minimum inhibitory concentrations (MICs) reported among clinical isolates. However, species-level variability in antimicrobial susceptibility has been documented, with some *Actinomyces* spp. exhibiting reduced susceptibility to fluoroquinolones, particularly ciprofloxacin, as well as resistance to macrolides and tetracyclines (Smith et al., 2005). Consequently, prolonged β-lactam therapy is the cornerstone of disease management. Parenteral penicillin, combined with appropriate local wound care, has been associated with favorable outcomes, while adjunctive administration of potassium or sodium iodide is commonly used to enhance antimicrobial penetration by liquefying fibrous tissue within granulomatous lesions (Gajdács et al., 2019). However, *actinomyces bovis* typically requires several weeks of treatment to achieve complete lesion resolution and prevent recurrence (Sasaki et al., 2013). Supportive care, including non-steroidal anti-inflammatory drugs such as flunixin meglumine, improves animal comfort and feed intake, while nutritional supplementation helps maintain body condition in severely affected animals (Gajdács et al., 2019). Surgical intervention is reserved for advanced cases with extensive bone involvement, severe deformity, or risk of obstruction and is most effective when combined with long-term antimicrobial therapy; however, due to its inherent risks, it should be carefully considered on a case-by-case basis (Boyanova et al., 2015).

Prevention and control methods

Good husbandry techniques, early detection, and the strategic use of antimicrobial drugs are necessary for the prevention and control of bovine actinomycosis. As a common predisposing factor for the disease, oral trauma reduction is the main goal of preventive efforts. Effective feeding management can greatly lower the risk of *Actinomyces bovis* infection and consequent oral mucosal injury (Gajdács et al., 2019). This includes avoiding sharp feed and making sure the forage is of high quality. Furthermore, it is advised to practice good oral hygiene and schedule routine dental exams in order to identify and treat any early indications of the illness before they develop into serious granulomatous lesions. It has been recommended to strategically use iodine-based chemicals for both prevention and treatment; however, caution must be taken to watch for iodine toxicity in cattle (Habte et al., 2025).

In addition, environmental management is essential for preventing actinomycosis from spreading among cattle. Preventing overcrowding and maintaining clean, dry housing conditions are crucial in lowering the frequency of traumatic injuries in cattle, which can lead to infection. It is essential to identify and isolate afflicted animals as soon as possible in order to stop the disease from spreading and to start systemic antibiotics such as

penicillin treatment right away (Masand et al., 2015).

Economic Impact on Cattle Farming

Actinomyces bovis remains a major constraint to the profitability and productivity of Ethiopia's cattle industry, as the disease leads to considerable direct and indirect economic losses. Affected animals often exhibit reduced body weight, diminished milk yield, and increased treatment expenditures, thereby lowering overall herd performance (Neja & Gari, 2020). Treatment is frequently prolonged due to the need for repeated veterinary interventions and extended antibiotic therapy, further escalating financial costs. Additionally, reproductive efficiency is often compromised, resulting in prolonged calving intervals and decreased fertility, which intensifies the economic strain on farmers (Gizaw et al., 2021). These cumulative impacts reduce profit margins for both smallholder and commercial cattle producers who depend on dairy and meat production for their livelihoods.

Beyond the direct production losses, bovine actinomycosis also affects marketability and carcass value, thereby extending its economic repercussions across the livestock value chain. Cattle exhibiting visible jaw lesions or skeletal deformities typically receive lower market prices and are less acceptable in both local and export markets (Neja & Gari, 2020). Moreover, farmers often incur additional expenses related to preventive measures such as routine oral examinations, improving feed quality, and adopting better husbandry practices. Effective mitigation of these financial burdens requires an integrated control strategy that combines early diagnosis, improved management, and timely therapeutic interventions to reduce disease incidence and enhance herd productivity.

Despite its significant economic and health implications, bovine actinomycosis remains under-researched in Ethiopia, even though recent studies indicate a relatively high prevalence in regions where cattle production is economically essential, including Tigrai and Oromia (Tedla et al., 2018). The disease, caused by *Actinomyces bovis*, typically presents as a chronic granulomatous infection leading to severe mandibular or maxillary distortions, which impair feeding efficiency and cause substantial weight loss and reduced milk production. These clinical manifestations ultimately diminish the animals' market value and impose severe financial losses on households reliant on cattle as a primary source of income (Neja & Gari, 2020). As reported by Gizaw et al. (2021), major cattle diseases, including actinomycosis contribute to reduced productivity, lowered reproductive performance, and poor carcass quality, collectively resulting in significant indirect economic losses. Thus, implementing sustainable disease management strategies is essential for safeguarding Ethiopia's cattle sector and ensuring long-term economic resilience.

Public health significance of the diseases

The zoonotic potential of Actinomyces species, which are opportunistic diseases in humans, makes bovine actinomycosis a significant but restricted public health concern. Actinomyces bovis mostly affects cattle; however, people may be at low risk of contracting the disease through intimate contact with infected animals, exposure to purulent exudates, or handling contaminated tissues, especially among slaughterhouse workers, veterinarians, and livestock handlers (Könönen & Wade, 2015). Actinomycosis is a chronic, suppurative granulomatous illness that affects the cervicofacial, thoracic, or abdominal areas in humans. It frequently follows mucosal disruption and can be challenging to identify because of its sluggish course and similarities to neoplastic disorders (Valour et al., 2014).To guarantee meat hygiene and avoid possible exposure, carcass condemnation and cutting of impacted tissues are essential from the standpoint of food safety, which indirectly protects public health. The illness emphasizes the significance of appropriate animal health management, workplace hygiene, and veterinary inspection within a One Health framework, even if direct transmission from cattle to humans is uncommon (Könönen & Wade, 2015; Valour et al., 2014).

Actnomycosis Distrubution in Ethiopia

In Ethiopia, in both cattle and occasionally people, however, there are few studies and data available. Actinomycosis has been shown to be a very prevalent bacterial illness in cattle, especially in locations like Eastern Tigray (Table 1). According to certain veterinary clinic surveys, it accounts for 15-16% of clinically diagnosed cases, suggesting that it is widespread in all livestock populations in rural areas, as depicted in table1(Tedla et al.,2018).

Table 1

Actinimyces bovis distribution and its prevalence in Ethiopia

Region	Prevalence	References
Tigray	15.83	Tedla et al. ,2018
Tiray (Mekele)	5.12	Tedla et al.,2018
Wenbera	0.35	Getnet et al.,2024
Addis Abeba City	4.23	Abunna et al.,2013
Central Zone of Tigray	3.78	Abay et al.,2017

CONCLUSION

Actinomyces bovis, often known as lump jaw in cattle, is a bacterial disease brought on by the proliferation of actinomyces bovis bacteria in the tissues. It manifests as a lump or significant swelling, especially on the cattle's jaw and maxilla, and causes osteomyelitis. Often, the lesions are not discovered until they are too large for therapeutic therapy. One safe, simple, quick, efficient, affordable, and minimally invasive diagnostic method for diagnosing the condition is fine-needle aspiration (FNA). Antibacterial treatments, especially iodides, and surgical debridement are the methods used to treat the condition. In Ethiopia, bovine actinomycosis is a major livestock productivity concern that results in large economic losses. For effective control, better management techniques, quick diagnosis, and alternative therapies like bacteriophages are required. Furthermore, it is crucial to incorporate comprehensive systems for managing the health of herds that prioritize illness prevention via environmental and nutritional management.

Recommendations

Collaboration between veterinarians, researchers, and farmers will be important in creating sustainable treatments that lower the occurrence of actinomycosis and enhance cattle health and productivity in afflicted regions. Therefore, early diagnosis, proper disease investigation, reduction of predisposing factors, and isolation of affected animals remain critical recommendations for controlling actinomycosis in cattle. Since the disease does not often have a visible onset, it is important to seek early, accurate diagnosis and therapy to prevent fibrous tissue reactivity and subsequent significant damage. To prevent incorrect diagnosis, a thorough investigation of the pathomechanism of the disease, including any involvement of other soft tissues, should be carried out. Since oral laceration was a predisposing factor for the disease, minimizing risk factors for this condition is recommended. It was also crucial to isolate the animals that had lesions that were leaking fluid.

CRediT Authorship Contribution Statement

The author confirms they are the sole creator and are responsible for all aspects of this work, including conception, data analysis, and manuscript preparation.

Declaration of competing interest

The author declares that there is no conflict of interest.

Ethical approval

Informed consent was obtained from all subjects and/or their legal guardian(s).

Data availability

The compiled or raw data used for this research is available upon request from the corresponding author.

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