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GRADUATE REVIEWS

Prevalence and Impact of Cattle Infections in Ghana: Challenges in Livestock Health and Disease Management

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ABSTRACT

This article examines the critical issues surrounding cattle diseases in Ghana and their detrimental effects on animal farming, food supply, and public health. It offers a comprehensive analysis of common infections affecting cattle in Ghana's farming industry, along with proposing potential strategies to manage these health challenges. A literature search was conducted across four databases, retrieving 117 records, of which 12 were included for analysis. The most widespread disease found was trypanosomiasis, along with other infections such as bovine tuberculosis, bovine coronaviruses, heartwater, and parasitic worm infestations. Farmers often rely on antibiotics, antiprotozoal, anthelmintics, and vaccines to address these health concerns. The findings reveal that these diseases have a profound effect on cattle productivity, resulting in notable economic setbacks, and a decline in the availability of cattle-based products. Although various diagnostic techniques are employed, it is evident that there is a need for simpler and more effective diagnostic tools to identify and treat these infections early. The study highlights the need for continuous research on cattle diseases to develop more effective treatments and suggest the development of improved diagnostic methods. Additionally, it stresses the importance of implementing early detection technologies and control systems to reduce the economic and agricultural consequences of cattle diseases in Ghana.

Keywords: Cattle Infection, Cattle Production, Trypanosomiasis.

1 Introduction

Agriculture remains a vital occupation globally, with approximately 26.7% of the world's population participating in it, according to the Food and Agriculture Organisation [1]. Cattle rearing, in particular, has seen substantial growth over the last few decades, driven by the increasing global demand

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for cow products, including dairy and leather [2]. This demand has positioned cattle farming as a high-return investment compared to other livestock species, significantly contributing to revenue generation, particularly in developing regions where cattle farming plays a central role in economic livelihoods [3]. Cattle production not only fulfils local food demands but also plays an essential role in the global economy, supplying meat, milk, and other byproducts to international markets [2]. However, as cattle rearing intensifies, the risk of infectious diseases grows, threatening both productivity and economic sustainability in the agricultural sector [4]. This review aims to address the pressing issue of cattle infections by exploring the need for early diagnosis, efficient disease control measures, and the potential for innovative diagnostic and therapeutic approaches. By addressing these gaps, it hopes to provide a comprehensive strategy for safeguarding livestock health and the livelihoods of those dependent on cattle farming.

Cattle are susceptible to numerous infections that vary in severity depending on the causative agent. Among the many diseases affecting cattle, some can be fatal. For instance, *Clostridium chauvoei*, the bacterium responsible for blackleg, has a high mortality rate if not treated early [5]. Prion diseases also pose significant threats to cattle populations, with serious consequences for cattle health and productivity [6]. While treatments such as penicillin and tetracycline are commonly used to manage these diseases, the success of treatment often hinges on early detection. Furthermore, zoonotic transmission can occur, spreading diseases from animals to humans and worsening the problem, thereby extending the impact of these diseases beyond animal health to public health, [7].

The lack of effective disease control measures can severely hamper livestock productivity with significant economic consequences [8]. In sub-Saharan Africa, livestock diseases significantly impact cattle productivity, leading to major economic losses for farmers and affecting the overall value of the livestock sector. These diseases reduce production efficiency and market access, leading to long-term challenges for food security and rural livelihoods [9]. This economic burden not only threatens the sustainability of the cattle farming industry, but also affects broader agricultural production and food security [10]. The economic impacts of these diseases necessitate comprehensive and strategic disease management systems that include vaccination programs, biosecurity protocols, and early detection tools. Given the increasing incidence of cattle infections, more attention is being directed toward understanding the economic implications of these diseases and the development of preventive measures to curb their spread.

The growing incidence of cattle infections coupled with the potential for zoonotic transmission underscores the need for more robust disease surveillance and biosecurity strategies. Recent advancements in technology, including artificial intelligence (AI) based predictive tools and real-time monitoring systems, offer promising solutions for managing cattle health more effectively [10]. These technologies enable early detection of disease outbreaks, providing farmers with the tools necessary to implement timely interventions. However, many small-scale farmers, particularly in developing regions, face challenges in adopting these advanced technologies due to limited resources. Addressing these gaps in disease management is crucial for ensuring the viability of cattle farming and minimising the broader socio-economic impacts associated with cattle infections [11].

2 Methodology

Four databases were considered for the literature search. The search was carried out on Web of Science, Scopus, PubMed, and African Wide Information using the search terms (((infection [MeSH Terms]) AND ((((cattle) OR (cow)) OR (calf)) OR (bull))) AND ((((production)) OR (rearing)) OR (keeping))) AND (Ghana). The retrieved articles from these databases span from 1991 to 2022. The articles retrieved were uploaded onto Endnote, a web-based bibliography database manager and were screened in tiers. Firstly, the titles were screened, followed by abstracts and full text. The inclusion criteria included: (1) full text articles; (2) articles available in English, (3) publications on cattle infections, (4) publications on cattle health, and (5) articles on cattle farming from Ghana. The exclusion criteria included: (1) thesis and review articles; (2) records on animal infection other than cattle infection; (3) articles not published on cattle

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Etwire *et al*., *Adv. J. Grad. Res.;* Vol. 15, Issue 1, pp: 22-33, December 2024

from Ghana. Data was collected using Microsoft Office Excel with the following parameters: first author's name, last author's name, DOI number, sampling method, infection, region of reported infection, treatments used in the articles, year of publication, cattle breed, and preventions methods. The publications were evaluated, and any conflict between the author's judgements was resolved. The data was entered into Microsoft Excel and analysed using GraphPad Prism version 10.2. The prevalence of cattle infection was determined from various graphs and charts drawn using the GraphPad prism. Figure 1 represents preferred reporting items for systematic review and meta-analysis (PRISMA) flowchart diagram.

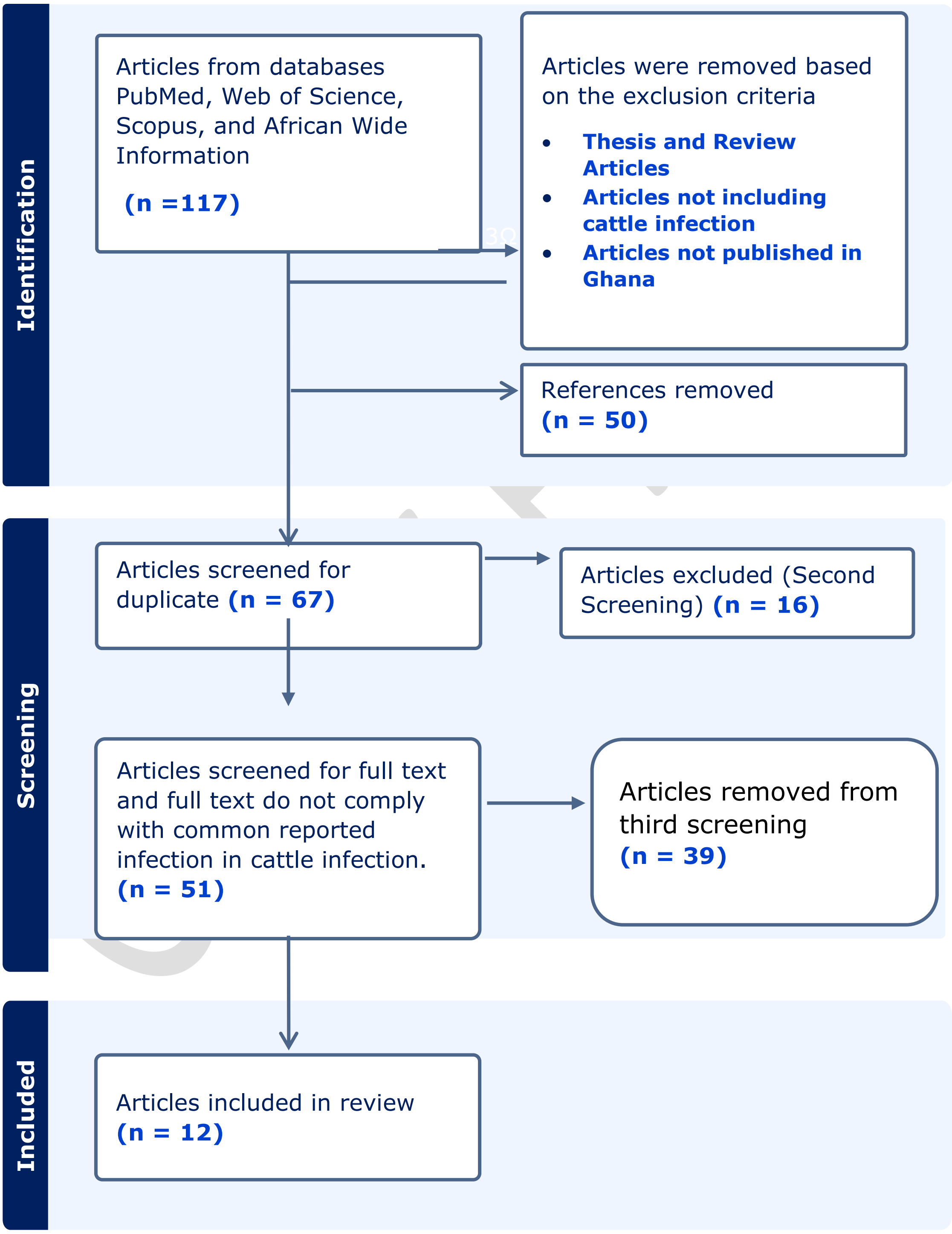

Figure 1: *PRISMA flowchart diagram of the article selection process*

3 Results and Discussion

3.1 Cattle breeds

There are currently over thousand recognized cattle breeds worldwide, each varying based on specific traits such as climate adaptation, productivity, and utility [12]. Other traits include the resistance to a variety of illnesses and diseases. There are two basic categories into which cattle breeds belong. Bos Taurus and Bos Indicus [13]. The Bos indicus cattle breed, often known as the zebu, originated in tropical regions of the world like India, Sub-Saharan Africa, China, and Southeast Asia [14]. Bos taurus, also known as "taurine" cattle, includes practically all varieties of cattle from Europe and northern Asia and are typically acclimated to colder climates [15]. The type of breed may influence their activities and products obtained, such as milk, meat, and dairy products. Despite several efforts to remove and prevent these illnesses, cattle infection continues to be a significant barrier to animal productivity [16]. Different species cause these infections, and the specific specie involved can affect the severity of the infection. The degree of infection can range from mild to chronic to transient. Many infections share common symptoms because they may originate from the same family; however, different infections also have different symptoms. From 117 articles retrieved, 12 articles were retained for data extraction and systematic review. Eleven (11) different species were identified, which belong to the Bos indicus breed (Table 1). They were Short Horn, Zanga, Zebu, West African Short Horn, N"dama, Sanga, Sanga Cross, white Fulani, Sahiwal, Boran and Friesian Crosses (Table 1). West African Short Horn breed was mentioned in 6 (six) of the publication (Table 1). West African short horn and Sanga breed were found in 4 (four) regions of Ghana, indicating that they are commonly reared in Ghana (Table 1).

Table 1: *Type of breeds retrieved*

Cattle breed	Geographical location/region	Frequency/number of publications	Reference
Short Horn	Upper West Greater Accra	3	[17] [18]
Zanga	Upper West	2	[17]
Zebu	Upper West Greater Accra Northern	4	[17] [18] [19]
West African Short Horn	Greater Accra Central Coastal Plains Northern	6	[18] [19] [20]
N"dama	Greater Accra Northern Region	3	[18] [19] [20]
Sanga	Greater Accra Central Coastal Plains Northern	5	[18] [21] [22] [20]
Sanga Cross	Greater Accra	2	[18] [21]
White Fulani	Greater Accra	1	[18] [19]
Sahiwal	Central	1	[22]
Boran	Central	1	[22]
Friesian Crosses	Central	1	[22]

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3.2 Reported Infections and Diseases

3.2.1 Trypanosomiasis

The most common infectious Disease affecting cattle is trypanosomiasis. In sub-Saharan Africa, it is commonly referred to as African Animal Trypanosomiasis (AAT) [23]. The economic loss in Africa caused by this infection is between US$1.0 and US$1.2 billion in cattle production alone, and more than US$4.75 billion in agricultural GDP [24]. Many Trypanosome species are responsible for the disease [25]. These species include *Glossina palpalis, gambiensis, Vanderplank,* and *Glossina tachinoides*; *Trypanosoma congolense; T. vivax*, *T. brucei, T. simiae,* and *T. vivax* [25]. Trypanosomiasis is a hemoprotozoan disease that is primarily spread by tsetse flies [26]. It can lead to serious illness in both humans and animals. The infection typically results in anaemia, which is frequently followed by poor growth, weight loss, infertility, abortion, and paralysis. This leads to a reduction in milk supply, meat, and other products. Additionally, trypanosomes can evade immune reactions (immunosuppression) during infection and attack vital organs like the liver, spleen, and kidneys. Following the infection, various pathological conditions appear [27]. Areas with high temperatures have been linked to higher rates of tsetse infection [23]. The direct and indirect impacts of African animal trypanosomiasis on agriculture have become a major problem for socio-economic development.

3.2.2 Cowdria Ruminantium

Cowdria ruminantium, also known as rickettsia illness, causes heartwater infection. It is a cow illness spread by ticks [28]. The tick genus *Amblyomma* is responsible for transmitting infection [28]. These ticks are also linked to the economically significant bacterial skin illness dermatophilosis in cattle [28]. Within 1-2 days following the first episode of fever, the infection causes a sharp increase in body temperature that may approach 41°C. Particularly in cattle, diarrhea occurs after the fever [29]. The animal trembles in the superficial muscles and is restless, walking in circles and sucking motions. It also stands stiffly in an aggressive display; cattle may hit their heads against a wall [29]. Additionally, the illness weakens the cattle's immune system. The animal typically dies during or after such an attack [29].

3.2.3 Mycobacterium Bovis

Mycobacterium Bovis is responsible for bovine tuberculosis [30]. When an animal is stressed out and malnourished, they are more susceptible to the infection. Infection rates are higher in intensive agricultural systems [30]. Although many physiological systems may be affected, the respiratory tract often only exhibits symptoms. Once or twice a month, a mild, chronic cough will appear [31]. Additionally, the illness may cause weight loss and cause calves to be rejected during livestock inspection. When an animal is infected, there are several ways the infections can spread [31]. They can transmit the disease by their breath, milk, discharge from lesions, saliva, urine, or feces. The skin and IFN-gamma test are two types of tests for bovine tuberculosis. For the skin test, a tiny amount of bovine tuberculin (a protein derivative of M. bovis) is injected into cattle, and after 72 hours, the immunological response is assessed [32]. For the IFN-gamma test, a blood sample from the animal is taken. The blood sample is then incubated with M. Pavis antigens [32] to show the presence of M. Bovis.

3.2.4 Coronaviridae

Coronaviridae is responsible for bovine coronavirus (BCoV). It is a 31-kb genome, which codes for five major structural proteins, including the nucleocapsid, hemagglutinin esterase, membrane, spike (S), and envelope proteins. It is an envelope, a single-stranded, positive-sense RNA virus [33]. The respiratory and intestinal epithelial cells of cattle are primarily infected during transmission [34]. The typical incubation period for infection in cattle is one week to three months [33]. Numerous indications include anorexia, dehydration, melancholy, and severe diarrhea. With a secondary bacterial infection, symptoms could get worse. Although BCoV infection has a low mortality rate, it often manifests in cattle of all ages with a high

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morbidity [35]. Compared to tropical settings, temperate regions allow BCoV to stay longer in colder temperatures and hence remain active in the environment year-round [36].

3.2.5 Bacteria Dermatophilosis Congolensis

Bacteria *Dermatophilosis congolensis* is the cause of the infectious dermatitis known as streptothricosis in livestock [37]. Cattle suffering from severe dermatophilosis are normally found in Africa and the Caribbean. There are two distinct manifestations: the summer form, which is less severe, and the winter form, which is more severe [37]. Cattle are typically affected on the back, head, and neck, which are popular areas for insect bites, as well as the legs, which are more likely to become infected if the cattle are kept on a moist ground [38]. The cattle will first have lumps and a matted coat, which will develop into crusty scabs and sores over time. Additionally, the animal shows signs of pain [38]. The most frequent method of diagnosis involves microscopic examination to identify bacteria in lesions. The infection is confirmed if filamentous bacteria are seen. Blood agar cultures can be generated to confirm the presence of D. Congolensis when a diagnosis cannot be verified under the microscope.

3.3 Other Infections

Other infections apart from the major ones reported were also identified. These included Brucellosis, echinococcosis, Bovine Alpha Herpesvirus 1, and *Ehrlichia minasensis*. Brucellosis is a contagious disease that results from direct exposure to infected animals or animal products contaminated with *Brucella melitensis* [39]. *Cystic echinococcosis* is a neglected tropical disease caused by the larval stage of the canine tapeworm *Echinococcus granulosus sensu lato* [40]. The annual cost of treating cystic echinococcosis in people and the losses suffered from the condemnation of infected organs in animals is estimated to be $3 billion [41]. Bovine Alpha Herpesvirus 1 is caused by *Varicellovirus* and *Alphaherpesvirinae* [42]. Cattle's upper respiratory or vaginal tract mucosal membranes can become infected with BoHV-1 naturally by contact with the virus [43]. Aerosolised viruses, or viruses directly contacted in nasal secretions, can enter the respiratory system [42]. Clinical signs include anorexia, pyrexia, lethargy, and an elevated respiratory rate accompanied by a persistently severe cough [44]. There is also a marked decline in milk production in adult dairy cows. Clinical symptoms and severity of BoHV-1 are influenced by a number of parameters, including host age, resistance factors, subsequent bacterial infection, infected tissue type, and strain-specific pathogenicity [44]. *Ehrlichia minasensis* is a novel species of obligate intracellular bacteria carried by ticks that cause infections in cattle. It is composed of various pathogenic species. Signs of infection in cattle include depression, anorexia, fever, and lethargy. [45].

3.4 The Prevalence of Cattle Infection

The prevalence of these infections in Ghana was analyzed. From the results, trypanosomiasis was very high among the other infections; its percentage prevalence was 36%, indicating that, it frequently affects cattle (Figure 2). Bovine tuberculosis recorded a percentage prevalence of 15%, the second highest and a little higher than Helminth infection (14%) and Unspecified infections (14%) (Figure 2). Between the year 1990 and 2022, 2020 and 2022 recorded the highest number of articles published on cattle infection in Ghana, twice as much as in any other year (Figure 3). This indicates that a lot of cases were recorded in that year. Among the 16 regions of Ghana, Greater Accra recorded the highest report of Cattle Cases (5 cases), followed by Northern (4 cases) and Volta (2 cases). The rest of the regions recorded only one case. Studies employed in the investigation of these cattle infections were categorized into 3. They were cross-sectional study, longitudinal study, epidemiological/experimental study, and studies not stated clearly (Figure 3). Epidemiological or experimental studies were utilized in 50% of research on these infections, followed by unclear study types at 22%, cross-sectional studies at 21%, and longitudinal studies at 7%.

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Etwire *et al.*., *Adv. J. Grad. Res.;* Vol. 15, Issue 1, pp: 22-33, December 2024

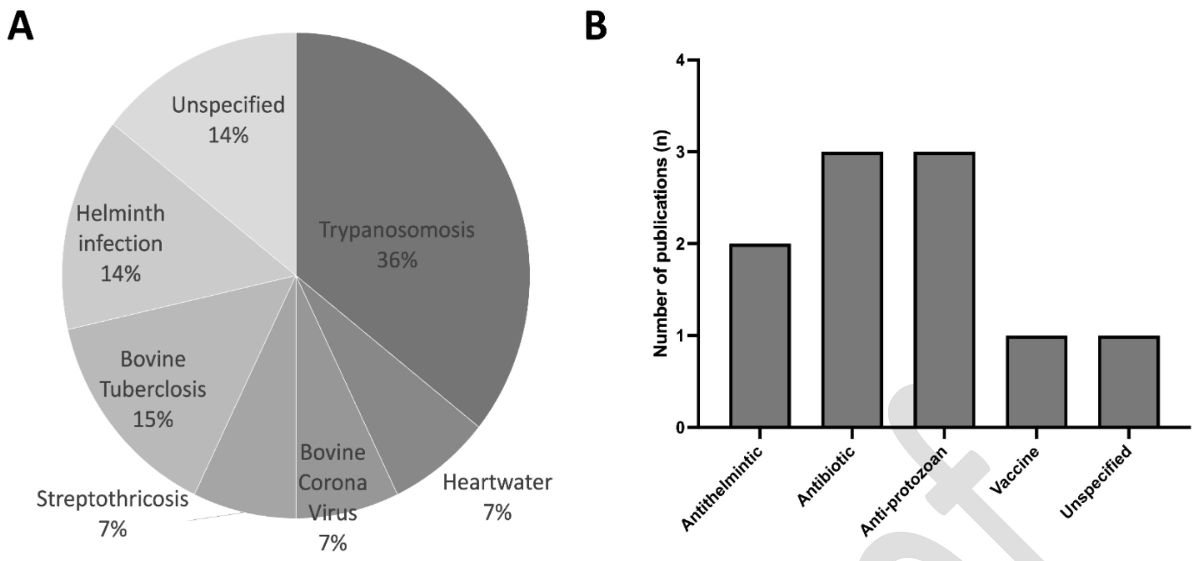

Figure 2: *Cattle infections and treatments.*
(A) Cattle infections reported in Ghana. (B) Treatments given to the infected animals

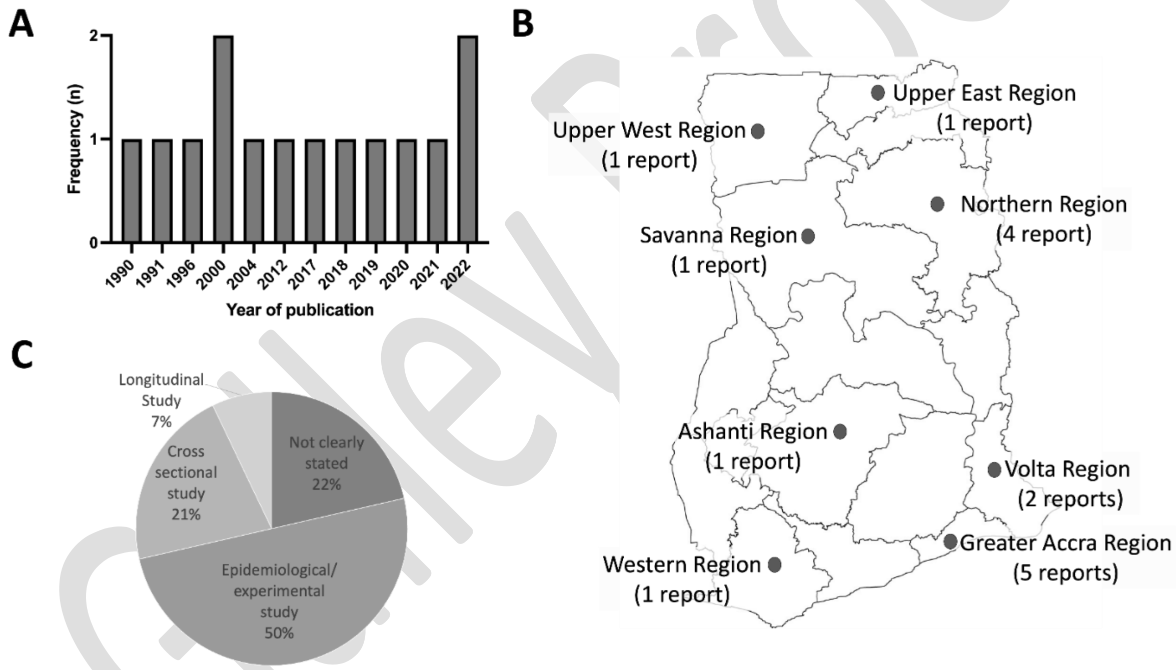

Figure 3: *Characteristics of publications retrieved and included in this study. (A) Year of publication; (B) geographical report of infections; (C) study designs used to investigate cattle infections*

3.5 Treatment of Cattle Infection

Cattle infections cause large financial losses, which have an adverse effect on the global community and animals. These infections cause adverse effects on animal feed intake, growth rate, carcass weight composition, wool growth, fertility, and milk output [46]. Numerous factors, including temperature and geographic conditions, vegetation, livestock density, and management, might affect the occurrence of these illnesses in animals. Treatment is very important because it helps eradicate infections affecting cattle production. These treatments reported include the use of anthelmintic drugs, antiprotozoal drugs, antibiotics, and vaccines. Antibiotics and antiprotozoal are commonly used treatments for cattle infections.

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The study revealed that, anthelmintic drugs were used higher than vaccines. Vaccines and unspecified treatments recorded the same number.

3.5.1 Anthelmintic

Anthelmintic Drugs are utilized to treat infections caused by parasitic worms or helminths [47]. The primary role of anthelmintic medications is to remove parasitic worms from the host's body. Anthelmintic interferes with vital physiological and biochemical functions of parasitic worms (helminths). The idea is to target parasites and render them immobile or dead so that the host's immune system or natural processes can eradicate worms. Fenbendazole is a common example of an anthelmintic drug used to treat these infections caused by worms or helminths in cattle [48]. Its molecular mechanism of action involves interrupting cellular processes and tampering with the microtubule structures of the parasites. It functions similarly to other anthelmintics in the benzimidazole class. Microtubules constitute the essential structural elements of the worm's cytoskeleton and play a role in a variety of biological functions, including intracellular transport, cell division, and shape maintenance. Fenbendazole inhibits the polymerisation and assembly of microtubules through binding to beta-tubulin. The disturbance restricts the parasites' biological functions, specifically their capacity to divide their cells through mitosis. Consequently, parasites experience cell cycle arrest and compromised reproduction as a result of their inability to correctly partition their chromosomes during cell division. The disruption of microtubule activity finally causes the parasites to become paralyzed. Worms that are paralysed cannot continue moving or functioning normally. Restrictions on mobility have the potential to kill the worms or, in rare situations, force them out of the host's digestive system.

3.5.2 Antibiotics

Antibiotics are utilized to treat infections caused by bacteria by either killing them or stopping their growth and reproduction [49]. Antibiotics are extremely effective medical instruments that have been used to treat a variety of cattle infections, such as heartwater infections [50]. Treatment for heartwater infections involves the use of two types of antibiotics: sulfonamides and tetracyclines [51]. Doxycycline, an example of tetracycline, works by interfering with the bacterial protein synthesis. Tetracyclines attach themselves to the bacterial ribosome, the part of the cell that makes proteins. In prokaryotic (bacterial) cells, they primarily target 30S ribosomal subunit [52]. It stops aminoacyl-tRNA molecules from attaching themselves to the ribosome. During protein synthesis, amino acids must be added to the expanding polypeptide chain. When this process is achieved, tetracyclines effectively avoid the developing polypeptide chain from lengthening [52]. This interference obstructs the translation process, which uses the genetic information in mRNA to put together proteins. Sulfonamides, also referred to as sulfa medicines, work by interfering with folic acid production. Folic acid is a cofactor that is required for the synthesis of proteins, RNA, and DNA in bacterial cells. The precursor molecule for the bacterial manufacture of folic acid, para-aminobenzoic acid (PABA), is structurally analogous to sulfonamides [52]. Bacteria synthesize the fully active form of folic acid by starting with dihydrofolic acid as the initial substrate. Sulfonamides act as competitive inhibitors, binding to and blocking the active site of the enzyme dihydropteroate synthase, which is involved in the conversion of PABA to dihydrofolic acid [52]. This binding interferes with the enzymatic reaction, preventing the production of dihydrofolic. When this is achieved, it hinders the bacterial cell's ability to synthesize folic acid [52].

3.5.3 Antiprotozoal

Antiprotozoal agents are a group of medications used to treat infections caused by protozoa [53]. Some agents that inhibit protozoa include isometamidium chloride and diminazen aceturate [54]. Their mechanisms of action are identical. These drugs work by interacting with the parasite's DNA, causing damage to the DNA and eventually the parasite's death. Once within the parasite's cells, the medication attaches itself to its DNA and begins to interact with it [55]. When diminazen aceturate and parasite DNA combine, stable complexes are formed. These complexes hinder the parasite's ability to replicate DNA and

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transcribe it normally, which stops it from creating vital genetic material. Consequently, the parasites' inability to precisely copy their DNA results in mutations and the loss of genetic integrity. The buildup of DNA damage prevents the parasites from proliferating and growing.

3.5.4 Vaccines

Vaccines are biological substances created to stimulate immunity against particular infectious diseases. They are one of the most effective and important tools in public health for preventing and controlling the spread of infectious diseases [56]. Vaccines function by stimulating the immune system to identify and retain a specific pathogen. In this manner, the immune system of the vaccinated person may react and protect itself against the virus as soon as it comes into contact with it [56]. An example of a vaccine used for cattle infection is Adjuvanted Protein Subunit Vaccine M72/AS01E [57]. Purified protein subunits from the pathogen, for example, *Mycobacterium tuberculosis*, and an adjuvant are combined to create adjuvanted protein subunit vaccines [57]. These vaccines function by inducing a strong and targeted immune response against the pathogen proteins, particularly targeting *Mycobacterium tuberculosis*. M72/AS01E is intended to provide protection against TB. Certain bacterial protein components, or antigens, are included in the vaccine because they are known to be critical to the pathogen's vitality and pathogenicity [58]. These antigens have been chosen with care to elicit an immune response that is defensive [58]. The *Mycobacterium* TB protein subunits are the target of these antibodies in the instance of M72/AS01E. The immune system produces memory T and B cells, which are able to remember the antigens of the disease. If the person later encounters Mycobacterium tuberculosis, this immune memory allows the immune system to respond rapidly.

3.5.5 Prevention

With increasing infections in cattle, it is necessary to adopt preventive measures along with various treatments for effective eradication. A variety of measures are available that go beyond traditional approaches. By combining state-of-the-art methods and holistic approaches, using taurine breeds can enhance ecological agricultural methods while also utilizing genetic resistance [59]. Treating potential external dangers and internal parasites, deworming, and blanket treatments provides additional levels of defense [60]. One method that shows potential is artificial insemination, which allows for a regulated genetic variety for improved disease resistance [60]. The integration of good sanitation practices ensures a hygienic environment, limiting the breeding grounds for pathogens [61]. Using natural plant medicine as a supplement to the traditional veterinarian care gives the herd's general health even more support [62]. A healthy diet plays an important role in enhancing the immune function, which is beneficial for a robust and thriving cattle herd despite the challenges of infectious illnesses. [63].

4 Conclusion

This study offers valuable insights into the complexities of livestock health management. Infections such as trypanosomiasis, bovine tuberculosis, and others have been identified as significant challenges, leading to considerable economic losses and reduced cattle productivity. Despite advances in treatments like antibiotics and vaccines, there remains a crucial need for more effective and accessible diagnostic tools to ensure early detection. A stronger focus on research, innovative technologies, and the integration of molecular diagnostics can greatly enhance the management and control of cattle infections. Addressing these issues is critical not only for improving cattle health but also for safeguarding food security, public health, and the broader economic landscape in Ghana and similar regions. Ultimately, a multi-faceted approach combining advanced diagnostics, preventive strategies like vaccination, and effective biosecurity measures will be essential in mitigating the impact of cattle infections. Researchers should prioritize the development of cost-effective and user-friendly diagnostic technologies, which can be deployed widely across affected regions. Collaboration between veterinarians, researchers, and policymakers will play a pivotal role in creating sustainable solutions for livestock management in Ghana.

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5 Declarations

5.1 Study Limitations

Lack of access to complete and consistent data on cattle illnesses across various regions posed a significant challenge and hence may have affected the findings. Inadequate reporting mechanisms can obscure the full extent of cattle health issues, leading to gaps in understanding the national picture of infection control. Additionally, the variability in study designs and methodologies used across the included studies added complexity to the analysis. Language barriers may have restricted the inclusion of relevant studies, as some potentially informative data might not have been accessible due to language constraints or limited availability in scientific databases. These limitations could potentially introduce bias in estimating the disease prevalence and treatment efficacy.

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5.3 Competing Interests

The authors declared that no conflict of interest exists.

5.4 Publisher's Note

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