Tuberculosis prevalence among livestock in Djibouti: A regional investigation and herbal treatment recommendations

Fatouma MOHAMED ABDOU-LATIF*, Ahmed ABDALLAH OKIEH, Ali MERITO ALI, Abdillahi ADEN DJAMA

Medicinal Research Institute, Center for Research and Study of Djibouti, BP 486, Djibouti.

ARTICLE INFO
Received May 21st, 2023
Received in revised form May 22nd, 2023
Accepted July 25th, 2023

Keywords:
Tuberculosis, Djibouti, Mycobacterium, Prevalence, i-ELISA, Herbal treatment.

ABSTRACT
Bovine tuberculosis is a persistent animal disease primarily affecting cattle, but also known to affect other mammalian species. As a significant zoonosis, it can be transmitted to humans through inhalation of aerosols or consumption of unpasteurized milk. The causative agent of bovine tuberculosis is Mycobacterium bovis. Despite its status as a serious zoonotic concern, there is a lack of epidemiological data concerning Djibouti. To address this gap, we conducted an exploratory study in Djibouti, encompassing fifty-three livestock farms across six regions or districts (Djibouti City, Arta, Ali Sabieh, Dikhil, Tadjourah, and Obock). The objective was to determine the prevalence of bovine tuberculosis within herds. For diagnostic purposes, Mycobacterium bovis was identified using immune-chromatography and indirect Enzyme-Linked Immunosorbent Assay (i-ELISA) on blood samples collected from 252 cattle on these farms. The study revealed 35 positive cases of bovine tuberculosis, with these cases being isolated to only two regions: Djibouti City (19 positive cows, 16.66% prevalence) and Tadjourah (16 positive cows, 14.41% prevalence), resulting in an overall prevalence of 13.88%. Tuberculosis remains a significant zoonotic concern in the region, prompting farmers to employ various herbal remedies for its management. Many of these herbal treatments are concentrated within Day National Park in Djibouti.

© 2023 EST-Khenifra, University of Sultan Moulay Slimane. All rights reserved.

1. Introduction:
Animal tuberculosis, particularly bovine tuberculosis, recognized as a chronic ailment, is triggered by the bacterium Mycobacterium bovis, which bears a close kinship to the agent responsible for human and avian tuberculosis [1]. This disease holds sway as a significant infectious threat to cattle, also extending its grasp to impact other domesticated animals and certain wildlife species, inducing a range of maladies including general ailment, pneumonia, weight loss, and eventual mortality [2]. While cattle emerge as the presumed primary reservoir for M. bovis and a pivotal source of human infection, the disease's reach extends to numerous other domestic and non-domestic creatures [3].

The sphere of bovine tuberculosis encompasses dimensions far beyond mere livestock concerns, entailing profound ramifications for public health, wildlife preservation, international trade, tourism, and an array of other public and private domains [4]. In many developing nations, extensive rural populations not only grapple with elevated risks of zoonotic diseases due to close livestock interactions but also remain susceptible to poverty's grasp, catalyzed by reduced livestock productivity, institutional deficiencies, and the absence of structured disease control mechanisms [5]. Cattle, pivotal to

(*) Corresponding author:
Tel.: + 253 77 03 27 81
E-mail address: fatouma_abdoulatif@yahoo.fr
livelihoods, suffer productivity losses primarily marked by diminished milk and meat output alongside escalated production efforts [6].

The genesis of this bacterium can be traced back to domestic cattle, with transmission pathways encompassing various avenues, although the respiratory and gastrointestinal routes remain predominant. Human vulnerability to infection arises from consuming unpasteurized cow's milk or direct exposure to contaminated tissues in abattoirs or slaughterhouses [7]. The disease's progression is gradual, spanning months or even years before culminating in fatality, thereby enabling infected animals to silently disseminate the bacteria within a herd prior to the emergence of clinical signs [8]. The inconspicuous movement of these carriers thus stands as a potent vector, facilitating the disease's propagation. Within cattle farming contexts, the primary wellspring of *M. bovis* often lies in infected resident cattle within the herd or those introduced from external sources [9]. In regions grappling with elevated *M. bovis* prevalence, curbing fresh human infections necessitates comprehensive education initiatives to enhance awareness, fortified food hygiene practices, and refined animal handling to minimize exposure, while concurrently striving to curtail *M. bovis* levels among cattle.

The widespread use of antibiotics by livestock producers fosters the emergence of novel drug-resistant strains, some of which bear zoonotic implications, precipitating a surge in foodborne illnesses among human populations [10]. In light of this challenge, the exploration of plant-based platforms for the development of recombinant therapeutic proteins offers a promising pathway, replete with advantages such as the absence of animal-borne pathogens, cost-effectiveness, swift processing and response times, and the potential for rapid, extensive upscaling [11-13]. Effectively curtailing bovine tuberculosis presents a complex undertaking that hinges on a nuanced comprehension of infection dynamics within the broader ecological context, spanning humans, domesticated animals, and diverse wildlife species [14]. A noteworthy component of successful animal disease control initiatives is the practice of compensating farmers for culling affected animals. However, for most developing nations, implementing control programs predicated on compensatory mechanisms remains a challenge. Zoonotic diseases, particularly bovine tuberculosis, are intrinsically interwoven with the intricate web of poverty-associated challenges.

Bovine tuberculosis looms as a formidable zoonotic threat. However, the absence of comprehensive epidemiological data on animals hampers a holistic understanding. Thus, the present study seeks to contribute by updating epidemiological knowledge concerning bovine tuberculosis in central Djibouti. Conducted by the Center for Research and Study of Djibouti (CERD), the study's objective is to identify afflicted animals capable of transmitting tuberculosis to humans. As this research strives to bridge gaps in knowledge, it underscores the pivotal role of informed scientific inquiry in tackling the intricate challenges posed by zoonotic diseases, ultimately safeguarding both human and animal well-being.

2. Materials and methods:
2.1. Study area and sample collection:
This study encompassed a total of fifty-three farms spanning the six regions or districts of Djibouti, namely Djibouti City, Arta, Ali Sabieh, Dikhil, Tadjourah, and Obock. The focus of this investigation centered on the detection of *M. bovis*, the causative agent of tuberculosis, and for this purpose, the sample size was confined to 252 cattle.

2.2. Diagnosis of bovine tuberculosis:
Diagnosing bovine tuberculosis involves the utilization of two established serological tests for detecting the presence of *Mycobacterium bovis*:

- **Immuno-chromatographic Test:**
The immuno-chromatographic test offers a rapid and uncomplicated diagnostic approach, particularly suitable for field settings. It functions by facilitating the movement of liquid across a nitrocellulose membrane surface, and its popularity has grown over the past decade due to its convenience and versatility. This format yields results in approximately 20 minutes and requires only a small volume of serum (<200 µL), which is applied to the test strip. Notably, the immuno-chromatographic test kits employed for detecting *M. bovis* include the "ANTIGEN RAPID BOVINE TB Ab TEST KIT." These kits are supplied by BIONOTE (Bionote Inc), a South Korean company specializing in developing and manufacturing diagnostic kits for both human and animal diseases since 2003 [15].

- **i-ELISA - IDEXX M. bovis Antibody Test Kit:**
The IDEXX *M. bovis* Ab Test is meticulously designed to detect antibodies to *M. bovis* in serum and plasma samples obtained from bovines. Integration of the IDEXX *M. bovis* Ab Test into bovine tuberculosis (bTB) control programs enhances detection precision by identifying infections that may evade other diagnostic methodologies. This test stands as a robust and reproducible tool, offering a swift 2-hour protocol for quantifiable and objective outcomes. The user-friendly IDEXX *M. bovis* ELISA format requires no specialized training or handling procedures and can be repeatedly employed as necessary, facilitating streamlined bTB monitoring [16].
2.3. Herbal treatment surveys:
To gather herbal treatment recommendations, an inquiry was conducted to catalog the herbs employed within the scope of this research. A comprehensive questionnaire and interview guide were formulated, encompassing both traditional healers and agriculturalists. The analysis of outcomes was undertaken by the CERD team, scrutinizing responses to discern prevalent patterns and recurrent motifs. These findings were construed to fathom the underlying motivations and perceptions underpinning the employment of herbal treatments. The deductions were disseminated within the scientific community through collaboration with national and international scholars, facilitated by a compilation of articles within the Djibouti medicinal plants thematic domain.

3. Results:
Based on the data outlined in Table 1, among the 252 blood samples collected from cattle within the farms for *M. bovis* analysis, 35 blood samples exhibited positive outcomes (indicating presence of *M. bovis*). Consequently, 35 cows were identified as carriers of bovine tuberculosis, amounting to a prevalence of 13.88% among the bovine population in the Republic of Djibouti.

### Table 1. Distribution of tuberculosis prevalence by farm and grouping by locality.

<table>
<thead>
<tr>
<th>Localities</th>
<th>Type of herd</th>
<th>Number (Serum)</th>
<th>Positive animal</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Test IC</td>
<td>Test iELISA</td>
<td>Test IC</td>
</tr>
<tr>
<td>Djibouti</td>
<td>Cattle</td>
<td>114</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Arta</td>
<td></td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ali Sabieh</td>
<td></td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dikhil</td>
<td></td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tadjourah</td>
<td></td>
<td>111</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Obock</td>
<td></td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>252</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

The prevalence of these infected cows is concentrated exclusively within two specific regions: Djibouti City and the Tadjourah Region. Precisely, 19 positive cases (accounting for 16.66%) were identified in Djibouti City, while another 16 positive cases (14.41%) were observed in the Tadjourah Region. Evidently, the remaining four regions, namely ARTA, ALI-SABIEH, DIKHIL, and OBOCK, have not been affected by bovine tuberculosis. Consequently, it becomes evident that the risk of bovine tuberculosis in cattle is notably elevated and is currently confined to solely these two regions, Djibouti and Tadjourah, as depicted in Figure 1. Thus, a pivotal imperative emerges to eliminate the disease from these specific regions, a crucial measure to avert its potential transformation into a significant public health concern.

![Figure 1. Distribution of tuberculosis in Djibouti.](image-url)
4. Discussion:

Tuberculosis, a disease with the potential to rapidly escalate into a significant epidemic due to its high transmission rate, is classified as a notifiable communicable illness. Its intrinsic clinical variability necessitates a comprehensive grasp of the underlying activation mechanisms for accurate diagnosis, prompting further testing [17]. The gravity of tuberculosis is underscored by the existence of secondary lesions, some of which could prove life-threatening, compelling prolonged antibiotic administration and, in certain severe instances, surgical intervention. The magnitude of its impact on individuals is thus intricately linked to the severity of secondary lesions. In an overarching bid to curtail its reach, the emphasis pivots towards a preventive approach, encompassing rigorous hygiene practices, raising public awareness, advocating against the consumption of unpasteurized dairy products, and an emphasis on livestock vaccination [18].

Djibouti, on the other hand, boasts an extraordinary reservoir of biodiversity, housing a diverse spectrum of plant species that hold promise for a myriad of medical applications. Scientists and researchers have embarked on an extensive exploration of these botanical resources, uncovering their potential for diverse disease treatments [19-23]. This exploration has culminated in the identification of plant-based bioreactors as a promising avenue for the production of recombinant protein therapeutics targeting animal health. This innovative approach underscores the convergence of traditional wisdom and cutting-edge biotechnology to address contemporary challenges [24-26].

The burgeoning interest in herbal remedies within the realm of veterinary medicine is driven by multifaceted factors. One salient catalyst for this resurgence is the pervasive public sentiment that medicinal plants harbor efficacy and safety advantages over synthetic compounds. This resounding belief resonates with both practitioners and the general populace, contributing to the growing prominence of herbal treatments in veterinary care. The profound shift towards herbal interventions reflects an evolving paradigm in veterinary medicine, one that aligns with holistic approaches and a deeper connection with nature [27].

At the heart of the epidemiology of bovine tuberculosis lies an enigmatic paradox: a disparity between the low prevalence at the individual level and a heightened prevalence within herds. This intricate interplay between individual and communal dynamics engenders a unique disease profile, where numerous instances of the affliction manifest at sub-threshold levels across multiple herds. This curious pattern stems from the intricate dance of infection dynamics and management practices that limit the unfettered transmission of the disease within impacted groups. The very nature of this paradox underscores the complexity inherent in understanding the dissemination of bovine tuberculosis and further underscores the need for multi-dimensional strategies for control and prevention [28].

In the context of Djibouti, the ramifications of bovine tuberculosis on both livestock productivity and public health remain somewhat contained. The scarcity of advanced strains capable of posing a direct threat to humans via the consumption of raw milk serves as a mitigating factor. However, the presence of even these isolated instances underscores the latent potential for transmission and necessitates vigilance. As farming practices intensify and anthropogenic and environmental factors evolve, the latent risks associated with bovine tuberculosis's spillover into human populations could be exacerbated. Thus, the intrinsic imperative to mitigate these risks through strategic interventions becomes more pressing than ever.

The identification of epidemiological profiles serves as a linchpin in the broader strategy of disease management. This strategic approach is exemplified by a dual-pronged approach involving the elimination of disease reservoirs, coupled with vigilant regulation of livestock imports into herds deemed free of the ailment [29]. This two-fold strategy not only safeguards the health and well-being of animals but also extends its protective embrace to encompass human populations. A microcosmic representation of this strategic vision can be discerned in the domain of peri-urban milk production, where a comprehensive approach to disease control, encompassing both veterinary and public health perspectives, could be instrumental in optimizing outcomes [30]. As the field of veterinary medicine continues to evolve, driven by insights from interdisciplinary collaborations, it is imperative to view challenges through a holistic lens. Djibouti's pursuit of tackling bovine tuberculosis stands as a testament to the interconnectedness of animal health, human well-being, and environmental dynamics. In essence, the journey of understanding, managing, and ultimately eradicating bovine tuberculosis in Djibouti, as in any other region, is an intricate tapestry woven from the threads of scientific inquiry, traditional knowledge, and a steadfast commitment to safeguarding life in all its diverse forms [31-32].

Finally, the complex interplay between tuberculosis and the rich biodiversity of Djibouti presents a multifaceted tapestry of challenges and opportunities. Tuberculosis, with its potential to transform into an epidemic of significant proportions, demands vigilance, early detection, and stringent preventive measures. Meanwhile, Djibouti's abundant plant species offer a realm of possibilities for novel therapeutic interventions, necessitating a harmonious fusion of traditional wisdom and modern science. As Djibouti navigates the intricate landscape of disease control and prevention, it embarks on a journey that reflects the symbiotic relationship between nature and humanity. This journey calls for collaborative efforts, transcending boundaries, and seamlessly blending knowledge from diverse domains to safeguard not only the well-being of animals and humans but also the delicate equilibrium of its unique ecosystem. In this intricate dance between science and nature, Djibouti's pursuit of holistic health represents a harmonious symphony echoing across the realms of biology, ecology, and human society.
5. Conclusion:
This study reveals a tuberculosis prevalence of 13.88% among cattle herds in Djibouti. Validating the findings through bacterium identification in cattle lesions at slaughterhouses would strengthen their credibility. The results provide crucial insights into Djibouti's tuberculosis landscape, underscoring the urgent need for action. While estimations rely on previously collected sera, Djibouti's rich biodiversity offers potential solutions worth exploring. Investigating indigenous plant species with traditional knowledge and modern methods could yield innovative medical applications, particularly for tuberculosis. This comprehensive approach presents a robust alternative to relying solely on imperfect diagnostic tests. Djibouti's strategic stance at the forefront of disease management blends scientific advancements with nature's wisdom, bolstering efforts to combat tuberculosis and safeguard public health.

Acknowledgment:
Our sincere gratitude extends to the CERD of Djibouti for their seamless facilitation in providing access to invaluable data and information, alongside the unwavering support of our esteemed national and international partners.

Funding: This research received no external funding.
Institutional Review Board Statement: Not applicable.
Informed Consent Statement: Not applicable.
Data Availability Statement: Data is contained within the article.
Conflicts of Interest: The authors declare no conflict of interest.

References:


© JASAB 2023