BOVINE BRUCELLOSIS: EMPHASIS ON PREVENTION AND CONTROL

https://doi.org/10.56238/sevened2024.030-016

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ABSTRACT

Every year Brazil advances in cattle production, facing challenges that cause economic losses, including diseases. This chapter aims to address the general aspects of brucellosis, with a focus on prevention and control. Brucellosis is a bacterial infection caused by bacteria of the genus Brucellas spp., of chronic evolution, whose main clinical sign in the herd is abortions in the final third of gestation, of wide worldwide distribution, of significant importance due to economic losses and its zoonotic character, in addition to being a notifiable disease. The economic importance attributed is related to the possibility of infection in humans, productive losses of the herd, death of animals, decrease in milk production, early disposal, elimination of animals of high zootechnical value and condemnation of carcasses at slaughter. It is estimated a loss of 10% to 25% of the productive efficiency of infected animals. Being considered an occupational disease, they affect farmers, handlers, veterinarians, vaccinators, laboratory workers, slaughterhouse workers, due to the routine of direct contact with infected animals and/or their secretions. In 2001, the government established the National Program for the Control and Eradication of Brucellosis and Tuberculosis (PNCEBT), revised by IN No. 10 of 2017. The PNCEBT recommends the vaccination of bovine and buffalo females between 3 and 8 months of age against brucellosis, elimination of carriers, tests with negative results for transit regardless of the purpose and certification of properties free of brucellosis or tuberculosis. The lack of knowledge and negligence about brucellosis puts the health of productive herds and citizens at risk.

Keywords: Zoonoses. Preventive measures. Cattle farming.

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INTRODUCTION

Cattle production has exponential growth every year. According to the IBGE, in 2022, Brazil reached a milestone of 234.4 million cattle, an increase of 4.3% compared to 2021 (Brasil, 2023a). Regardless of economic exploitation, whether focused on beef or milk, producers face challenges in breeding, with market variation, high input prices, low financial recognition and diseases in the herd that cause economic losses.

Among the diseases that affect the herd is Brucellosis, a bacterial infection caused by bacteria of the genus *Brucellas spp.,* of chronic evolution, whose main clinical sign in the herd is abortions in the final third of gestation, of wide worldwide distribution, has a significant importance due to economic losses and its zoonotic character (Brasil, 2017a. Sola, *et al*., 2014).

The economic importance attributed to zoonoses is related to the possibility of infection in humans, productive losses of the herd, death of animals, drop in weight gain, decrease in milk production, early disposal, elimination of animals of high zootechnical value and condemnation of carcasses at slaughter. It is estimated a loss of 10% to 25% of the productive efficiency of infected animals, losing the authority and credibility of the production unit where the disease is detected (Murakami *et al.*, 2009; Barcellos *et al.*, 2019).

Over the years, noting the importance of zoonoses, the government established programs aimed at prevention and eradication, contributing to the sustainability of national livestock, governed by the Ministry of Agriculture, Livestock and Supply (MAPA) (Nicodemo; Gusmão, 2012), among them is the National Program for the Control and Eradication of Brucellosis and Tuberculosis (PNCEBT).

The PNCEBT was instituted in 2001, revised in 2017 by Normative Instruction No. 10, with the objective of reducing the prevalence and incidence of brucellosis and tuberculosis, aiming at eradication. The current legislation recommends compulsory sanitary measures and voluntary adherence measures. Among the compulsory measures are vaccinations of bovine and buffalo females between 3 and 8 months of age against brucellosis, elimination of carriers, tests with negative results for transit and participation in livestock events. The voluntary measure, on the other hand, consists of the certification of brucellosis-free properties (Brasil, 2017; Brazil, 2024b).

In 2013, Normative Instruction No. 50, of September 24, 2013, listed the diseases subject to Mandatory Notification, where brucellosis falls into diseases of immediate notification in confirmed cases (Brasil, 2013).

Being considered an occupational disease, that is, an illness related to the exercise of work, which affects; farmers, handlers, veterinarians, vaccinators, laboratory workers, slaughterhouse workers, due to the routine of direct contact with infected animals and/or their secretions, handling of vaccines, risk of contamination via penetration through intact or injured skin, formation of aerosols, and the handling of carcasses of infected animals (Brasil, 2024b).

Possible gaps in knowledge about Brucellosis put the health of productive herds and citizens at risk. Therefore, this chapter aims to address the general aspects of this zoonosis, focusing on prevention and control.

BOVINE BRUCELLOSIS

ETIOLOGICAL AGENT

Brucellosis is an infectious-contagious disease, with a chronic evolution and diffuse granulomatous character (Paulin; Ferreira Neto, 2003), of great importance for public health due to its zoonotic characteristic. Its etiological agent is bacteria of the genus *Brucella spp.,* characterized by infertility and abortion in the final third of gestation in bovine and buffalo species (Brasil, 2017a). The disease has some synonyms such as Bang's disease or disease, infectious abortion, contagious abortion, these described for cattle, while in humans it is known as undulating fever, Maltese fever, Mediterranean fever and Gibraltar fever (Megid; Brook; Paes, 2016).

Caused by an obligate intracellular bacterium, they belong to the class *Proteobacteria*, gram negative, short rods measuring from 0.6 to 1.5 micrometer (μm) by 0.5 to 0.7 μm in size, immobile and non-spore-forming, considered aerobic, multiply in the range of 20 to 40 Degree Celsius (ºC), where 37 ºC is the ideal temperature, pH from 6.6 to 7.4, some strains require carbon dioxide (CO2) supplementation for multiplication (Sola *et al*., 2014; Megid; Brook; Paes, 2016), affects several species, including domestic animals, wild animals and humans (Ayres; Rabbit; Neto, 2018).

Species include *Brucella abortus, Brucella militensis, Brucella suis, Brucella canis, Brucella ovis, Brucella neotomae, Brucella microti, Brucella ceti, Brucella pinnipedialis,* and *Brucella inopinata.* There is no specificity as to the host that infects, but a predilection for the corresponding species (Gomes, 2013; Sola *et al*., 2014).

They may present primary cultures with smooth or rough colonial morphology, which may vary in strict rough or mucoid, morphology associated with the biochemical composition of the lipopolysaccharide of the cell wall, and for some species are related to the virulence of the agent. B . *abortus, B. melitensis and B. suis* usually have a smooth morphology and

can evolve into rough or mucoid, ceasing to be pathogenic. Although cattle and buffaloes are susceptible to *B. suis* and *B. melitensis,* the most important species is *B. abortus*, which is responsible for the vast majority of infections (Brasil, 2024b).

The resistance of this species outside the host is about five days at room temperature, 30 to 37 days in the soil and 75 days in the fetus (Gomes, 2013; Sola *et al*., 2014). Favorable conditions of pH, temperature and light favor the viability of the agent in water, fetuses, placental remains, feces, wool, hay, materials and clothing (Sola *et al.*, 2014).

EPIDEMIOLOGY

Brucellosis is distributed worldwide, being considered one of the main zoonoses (Sola *et al.*, 2014). In Brazil, it is characterized by being an endemic disease in almost the entire national territory, regardless of the mode of creation and economic exploitation (Megid; Brook; Paes, 2016).

The species *B. abortus* is the most widely spread, preferentially infecting buffaloes and cattle, and is the most important for cattle farming, due to economic losses (Costa *et al.*, 2022).

Brazilian states present variations, due to their territorial dimension and their own characteristics (Lage *et al*., 2008). According to the data processed in 1975, bovine brucellosis was present throughout the national territory. The estimated prevalences by regions were as follows: Central-West 6.8%; Northeast, 2.5%; North, 4.1%; Southeast, 7.5% and South, 4%. Other surveys were carried out over the years, but they did not show significant changes in relation to the 1975 data, indicating a prevalence of 4 and 5% of seropositive animals (BRASIL, 2006), so the epidemiological situation of brucellosis in Brazil is not well elucidated (Lira, 2015).

The southern region of the country, especially the state of Santa Catarina (SC), has a low prevalence of the disease, due to this low, vaccination is not mandatory, being an example to be followed by the other states, seeking to achieve the eradication of brucellosis (Ferreira Neto, 2009).

According to the Coordination of Information and Epidemiology - Animal Health, MAPA (2024), 432,644 cases of Brucellosis in cattle were recorded in Brazil from 1999 to 2023, showing a higher number of cases in 2004 (Brasil, 2024d).

TRANSMISSION

Transmission can happen directly and indirectly. The direct form happens through contact with secretions from infected cows, which eliminate the agent at the time of calving, abortion or during the puerperal period. The form of indirect contagion is through contaminated water, pastures, and fomites (Brasil, 2020c). In cattle, most infections occur through ingestion of contaminated pastures, food and water, the direct form also occurs from direct contact with the infected animal or contaminated semen (Megid; Brook; Paes, 2016; Battle-axe; Szyfres, 2003).

Contamination of pastures and food occurs through the elimination of discharge and fetal membranes from infected cows, as well as contact with aborted fetuses and infected newborn calves. The risk of postpartum contamination depends on the amount of microorganisms excreted, the survival of these microorganisms in the environment and the probability of the animals being exposed to sufficient amounts for infection (Radostits *et al.*, 2002).

Females contaminated after aborting for the first time become chronic carriers, eliminating the bacteria through milk, urine and uterine discharges during subsequent births, and new episodes of abortion may or may not occur (Radostits *et al.*, 2002; Pacheco, 2007). From the third pregnancy onwards, after infection, abortions do not occur, due to immune development and the reduction of necrosis present in the placentomas, allowing the birth of calves (Paulin; Ferreira Neto, 2003).

The bacterium can be found in semen, but the incidence of transmission by natural breeding is low, and it is not characterized as the most frequent form of occurrence of the disease. The vagina has specific barriers that hinder infection by this route, while in artificial insemination, where semen is deposited directly in the uterine body, the vaginal barriers do not play their role, becoming an important route in transmission (Megid; Brook; Paes, 2016), being deposited in an environment conducive to the multiplication of the agent (Brasil, 2006; Lage *et al.*, 2008).

The introduction of infected animals into healthy herds is the main risk for rural properties. The acquisition of new animals must be from places with sanitary conditions, free or with negative diagnostic tests, in order to ensure the health of the herd (Lage *et al.*, 2008; Ribeiro *et al.*, 2008; Meirelles - Batoli; Shah; Mathias, 2014).

Transmission to humans occurs through the consumption of raw milk and dairy products from unpasteurized milk from infected animals, through direct contact with tissues and/or secretions of these animals, blood, urine, vaginal secretions, aborted fetuses and, especially, the placenta. Inhalation of bacteria in contaminated environments. There are

reports of sexual and congenital transmission, blood transfusion, and organ or tissue transplants, which are uncommon by these means (Meirelles - Bartoli; Shah; Mathias, 2014; De Jesus Lawinsky, 2010).

Considered an occupational zoonosis, it affects farmers, handlers, veterinarians, laboratory workers, slaughterhouse-slaughterhouse workers, due to its ability to penetrate intact or injured skin and mucous membranes, in addition to the formation of aerosols. The microorganism can be isolated in the udder and uterus, the handling of a carcass of an infected animal can represent a serious exposure (Lage *et al.*, 2008; Radostits *et al.*; 2002, Brazil, 2024b).

The survival of *Brucella spp.* in milk and dairy products, it is correlated with environmental factors and the presence of other microorganisms that can prevent its multiplication, and the permanence time can vary from 15 to 90 days. Refrigeration inhibits its multiplication, but in freezing its viability is maintained. The rapid pasteurization process (Costa, 2003) and sterilization methods are effective in inactivating the microorganism (Paulin; Ferreira Neto, 2003), rapid pasteurization consists of heating the milk in a laminar layer between 72ºC and 75ºC for fifteen to twenty seconds, followed by refrigeration at 5ºC (Resende *et al.*, 2019; Brazil, 2020b).

The B19 and RB51 vaccines indicated by the PNCEBT have a pathogenic character for humans, and there are reports in the literature of accidental infections, especially in veterinarians and vaccinators (Lage *et al*., 2008, Brazil, 2024b).

Cases of brucellosis due to ingestion of meat or meat products is uncommon since the number of bacteria in the muscle is low, in addition to the fact that the consumption of raw meat is rare, while the consumption of blood and bone marrow can be considered potential in the transmission of the disease. The survival of the microorganism in meat depends on the degree of contamination and the type of processing. The bacteria can remain in the cells of the phagocytic monocytic system, in uterine secretions, in the mammary gland and in the bone marrow. The disposal of tissues that concentrate a large amount of bacteria can minimize or even avoid the contamination of carcasses and viscera during slaughter (Pessegueiro *et al.*, 2003; Sola *et al.,* 2014).

KNOCKING

The pathogenicity of *Brucella* is related to the factors that allow its invasion, survival, and intracellular multiplication in host cells (Radostist *et al*., 2002; Xavier, 2009). It penetrates the body through the oral, nasopharyngeal, conjunctival, genital mucosa or direct contact with the skin, and the main route for cattle is the oropharyngeal (Gorvel; Moreno,

2002; Campanã *et al.*, 2003; Ribeiro *et al*., 2008). After penetration, they are taken to regional lymph nodes and disseminated to the body. It produces cellular and humoral responses, forming hyperplasia and lymphadenitis (Lage *et al.,* 2008; Neta *et al.*, 2009).

One of the characteristics of the infection is the resistance of the bacterium to the defense mechanisms of phagocytic cells, surviving in macrophages for long periods (Barbosa *et al.*, 2016), which can remain quiescent for months (Acha; Szyfres, 2003).

B. Abortus has a predilection for pregnant uterus, udder, testicle, male sex glands, lymph nodes, joint capsules, and synovial membranes. The agent can spread freely or within macrophages, via the blood and lymphatic routes, lodging in the lymph nodes, especially the supramammary lymph nodes, and in hematopoietic organs, such as the spleen, liver and other tissues, and can escape the immune response (Radostits *et al*., 2002; Lage *et al.*, 2008; Xavier, 2009).

Infection of the pregnant uterus occurs by hematogenous route and the changes vary according to the intensity of the infection and length of gestation. The affinity of *brucellas* for trophoblasts is correlated with the presence of erythritol and progesterone concentrations in the placenta (Paulin; Neto, 2008).

The organs of predilection for infection are those that offer the necessary conditions for its development, erythritol - four-carbon polyhydric alcohol - present in the pregnant uterus, osteo-articular tissues, breast tissues and organs of the male reproductive system. Humans, horses, rabbits and rodents have low or no erythritol production, due to this fact, the impact of brucellosis on the reproductive system in these species is irrelevant (Ribeiro *et al*., 2008; Xavier, 2009).

The multiplication of *B. abortus* in the uterine environment triggers an inflammatory reaction of the placentomas that evolves to necrosis, destruction of the villi, and detachment of the cotyledons and caruncles. In acute cases, this process triggers abortion. In processes where necrosis is of low intensity, there is a high deposition of fibrin between the villi, making the abortion late, which can allow the pregnancy to reach term, generating products of low survival. Fibrin deposition predisposes to retained placenta. The lesions compromise the maternal-fetal circulation, which can lead to the death of the fetus, and may be due to the bacteria themselves, depending on the concentration in the amnion. It may develop macerated and/or mummified fetuses (Paulin; Neto, 2008).

The immune development of the animal after the first episode of abortion decreases the number and size of lesions in the placentomas in subsequent pregnancies. Causing abortions to become infrequent, predisposing to other clinical manifestations, such as retained placenta, stillbirth or the birth of weak calves, chronic metritis or endometritis, and

consequently subfertility, infertility, or sterility (Lage *et al.,* 2008; Ribeiro *et al.*, 2008; Xavier *et al.*, 2009).

Megid; Brook; Paes (2016) believe that there is an individual variation in relation to the susceptibility of the disease, because when it settles in a herd not all animals become infected.

CLINICAL SIGNS

The striking clinical signs in cattle and buffaloes are abortion around the 5th to 7th month of gestation and infertility, causing retained placenta, metritis, and occasionally permanent sterility, or stillborn or weak animals (Brasil, 2020c), which can affect the mammary gland in chronic cases. It is estimated that 20% of infected animals do not abort and 80% abort only once (Megid; Brook; Paes, 2016; Radostits *et al.*, 2002; Brazil, 2020c).

In males, the infection is mainly located in the testicles, seminal vesicles and prostate. The scrotum may be swollen, the testicles may present degeneration, adhesions and fibrosis. The clinical manifestations are: orchitis, epididymitis, low libido and infertility (Radostits *et al.*, 2002; Megid; Brook; Paes, 2016; Brazil, 2020c).

The bacterium can be found in the bursa, tendons, muscles and joints, leading to arthritis, specifically in the carpal and tarsal joints, spondylitis and bursitis, in the thoracic and lumbar vertebrae, and can reach the bone marrow (Paulin; Ferreira Neto, 2003; Radostits *et al.*, 2002; Megid; Brook; Paes, 2016).

Calves born to infected cows can become latent carriers, are born healthy and may or may not have maternal antibodies. The infection occurs in cattle of all ages, but is common in sexually mature animals, particularly dairy cattle (Radostits *et al.,* 2002).

In men, the symptoms of brucellosis are nonspecific. In the acute phase, weakness, malaise, muscle pain and continuous, irregular or intermittent fevers are described, similar to a strong flu. The pains are characterized by headaches, and can affect the joints. The chronic form is predominant. Neuropsychic symptomatology involves signs of melancholy, irritability, prostration, inappetence, hypertension, dyspnea, or even decreased fertility. Nausea, vomiting, abdominal discomfort are common symptoms when transmission occurs through food, especially the consumption of unpasteurized milk or dairy products (Schmitt *et al.*, 2017; De Jesus Lawinsky, 2010).

DIAGNOSIS

Brucellosis can be diagnosed by direct and indirect methods, and the methods can be used alone or together, with emphasis on clinical diagnosis, based on clinical signs and

animal history, such as the occurrence of abortions, birth of weak calves and sterility in females and males of the herd (Lage *et al*., 2008).

Direct diagnostic methods include agent isolation and identification, immunohistochemistry, and nucleic acid detection methods by polymerase chain reaction (PCR) (Sola *et al.,* 2014). The detection of the presence of the bacterium is the safest method, with a slow, expensive and high risk process for laboratories, due to the direct manipulation of tissues and excreta of the animals, or indirect, by the search for an immune response to the microorganism (Lage *et al*., 2008)

Among the methods, it is designated that each country adopts its diagnostic protocol, considering its factors (Costa, 2003). The indirect method is recommended according to the PNCEBT, instituted by IN SDA No. 10, of March 3, 2017 (Brasil, 2017a).

Among the indirect diagnostic methods are the Buffered Acidified Antigen (AAT), 2 - Mercaptaethanol (2 - ME), Fluorescent Polarization (FPA), Complement Fixation (FC) and the Antigen for the Milk Ring Test (TAL) (Brasil, 2017a, 2020c).

The AAT is a screening test, the TAL is a monitoring test and the 2-ME, FC and FPA confirmatory tests (Aires; Rabbit; Neto, 2018; Brazil, 2024c).

The diagnosis is indicated for females vaccinated with B19 aged 24 months or older, in females not vaccinated or vaccinated with RB51, aged 8 months or older and in males destined for reproduction aged 8 months or older (Brasil, 2024c).

IMPORTANCE FOR PUBLIC HEALTH

Brucellosis is considered one of the most relevant zoonoses, with wide distribution and worldwide significance, with a high prevalence in some countries and regions, causing health and economic problems, however, it is little known, difficult to diagnose, underreported and neglected in humans (Schmitt *et al.*, 2017).

The symptomatology in humans is nonspecific, so it is important, based on the clinical suspicion, to carry out a good anamnesis to obtain clinical information relevant to the case, emphasize the occupational type, contact with animals, ingestion and form of food consumption, due to non-specificity the disease can be confused with others (Schmitt *et al.,* 2017).

Boudertte; Sano, (2023), analyzed the data of cases notified to the Notifiable Diseases Information System (SINAN) in the period 2014−2018, obtained 3,612 suspected notified cases of human brucellosis, of which 25% were confirmed. The South region had the highest percentage of reported cases, representing 22%, 75% of the cases were men, 53% had occupational correlation and 63% of the cases evolved to cure. Stating that human

brucellosis is an endemic disease in the country, with an increase in reported cases and incompleteness of recorded information.

According to Lira (2015), he reported in his work information that in 2011 the Hospital Information System of the SUS - SIH/SUS, of the Ministry of Health, reported in the period from January 2008 to April 2011, 108 hospitalizations due to brucellosis, 13 in the North region, 17 in the Northeast region, 34 in the Southeast region, 38 in the South region and 6 in the Midwest region.

Its economic impacts generate barriers to the national and international market to the trade of animal products and losses in the industry: condemnation of raw materials, price drops, devaluation for the foreign market, and high costs with control, eradication and research programs (Pacheco *et al.*, 2008).

PREVENTION AND CONTROL

In Brazil, prevention and control measures are based on the PNCEBT, established in 2001 by the Ministry of Agriculture, Livestock and Supply (MAPA) and revised in 2017, with the aim of reducing the impact of these zoonoses, aiming at the eradication of these diseases (Brasil, 2017a). It can be associated with its own state programs, due to the local diversities of each region (Baptista *et al.*, 2012; Sola *et al., 2014).*

The program specifies mandatory preventive measures, such as vaccination of bovine and buffalo females from 3 to 8 months of age, with the B19 or RB51 vaccine, notification of confirmed cases to the Official Veterinary Service (SVO), elimination of positive animals, certification of properties and classification of the federative units (FU's) as to the degree of risk for the disease (Hayashi *et al.,* 2020; Brazil, 2020c; Meirelles - Bartoli; Sousa: Mathias, 2014).

Vaccination is mandatory for all bovine and buffalo females between 3 and 8 months of age, with the live lyophilized vaccine made with sample 19 of *Brucella abortus* (B19) or with the non-inducing vaccine of agglutinating antibodies, RB51. Bovine females over 8 months old that have not been immunized with B19 may be vaccinated with RB51 (Brasil, 2017a).

Study carried out by MAPA on vaccination rates in bovine and buffalo calves against brucellosis from 2014 to 2022. In summary, the highest vaccination rate with a percentage of 81% was in 2017. The number of existing females is greater than the number of vaccinated females, representing 25,745,207 and 19,001,313 respectively. Chart 1 describes the federative units with the respective years of highest vaccination coverage and their percentage (Brasil, 2024d).

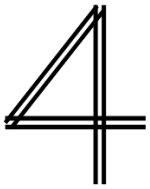
Frame 1- Data on the highest vaccination percentage of the states and their respective years.

UF	% VACCINATION	YEAR
AC	98,8%	2020
TO THE	65,6%	2021
ON THE	70,8%	2019
AP	61,5%	2019
THREE	71,6%	2018
THAT	2,31%	2022
DF	98,9%	2022
IS	63%	2020
GO	92,65%	2012
BUT	62,6%	2018
MG	83,7%	2022
MS	90,7%	2022
MT	99,5%	2014
PA	98,5%	2016
PB	263,5%	2021
ON	95,9%	2015
PI	59,2%	2016
PR	80,2%	2021
RJ	75,5%	2017
RN	50,7%	2019
RO	95,1%	2014
RR	97,6%	2018
RS	93,9%	2014
SC	0,6%	2022
HERSELF	27,6%	2022
SP	80,4%	2021

Source: Adaptation Brazil, 2024d.

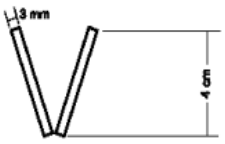
According to the PNCEBT (2017), vaccination must be carried out under the responsibility of the registered Veterinarian or his registered assistants, and it is mandatory to mark with a burning iron or liquid nitrogen on the left side of the face. Females vaccinated with B19 should be marked with the last digit of the vaccination year, as shown in figure 1, and those vaccinated with RB51 should be marked with a "V", as shown in figure 2.

Figure 1 - Example of iron for marking females vaccinated with the B19 vaccine.



Source: Personal archive, 2024.

Figure 2 - Definition of iron for marking females vaccinated with RB51.



Source: Brazil, 2017a.

The state of São Paulo has removed the obligation of iron marking as a method of identifying animals vaccinated against brucellosis, suggesting ear identifiers as a method, aiming at the well-being of the animals (São Paulo Department of Agriculture, 2024).

The standardization of the classification of FUs took place through a partnership between MAPA and the Collaborating Center for Animal Health of the Faculty of Veterinary Medicine and Animal Science of the University of São Paulo (FMVZ/USP). The classifications are based on epidemiological surveys, in order to know the prevalence of brucellosis in Brazil (Brasil, 2020a).

The action strategies through the classifications of the FUs regarding the degree of risk for these diseases are defined through the definitions and application of animal health defense procedures appropriate to the different realities (Brasil, 2020a).

The degrees of risk of FUs are based on classes A to E, determined by the prevalence of the disease from studies standardized by MAPA, where classification A has a prevalence of focus < 2%, B prevalence is ≥ 2 to < 5%, C has values ≥ 5 to < 10%, D ≥ 10% and E has unexplored revalence, and at levels 0 to 3, where 0 has non-existent enforcement actions, 1 has low actions, 2 has medium actions, and level 3 has high actions, where these actions are proposed in an action plan in accordance with animal health defense (Brasil, 2017a; Brazil, 2020a; Brazil, 2024).

The detection of a focus case, it is necessary to sanitize the property, starting from the interdiction, elimination of all positive animals and later presentation to the Official Veterinary Service (SVO) of negative herd tests. During sanitation, the animals on the property will not be allowed to transit, in excess of those intended for immediate slaughter or upon presentation of a negative diagnostic test (Brasil, 2020a).

Hygiene and disinfection of facilities, milking machines, sheds, paddocks, maternity paddocks or places where pregnant animals or animals undergoing sanitary treatment and other areas of potential animal circulation help in the environmental control of the agent. (Brazil, 2006; Schmitt *et al.,* 2017). It is necessary to carry out prior cleaning of the facilities, removing beds, straw, manure for better action of the disinfectants, the material removed must be burned or undergo disinfection processes, table 2 specifies disinfectants indicated for carrying out the management (Brasil, 2006).

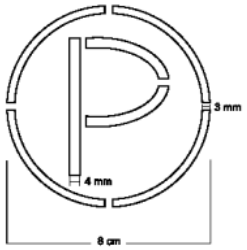
Frame 2- Main disinfectants that help in the disinfection of facilities in cases of bovine brucellosis.

DISINFECTANT	CONCENTRATION	EXPOSURE TIME	INDICATED USE
Sodium Hypochlorite	5%	1 hour	Facilities and utensils
Formaldehyde	5%	1 hour	Facilities, utensils and clothing
Calcium Hypochlorite	2,5%	1 hour	Facilities and utensils
Lime (Calcium Hydroxide)	15%	1 hour	Facilities and Ground
Cresols	5%	1 hour	Facilities
Phenol	1%	1 hour	Facilities
- Caustic soda (Sodium hydroxide)	2 - 3%	3 hours	Facilities and utensils

Source: Adaptation Brazil, 2006.

Animals that are positive for the diagnostic test for brucellosis should be marked, by the veterinarian responsible for performing the exam, with a hot iron or liquid nitrogen, on the right side of the face with a "P" contained in a circle of eight centimeters in diameter, as shown in Figure 3. The slaughter time is conditioned to thirty days after the reactive diagnosis (Brasil, 2006; Brazil, 2017a, Meirelles - Bartoli; Shah; Mathias, 2014).

Figure 3 - Iron model for marking positive animals.



Source: Brazil, 2017a.

Obtaining the certificate of free-breeding establishment is obtained by vaccinating all females between 3 and 8 months of age and two herd tests with consecutive negative results with an interval of 6 to 12 months, the second being mandatory to be carried out in a laboratory of the National Network of Agricultural Laboratories of the Unified System of Attention to Agricultural Health. The maintenance of the certificate is conditioned by the presentation to the official veterinary service of negative herd tests with maximum intervals of twelve months (Brasil, 2017a).

By the end of 2018, there were a total of 1,932 certified brucellosis-free properties in Brazil. Of the 27 FUs, 12 have certified properties, and 95% of these properties are located in the south of the country (Brasil, 2020a).

The issuance of the animal transit permit (GTA) for the transit of cattle or buffaloes, for any purpose, is required upon proof of vaccination, and the negative certificate issued by

the registered veterinarian (BRASIL, 2017a). The certificate is valid for sixty days, counting from the date of blood collection for diagnosis (Brasil, 2017a).

For humans, the recommended preventive measures are the consumption of pasteurized and/or boiled milk and/or dairy products, consumption of foods that have a quality verification seal from the Municipal Inspection Service (SIM), State Inspection Service (SIE), Federal Inspection Service (SIF) or MAPA (Brasil, 2020c).

For the occupational group, the use of personal protective equipment (PPE) is recommended, especially in vaccine management, in the manipulation of placentas, calves (Costa *et al.,* 2022; Schmitt *et al.*, 2017).

CARCASS CONDEMNATION DATA

According to the Open Data Portal of the Ministry of Agriculture, Livestock and Supply from the year 2000 to 2024 (partial until the month of March), during these 20 years there was the condemnation of 6,833 animals (table 3) for Brucellosis (Brazil, 2024d), with a varied destination, which can be rendering, partial or total condemnation, sterilization by heat, cold treatment, autoclaving/incineration, ingredient manufacturing. The destination is carried out according to the descriptions of RIISPOA (2020), according to the findings in the inspection line.

Picture 3- Data on carcasses condemned for brucellosis from 2000 to 2024 (partial until March).

FU	CONVICTION
AC	7
AM	2
BA	56
DF	-
ES	22
GO	89
MA	690
MG	770
MS	38
MT	219
PA	1566
PE	-
PR	535
RJ	-
RO	766
RR	3
RS	73
SC	436
SP	250
TO	1311
TOTAL	**6833**

Source: Adaptation Brazil, 2024d.

FINAL CONSIDERATIONS

Due to the facts presented, it is concluded that brucellosis is a disease present in Brazilian herds and is still neglected by many. Those working in livestock farming should be better instructed about the disease. A point of contribution would be the better dissemination of the general aspects of these diseases, emphasizing the risk and focusing on prevention and control measures in a clear and simple way, aiming to increase knowledge, consequently the execution of sanitary measures of the herd and actions for one's own benefit.

Field technicians and official veterinary services are the best disseminators of information, and can contribute by bringing practical knowledge to the field, especially to producers and rural workers.

REFERENCES

1. Acha, P. N., & Szyfres, B. (2003). *Zoonoses and communicable diseases common to humans and animals: bacterioses and micoses*. Pan American Health Org. Available at: https://iris.paho.org/handle/10665.2/3321?locale-attribute=pt. Accessed on February 6, 2024.

2. Aires, D. M., Coelho, K. O., & Neto, O. J. (2018). Bovine brucellosis: general aspects and context in official control programs. *Scientific Journal of Veterinary Medicine*. Available at: https://faef.revista.inf.br/imagens_arquivos/arquivos_destaque/oNZhrk8JQ0hsGE5_2018-7-12-17-17-34.pdf. Accessed on February 8, 2024.

3. Assi, J. M., Franchi, A. E., & Ribeiro, L. F. (2021). Bovine tuberculosis. *GETEC*, 10(30), 97–107. Available at: https://revistas.fucamp.edu.br/index.php/getec/article/view/2476. Accessed on January 10, 2024.

4. Baptista, F., Cerqueira, R., Amaral, J., & Almeida, K. (2012). Prevalence and risk factors for brucellosis in Tocantins and Brazilian national program to fight this disease. *Revista de Patologia Tropical*, 41(3), 285–294. Available at: https://pesquisa.bvsalud.org/portal/resource/pt/lil-664762. Accessed on January 20, 2024.

5. Barbosa, E. S., Araújo, J. I. M., da Silva, A. L. A., & de Araújo, J. M. (2016). Profile of producers' knowledge about brucellosis in public health, in Redenção do Gurgueia-Piauí. *Pubvet*, 10, 795–872. Available at: https://ojs.pubvet.com.br/index.php/revista. Accessed on February 29, 2024.

6. Barcellos, R. R., Jamas, L. T., Menozzi, B. D., & Langoni, H. (2019). Family agriculture and animal health. *Veterinária e Zootecnia*, 001–009. Available at: https://www.researchgate.net/publication/336402293_Agricultura_familiar_e_sanidade_animal. Accessed on February 11, 2024.

7. Cidasc. (2023). Animal welfare: Santa Catarina reaches the historic mark of 3 thousand rural properties certified free of brucellosis and tuberculosis. Available at: https://www.cidasc.sc.gov.br/blog/2023/09/11/santa-catarina-atinge-a-marca-historica-de-3-mil-propriedades-rurais-certificadas-livres-de-brucelose-e-tuberculose/. Accessed on March 30, 2024.

8. Brazil. (2013). Normative Instruction No. 50, of September 24, 2013. *Official Gazette of the Federative Republic of Brazil*. Available at: file:///C:/Users/Caseiro/Downloads/listadedoencasanimaisdenotificaoobrigatoria.pdf. Accessed on January 10, 2024.

9. Brazil. Ministry of Agriculture, Livestock and Supply. (2024a). Open data portal of the Ministry of Agriculture and Livestock. Brasília.

10. Brazil. Ministry of Agriculture, Livestock and Supply. (2024b). Brucellosis and tuberculosis. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/brucelose-e-tuberculose. Accessed on March 26, 2024.

11. Brazil. Ministry of Agriculture, Livestock and Supply. (2024c). Vaccination rates of bovine and buffalo calves against brucellosis. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/vacinacao-contra-brucelose. Accessed on April 23, 2024.

12. Brazil. Ministry of Agriculture, Livestock and Supply. (2023b). *Animal health reports*. World Organization for Animal Health (WHOA). Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/epidemiologia/portugues/SegundoSemestre2022OIEEsp.pdf. Accessed on: March 9, 2024.

13. Acha, P. N., & Szyfres, B. (2003). *Zoonosis y enfermedades transmisibles comunes al hombre y a los animales: bacterioses e micoses* (Vol. 3). Pan American Health Organization. Available at: https://iris.paho.org/handle/10665.2/3321?locale-attribute=pt. Accessed on: February 6, 2024.

14. Aires, D. M., Coelho, K. O., & Neto, O. J. (2018, January). Brucelose bovina: Aspectos gerais e contexto nos programas oficiais de controle. *Revista Científica de Medicina Veterinária*. Available at: https://faef.revista.inf.br/imagens_arquivos/arquivos_destaque/oNZhrk8JQ0hsGE5_2018-7-12-17-17-34.pdf. Accessed on: February 8, 2024.

15. Assi, J. M., Franchi, A. E., & Ribeiro, L. F. (2021). Tuberculose bovina. *GETEC*, 10(30), 97–107. Available at: https://revistas.fucamp.edu.br/index.php/getec/article/view/2476. Accessed on: January 10, 2024.

16. Baptista, F., Cerqueira, R., Amaral, J., Almeida, K., & Pigatto, C. (2012). Prevalence and risk factors for brucellosis in Tocantins and Brazilian national program to fight this disease. *Revista de Patologia Tropical*, 41(3), 285–294. Available at: https://pesquisa.bvsalud.org/portal/resource/pt/lil-664762. Accessed on: January 20, 2024.

17. Barbosa, E. S., Araújo, J. I. M., Da Silva, A. L. A., & De Araújo, J. M. (2016). Perfil do conhecimento dos produtores sobre a brucelose na saúde pública, em Redenção do Gurgueia-Piauí. *Pubvet*, 10, 795–872. Available at: https://ojs.pubvet.com.br/index.php/revista. Accessed on: February 29, 2024.

18. Barcellos, R. R., Jamas, L. T., Menozzi, B. D., & Langoni, H. (2019). Agricultura familiar e sanidade animal. *Veterinária e Zootecnia*, 001–009. Available at: https://www.researchgate.net/publication/336402293_Agricultura_familiar_e_sanidade_animal. Accessed on: February 11, 2024.

19. Bem-estar animal: Santa Catarina atinge a marca histórica de 3 mil propriedades rurais certificadas livres de brucelose e tuberculose. (2023). *CIDASC*. Available at: https://www.cidasc.sc.gov.br/blog/2023/09/11/santa-catarina-atinge-a-marca-historica-de-3-mil-propriedades-rurais-certificadas-livres-de-brucelose-e-tuberculose/. Accessed on: March 30, 2024.

20. Brasil. (2013). *Instrução Normativa nº 50, de 24 de setembro de 2013*. Diário Oficial da República Federativa do Brasil. Available at: file:///C:/Users/Caseiro/Downloads/listadedoencasanimaisdenotificaoobrigatoria.pdf. Accessed on: January 10, 2024.

21. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2024). *Portal de dados abertos do Ministério da Agricultura e Pecuária*. Brasília.

22. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2024b). *Brucelose e Tuberculose*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/brucelose-e-tuberculose. Accessed on: March 26, 2024.

23. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2024d). *Índices de vacinação de bezerras bovinas e bubalinas contra brucelose*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/vacinacao-contra-brucelose. Accessed on: April 23, 2024.

24. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2023b). *Informes zoosanitários*. Organização Mundial de Saúde Animal (OMSA). Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/epidemiologia/portugues/SegundoSemestre2022OIEEsp.pdf. Accessed on: March 9, 2024.

25. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2017a). *Instrução Normativa SDA nº 10 de 3 de março de 2017*. DOU nº 116, de 20 de junho de 2017,

Seção 1, págs. 4-8. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/principais-normas-pncebt/in-10-de-3-de-marco-de-2017-aprova-o-regulamento-tecnico-do-pncebt.pdf/view. Accessed on: February 10, 2024.

26. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2024). *Programa Nacional de Controle e Erradicação da Brucelose e da Tuberculose Animal – PNCEBT*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/controle-e-erradicacao-da-brucelose-e-tuberculose-pncebt. Accessed on: March 26, 2024.

27. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2023a). *Rebanho bovino brasileiro alcançou recorde de 234,4 milhões de animais em 2022*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/noticias/rebanho-bovino-brasileiro-alcancou-recorde-de-234-4-milhoes-de-animais-em-2022#:~:text=O%20rebanho%20bovino%20brasileiro%20alcan%C3%A7ou,Brasileiro%20de%20Geografia%20e%20Estat%C3%ADstica. Accessed on: February 6, 2024.

28. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2020). *Regulamento da Inspeção Industrial e Sanitária de Produtos de Origem Animal (RIISPOA)*. Brasília. Available at: https://wp.ufpel.edu.br/inspleite/files/2020/10/RIISPOA-ALTERADO-E-ATUALIZADO-2020.pdf. Accessed on: March 4, 2024.

29. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária (SDA), Departamento de Saúde Animal (DSA). (2006). *Programa Nacional de Controle e Erradicação da Brucelose e da Tuberculose Animal (PNCEBT)*. (Vera Cecilia Ferreira de Figueiredo, José Ricardo Lôbo, Vitor Salvador Picão Gonçalves, Eds.). Brasília. Available at: https://www.defesa.agricultura.sp.gov.br/www/programas/getdocdoc.php?idform=383. Accessed on: February 23, 2024.

30. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária (SDA), Departamento de Saúde Animal (DSA). (2020a). *Diagnóstico Situacional do PNCEBT: Programa Nacional de Controle e Erradicação da Brucelose e Tuberculose Animal*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/DSPNCEBT.pdf. Accessed on: March 4, 2024.

31. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária (SDA), Departamento de Saúde Animal (DSA). (2023d). *Ficha Técnica Tuberculose Bovina*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/Ficha_Tcnica_TUBERCULOSE_atual.pdf. Accessed on: January 16, 2024.

32. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária (SDA), Departamento de Saúde Animal (DSA). (2020c). *Ficha Técnica Brucelose Bovina*. Brasília. Available at: https://www.gov.br/agricultura/pt-br/assuntos/sanidade-animal-e-vegetal/saude-animal/programas-de-saude-animal/pncebt/Ficha_Tecnica_BRUCELOSE.pdf. Accessed on: January 16, 2024.

33. Brasil. Ministério da Agricultura, Pecuária e Abastecimento. (2024c). *Sistema de Informação em Saúde Animal. Coordenação de Informação e Epidemiologia*. Organização Mundial de Saúde Animal (OMSA). Brasília. Available at: https://indicadores.agricultura.gov.br/saudeanimal/index.htm. Accessed on: February 27, 2024.

34. Brasil. Ministério da Saúde. (2022b). *Orientações para profissionais de saúde*. Brasília. Available at: https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/r/raiva/orientacoes-para-profissionais-de-saude. Accessed on: March 6, 2024.

35. Brasil. Ministério da Saúde. (2023f). *Raiva humana*. Brasília. Available at: https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/r/raiva/raiva-humana. Accessed on: March 10, 2024.

36. BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde e Ambiente. Departamento de HIV/Aids, Tuberculose, Hepatites Virais e Infecções Sexualmente Transmissíveis. (2023). *Manual com orientações clínicas e de vigilância para a tuberculose zoonótica* [versão eletrônica]. Brasília, p. 28. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/manual_orientacoes_vigilancia_tuberculose_zoonotica.pdf. Acesso em: 10 abr. 2024.

37. CAMPANÃ, R. N.; GOTARDO, D. J.; ISHIZUCA, M. M. (2003). *Epidemiologia e Profilaxia da Brucelose Bovina e Bubalina*. Coordenadoria de Defesa Agropecuária CDA/SAA. Campinas, São Paulo, 20p.

38. CASTRO, K. G.; LIEVORE, J. P. M.; CARVALHO, G. D. (2009). *Tuberculose bovina: diagnóstico, controle e profilaxia*. Pubvet, Londrina, v. 3, n. 30, Ed. 91, Art. 648. Disponível em: https://bichosonline.vet.br/wp-content/uploads/2016/03/PUBVETTuberculosebovina.pdf. Acesso em: 25 jan. 2024.

39. COSTA, A. J. M.; MOURA, F. B. C.; DINAU, F. C.; SILVA, L. F.; MARTINELLI, M. E. R.; SOUZA, N. F.; SOUZA, N. F. D.; XIMENES, P. P.; SHING, T. F.; GHEDIN, V. (2022). *Manual de Zoonoses*. Unidade Estadual Paulista “Júlio de Mesquita Filho”, Faculdade

de Medicina Veterinária e Zootecnia de Botucatu. São Paulo. Disponível em: https://www.fmvz.unesp.br/. Acesso em: 24 fev. 2024.

40. DE JESUS LAWINSKY, M. L.; OHARA, P. M.; ELKHOWRY, M. R.; FARIA, N. C.; CAVALCANTE, K. R. L. J. (2010). Estado da arte da brucelose em humanos. *Revista Pan-Amazônica de Saúde*, 1(4), 75-84. http://dx.doi.org/10.5123/S2176-62232010000400012. Disponível em: http://scielo.iec.gov.br/scielo.php?script=sci_abstract&pid=S2176-62232010000400012&lng=pt&nrm=is. Acesso em: 06 fev. 2024.

41. FAO. (2017). *The Food and Agriculture Organization and Rabies Prevention and Control*. Food and Agriculture Organization of the United Nations. Disponível em: http://www.fao.org/3/a-i7873e.pdf. Acesso em: 03 fev. 2024.

42. FERNANDES, C. G.; RIET-CORREA, F. (2007). Raiva. In F. Riet-Correa, S. A. L., L. R. A. A., B. J. R. J. (Eds.), *Doenças de Ruminantes e Equídeos* (pp. 650–656). Gráfica e Editora Pallotti.

43. FERREIRA NETO, J. S. (2009). Situação epidemiológica da brucelose bovina no Brasil: Bases para as intervenções. *Ciência Animal Brasileira/Brazilian Animal Science*, 1. DOI: 10.5216/cab.v1i0.7669. Disponível em: https://revistas.ufg.br/vet/article/view/7669. Acesso em: 15 mar. 2024.

44. Furquim, N. R., & Cyrillo, D. C. (2013). Vantagens e desvantagens da pecuária no Brasil segundo atores da cadeia produtiva de carne bovina. *O Mundo da Saúde*, 37(3), 321-328. Disponível em: https://bvsms.saude.gov.br/bvs/artigos/mundo_saude/vantagens_desvantagens_pecuaria_brasil_atores.pdf. Acesso em: 15 mar. 2024.

45. Gomes, M. J. P. (2013). Gênero Brucella spp. Rio Grande do Sul: FAVET-UFRGS.

46. Gorvel, J. P., & Moreno, E. (2002). Brucella intracellular life: From invasion to intracellular replication. *Veterinary Microbiology*, 90(1-4), 281-297. https://doi.org/10.1016/s0378-1135(02)00214-6. Acesso em: 19 fev. 2024.

47. Hayashi, A. M., Guido, M. C., Gomes, M. N., Pinheiro, F. A., Benesi, F. J., Sucupira, M. C. A., Gregory, L., & Gomes, V. (2020). Brucelose bovina: Relato da atuação conjunta da Universidade, da Defesa Agropecuária e do Serviço de Saúde do Município no diagnóstico e controle da doença. *Revista MV&Z*, 18(3). https://doi.org/10.36440/recmvz.v18i3.38104. Acesso em: 28 mar. 2024.

48. Lage, A. P., Poester, F. P., Paixão, T. A., Silva, T. A., Xavier, M. N., Minharro, S., Miranda, K. L., Alves, C. M., Mol, J. P. S., & Santos, R. L. (2008). Brucelose bovina: Uma atualização. *Revista Brasileira de Reprodução Animal*, 32, 202-212. Disponível em: https://www.researchgate.net/publication/270341837_Brucelose_bovina_uma_atualizacao. Acesso em: 25 jan. 2024.

49. Lira, R. J. P. (2015). Importância das orientações para práticas de controle e erradicação da brucelose, tuberculose e controle da raiva dos herbívoros em Água Branca-PB. Disponível em: http://dspace.sti.ufcg.edu.br:8080/jspui/handle/riufcg/24050. Acesso em: 10 abr. 2024.

50. Megid, J., Ribeiro, M. G., & Paes, A. C. (2016). *Doenças infecciosas em animais de produção e de companhia*. Rio de Janeiro: Roca.

51. Murakami, P. S., Fuverki, R. B. N., Nakatani, S. M., Filho, I. R. B., & Biondo, A. W. (2009). Tuberculose bovina: Saúde animal e saúde pública. *Arq. Ciênc. Vet. Zool. Unipar*, 12(1), 67-74. Disponível em: https://revistas.unipar.br/index.php/veterinaria/article/view/2936/2148. Acesso em: 06 mar. 2024.

52. Neta, A. V. C., Mol, J. P. S., Xavier, M. N., Paixão, T. A., Lage, A. P., & Santos, R. L. (2009). Pathogenesis of bovine brucellosis. *The Veterinary Journal*, 184(2), 146-155. https://doi.org/10.1016/j.tvjl.2009.04.010. Acesso em: 18 mar. 2024.

53. Nicodemo, M. L. F., & Gusmão, M. R. (2012). Desafios para a pecuária bovina: Pontos para alinhamento da pesquisa e da extensão rural nas próximas décadas. *Revista UFG*, XIII(13). Disponível em: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/973447/desafios-para-a-pecuaria-bovina-pontos-para-alinhamento-da-pesquisa-e-da-extensao-rural-nas-proximas-decadas. Acesso em: 28 fev. 2024.

54. Pacheco, W. A. (2007). Excreção de *Brucella abortus*, estirpe B19 pelo leite e urina de fêmeas bovinas de diferentes faixas etárias vacinadas contra brucelose e sua relação com o ciclo reprodutivo (Dissertação de Mestrado, Universidade de São Paulo). https://doi.org/10.11606/D.10.2007.tde-14092007-144915. Acesso em: 19 fev. 2024.

55. Pacheco, A. M., Freitas, E. B., Bergamo, M., Mariano, R. S., & Zappa, V. (2008). A importância da brucelose bovina na saúde pública. *Revista Científica Eletrônica de Medicina Veterinária*, 6(11). Disponível em: https://faef.revista.inf.br/imagens_arquivos/arquivos_destaque/CeLaVm818NAfCPe_2013-6-17-16-19-47.pdf. Acesso em: 11 fev. 2024.

56. Paulin, L. M. S., & Ferreira Neto, J. S. (2008). Brucelose em búfalos. *Arquivos do Instituto Biológico*, 75(3), 389-401. https://doi.org/10.1590/1808-1657v75p3892008. Acesso em: 18 jan. 2024.

57. Pessegueiro, P., Barata, C., & Correia, J. (2003). Brucelose: Uma revisão sistematizada. *Medicina Interna*, 10(2), 91-100. Disponível em: https://www.spmi.pt/revista/vol10/vol10-n2-brucelose.pdf. Acesso em: 03 abr. 2024.

58. Radostits, O. M., Blood, D. C., & Gay, C. C. (2002). *Clínica Veterinária* (9ª ed.). Guanabara Koogan.

59. Resende, I. V., Silva, M. F. S., Alves, Y. R., Campbell, L. M., Carrijo, D. M., & Cardozo, S. P. (2019). Brucelose como uma doença transmitida por alimentos, tendo o leite como principal veiculador. *Anais Colóquio Estadual de Pesquisa Multidisciplinar* & *Congresso Nacional de Pesquisa Multidisciplinar*. Disponível em: file:///C:/Users/velan/Downloads/elenomarques,+B095.pdf. Acesso em: 16 jan. 2024.

60. Ribeiro, M. G., Motta, R. G., & Almeida, C. A. S. (2008). Brucelose equina: Aspectos da doença no Brasil. *Revista Brasileira de Reprodução Animal*, 32(2), 83-92. Disponível em: http://www.cbra.org.br/pages/publicacoes/rbra/download/RB155%20Ribeiro%20pag83-92.pdf. Acesso em: 11 jan. 2024.

61. Riet-Correa, F., Schild, A. L., Mendez, M. D. C., & Lemos, R. A. A. (2001). *Doenças de ruminantes e equinos* (2ª ed.). Laboratório Regional de Diagnóstico, Faculdade de Veterinária - Universidade Federal de Pelotas.

62. São Paulo, o governo do estado. (2024). Agro de SP sai na frente e marca a fogo em bovinos deixa de ser obrigatória. Disponível em: https://www.agricultura.sp.gov.br/pt/b/bem-estar-animal-agro-de-sp-sai-na-frente-e-marca-a-fogo-em-bovinos-deixa-de-ser-obrigatoria. Acesso em: 07 mar. 2024.

63. Sola, M. C., Freitas, F. A., Sena, E. L. S., & Mesquita, A. J. (2014). Brucelose bovina: Revisão. *Enciclopédia Biosfera*, 10(18), 686. Disponível em: https://conhecer.org.br/enciclop/2014a/AGRARIAS/Brucelose.pdf. Acesso em: 15 fev. 2024.

64. Suárez-Esquivel, M., Ruiz-Villalobos, N., Jiménez-Rojas, C., Barquero-Calvo, E., Chacón-Diaz, C., Viquez-Ruiz, E., Rojas-Campos, N., Baker, K. S., Oviedo-Sánchez, G., Amuy, E., Chaves Olarte, E., Thomson, N. R., Moreno, E., & Guzmán-Verri, C. (2017). *Brucella neotomae* infection in humans, Costa Rica. *Emerging Infectious Diseases*, 23(6), 997. Disponível em: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5443450/. Acesso em: 04 mar. 2024.

65. Xavier, M. N. (2009). Desenvolvimento de PCR espécie-específico para o diagnóstico da infecção por *Brucella ovis* e avaliação comparativa de métodos sorológicos (Dissertação de Mestrado, Universidade Federal de Minas Gerais). Disponível em: https://repositorio.ufmg.br/handle/1843/SSLA-7YSH6J. Acesso em: 22 jan. 2024.