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Occurrence of brucellosis in cattle and goats in Malaysia: a review

Abstract

The occurrence of brucellosis in Malaysian livestock population even though reported for many decades is low when compared to other countries in Asia. The presence of brucellosis in Malaysia was first confirmed in 1950 when B. abortus was first isolated from large ruminants. However, it was observed that there was a shift in the status of bovine brucellosis and unsubstantiated evidence suggests an increase of brucellosis infection among cattle. The most reliable and unambiguous method of diagnosing Brucella specie in animals is by isolation. Microscopic examination of smears made from vaginal, placenta or aborted foetus swabs have proven to be promising in the bacteriological examination of B. melitensis. Since the original recognition of the causative agent of brucellosis, large numbers of serological tests and various modifications to enhance accuracy have been developed for diagnosis of brucellosis. Serological testing for brucellosis among livestock is usually conducted as a component of the disease eradication and surveillance program. Rose Bengal plate test is the most widely used screening test for brucellosis. The test is internationally acknowledged as the choice for the screening of brucellosis in small ruminants and the OIE considers this test "prescribed tests for trade". Many countries are undergoing a re-emergence of the disease especially in sheep and goats. In many countries, vaccination of animals has been found as the most successful method for prevention and control of brucellosis. Crucial factors for the successful eradication programme are the implementation of an effective surveillance system with adequate laboratory support.

Keywords: brucellosis, cattle, epidemiology, goat, livestock

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Introduction

Brucellosis is an economically important disease in production animals worldwide caused by Brucella species.[1] Brucella is Gram-negative, facultative intracellular bacteria that infect many species of animals and man. Ten species are recognized within the genus Brucella specie. However, there are 6 "classical" species of the genus Brucella based mainly on differences in pathogenicity and host preference which include B. abortus, B. melitensis, B. suis B. neotomae, B. ovis and B. canis. The main pathogenic species of Brucella, worldwide are B. abortus and B. melitensis which cause abortion and infertility in their natural hosts.[2,3] Bovine brucellosis is usually caused by B. abortus and less frequently by B. melitensis.[4] On the other hand, caprine brucellosis is mainly caused by B. melitensis and sporadic cases have been observed in goats due to B. abortus.[5] Cattle and goats are considered as the main livestock in Malaysia due to increased local demand for their milk and meat.[6] However, these animals are being threatened by brucellosis. This finding has potentials to impede on socio-economic development and public health of the country.[7,8] Studies have shown that the occurrence of brucellosis in Malaysian livestock population have been reported for many decades. The prevalence was however low when compared to other countries in Asia.[8,9] The presence of brucellosis in Malaysia was first confirmed with the isolation of B. abortus from large ruminants in 1950. Small ruminants' brucellosis was first reported in sheep between 1987 and 1991 using serological method.[9] The cases of brucellosis in goats have increased during the period 2000-2009 affecting all states in Malaysia, especially in 2004 where a significant surge in the sero-prevalence was 0.91% observed and the trend had continued into recent years.[10] Similarly, bovine brucellosis has been reported to be widespread among herds in Peninsular Malaysia with prevalence 21.8%.[7] The disease status of brucellosis due to B. melitensis in Malaysia has been shifted from confirmed infection but no clinical disease to disease presence, which means that the disease status started unaccustomed condition.[11] The new status of brucellosis in Malaysia imposes an increase in demand for more surveillance programs to detect the infected animals within the herds and flocks. The spread of the disease later initiated in nationwide brucellosis eradication program, which involved the testing and slaughter of seropositive animals and consequently resulted in a marked decline in the number of seropositive cattle.[9] This policy has a significant impact on the operational activities of the farms which consequently affect their economy. Over the years, as part of efforts to control the spread of bovine brucellosis, the Malaysian veterinary authorities conducted an active serosurveillance studies. The exercise is involves test and slaughter method, in addition to full compensation to the farmers.[9] However, it was observed that there was a shift in the status of bovine brucellosis and unsubstantiated evidence suggests an increase of brucellosis infection among cattle.[7] Similarly, the pattern was also observed in goats, the serological evidence of infection is widespread among farms, affecting all 13 states and the federal capital territories in Malaysia. A significant increase in the seroprevalence was observed starting 2004 and the trend had continued into recent years.[10] Moreover, the disease status of brucellosis due to B. melitensis in Malaysia has been shifted from confirmed infection but no clinical disease to disease presence, which means that the disease status started unaccustomed condition.[11] At present, the disease appeared to have spread throughout the country. Therefore, the new status

of brucellosis in Malaysia imposes an increase in demand for more surveillance programs along with effective diagnostic tools to detect the infected animals within the herds and flocks.[7,9,12] The aim of this review is to highlight the occurrence of brucellosis in cattle and goat in Malaysia with a view to updating the missing information gap.

Diagnostic methods

The most reliable and unambiguous method of diagnosing Brucella specie in animals is by isolation.[13] Microscopic examination of smears made from vaginal, placenta or aborted foetus swabs have proven to be promising in the bacteriological examination of B. melitensis (stamp's method). However, misleading resulting may be observed in morphologically related organisms such as Brucella ovis, chlamydophila abortus and Coxiella burnetti. Therefore, for accurate diagnosis of B. melitensis, isolation on appropriate culture media is highly recommended. In goat and sheep, B. melitensis is known to persist in vaginal discharge and milk. This finding however shows that milk and vaginal discharge are the best sample for the isolation of B. melitensis.[13] Furthermore, the best site for collection of sample during postmortem examination of carcass is the spleen and lymph nodes (iliac, supramamary and prefemoral). In the laboratory, B. melitensis does not require special additives for growth, in fact studies have shown that it can grow on common solid media at 37^{o}C for 24-48hr aerobically. However, due to the burden of contaminants which is common with field samples, selective media such as Farrell selective medium is recommended for the purpose of isolation.[13,14] The only limitation however observed with Farrell medium is that the concentration of nalidixic acid and bacitracin used in that medium have inhibitory effects for some strains of B. melitensis. To significantly increase the frequency of isolation, the simultaneous use of both the Farrell and the modified Thayer –martin media is therefore recommended.[15]

Serological tests for diagnosis of brucellosis

Since the original recognition of the causative agent of brucellosis, Brucella sp., large numbers of serological tests and various modifications to enhance accuracy have been developed for diagnosis of brucellosis.[16] Nevertheless, there are considerable differences in the accuracy of the various serological tests; therefore, diagnosis is made based on the results of two or more tests.[14,17] Firstly, the initial testing is commonly done using a screening test, a test with high sensitivity and perhaps of less specificity. The screening tests are usually relatively inexpensive, fast and simple to perform. Secondly, a confirmatory test is performed usually if a positive reaction occurs in a screening test.[18,19] The confirmatory test is a test which provides good sensitivity but higher test specificity, thereby eliminating some false positive reactions. Most confirmatory tests are more complicated and more expensive to perform. Examples of screening tests are the RBPT and the indirect Enzyme linked immunoassay (I-ELISA) and a confirmatory tests are the CFT and competitive Enzyme linked immunoassay (C-ELISA).[16] Serological testing for brucellosis among livestock is usually conducted as a component of the disease eradication and surveillance program.[18,20,21] These tests have been developed and standardized basically for bovine brucellosis,[4] and it is widely assumed that the available tests for B. abortus infection in cattle are also adequate for diagnosing B. melitensis infection in small ruminants.[5] Accordingly, the RBPT and the CFT are the most widely used classic tests for the serologic diagnosis of brucellosis in sheep and goats.[18] The antigenic suspensions (whole cells) used in RBPT and CFT are mostly made with a A-dominant B. abortus biovar 1,[5,14] and, theoretically, infections due to M-dominant strains such as B. melitensis biovar 1 could be misdiagnosed.[14] Furthermore, these tests are widely used for diagnosis in small ruminants, largely based on their effectiveness in cattle, but they have not been sufficiently evaluated in sheep and goats.[14,22] Inspite of presence of variety of serological tests with different modifications, no single serological test is appropriate in all epidemiological situations; all have limitations especially when it comes to screening individual animals. Consideration should be given to all factors that impact on the relevance of the test method and test results to a specific diagnostic interpretation or application.[4]

Rose bengal plate test (RBPT)

RBPT is the most widely used screening test for brucellosis. The test is simple in application, requiring no further reagent such as enzyme conjugated secondary antibodies in ELISA, fast, the results could be obtained in minutes after running the test, and can be used under field and laboratory conditions.[16,17] However, the results must be confirmed by one of the confirmatory tests.[16] The RBPT is as a type of agglutination test which uses B. abortus S99 or S1119.3 cells stained with Rose Bengal and buffered to a low pH, usually 3.65±0.05. This pH discourages agglutination by IgM but encourages agglutination by IgG1, generally reducing cross reactions.[16] The test is internationally acknowledged as the choice for the screening of brucellosis in small ruminants and the OIE considers this test "prescribed tests for trade".[3,5,14] However, standardized conditions suitable for the diagnoses of cattle infection are not adequate in sheep and goats. This accounts for the low sensitivity of RBPT antigens in small ruminants. In addition, since a high proportion of animals in infected areas give negative result in RBPT but positive in CFT question the efficacy of the present RBPT as an individual test. Furthermore, the sensitivity of the RBPT antigens obtained from different sources might vary considerably especially when testing animals of low prevalence during the eradication programs. Additionally, the personal experience could affect the interpretation of the results.[15,23] Two types of false serological reaction might occur in the RBPT. False negative serological reactions (FNSR) might occur in the RBPT due to prozones.[3,16] However, a simple modification increasing slightly the amount of sera for the test dose from 25–30µl to 75–90µl. At the same time maintaining the antigen volume 25–30µl, increases significantly the sensitivity without affecting specificity.[14] On the other hand, false positive serological reactions (FPSR) could be happened after vaccination with B. abortus S19 vaccine in cattle or B. melitensis strain Rev.1 vaccine in sheep and goats, which result in serological responses similar to the antibodies produced due to infection with Brucella sp. field strain.[20,22] Another reason of FPSR comes from cross reacting antibodies due to natural infection by a number of Gram negative bacteria, mainly Yersinia enterocolitica O:9, E.coli O:157 and Pseudomonas sp. which induce cross reacting antibodies.[24–26] Nevertheless, Yersinia enterocolitica O:9 has been noted to be a major microorganism causing cross-reaction to serum from brucella-infected cases.[27] To improve the specificity of the RBPT, reducing agents such as dithiotreitol and 2-mercaptoethanol have been used which result in lowering the IgM levels through reduction of disulfide bridges in IgM molecule resulting in monomeric units. However, these reducing agents might affect some of IgG molecules and result in some false negative reactions.[17]

Complement fixation test (CFT)

Complement fixation test (CFT) is a prescribed test for international trade. The test is not highly sensitive but shows an

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excellent specificity. Therefore, it is widely used and it is a valuable asset as a confirmatory test in control/eradication programs.[4,5,18] The CFT allows the detection of anti-Brucella antibodies that are able to fix complement such as IgG1 isotype which offe us complement) and a titrated source of complement, usually guinea pig serum. After a suitable time a pretitrated amount of sheep erythrocytes coated with rabbit antibody is added. When a primary immune complex (B. abortus cells and test serum) is formed due to the presence of certain antibody isotypes in the serum, complement was activated. Therefore, it is no longer available for reaction with secondary immune complex of sheep erythrocytes and rabbit antibody resulting in slight or no lyses of the erythrocytes. Alternately, if no primary immune complex was formed, complement would cause all the sensitized sheep erythrocytes to lyses. Thus the amount of hemoglobin in solution is an inverse measure of anti-Brucella antibody activity.[16,17] Different formats of CFT are available in use, but the microtitre format is the most conveniently used. Either warm or cold fixation may be used for the incubation of serum, antigen and complement: either 37°C for 30 minutes or 4°C for 14–18 hours, respectively. However, a number of factors affect the choice of the method: anticomplementary activity in serum samples of poor quality is more evident with cold fixation, while fixation at 37°C increases the frequency and intensity of prozones. Accordingly, a number of dilutions must be tested for each sample.[4,17] The CFT is technically challenging because it is complex to perform, a number of reagents required for running the test and requiring good laboratory facilities and adequately trained staff to accurately titrate and maintain the reagents. In addition, difficulty in performing the test with hemolized sera.[4,22] When testing a limited number of sera obtained from B. melitensis culture positive and Brucella free goats, CFT provided the same sensitivity than those of RBPT and I-ELISA. However, the sensitivity of CFT has been reported to be lower in sheep in field conditions (88.6%) than those of RBPT (92.1%) and I-ELISA (100%).[14] Despite its complexity and the heterogeneity of the techniques used in the different countries, there is agreement that CFT is effective in small ruminants.[17]

Enzyme linked immunosorbent assay (ELISA)

The ELISA tests offer excellent sensitivity and specificity whilst being robust, fairly simple to perform with a minimum of equipment and readily available from a number of commercial sources in kit form.[16,22] ELISAs are divided into two categories, the I-ELISA and the C-ELISA.[4] The I-ELISA was first developed for the diagnosis of human brucellosis, and after that a large number of variations have been described. However, the most common format uses S-LPS antigen coated passively onto a polystyrene matrix. Diluted serum is added followed by an anti-species immunoglobulin, conjugated with an enzyme, usually horseradish peroxidase or alkaline phosphatase. By including a strong positive, a weak positive and a negative serum control, assay performance and quality control are easily assessed. Data is frequently expressed as a percent of the reactivity of the strongly positive serum control. The I-ELISA could be used for detection of bovine, caprine or ovine Brucella antibodies, and it is good test for surveillance purposes in countries in the latter phases of eradication and in which vaccination is no longer used. However, one disadvantage of the I-ELISA is its inability to differentiate vaccinal antibody resulting from B. abortus S19 or B. melitensis Rev.1 vaccination from antibody induced by field strains.[4,5] The C-ELISA was developed in order to overcome some of the problems arising from residual vaccinal antibody and from cross reacting antibody. When a monoclonal antibody with a slightly higher affinity for antigen is selected, reactivity by vaccinal antibody could be eliminated in the majority of cases. The selected monoclonal antibody target specific epitops in the O-chain of the smooth LPS of Brucella that are not shared with the LPS of Yersinia enterocolitica O:9. The specificity of the competitive enzyme immunoassay is very high, however, it is slightly less sensitive than the I-ELISA. This assay is an excellent confirmatory assay for the diagnosis of brucellosis in most livestock species (Poester et al., 2010). The most commonly used format of the C-ELISA utilizes S-LPS from B. abortus as antigen, passively attached to a polystyrene matrix, followed by incubation with competing antibody and appropriately diluted test serum. After mixing and incubation, a reagent for detecting bound monoclonal antibody, labeled with an enzyme, usually horseradish peroxidase or alkaline phosphatase is added. This is followed by another substrate or a chromogen after a suitable incubation period. A wash procedure is performed between each step. A series of controls, including a strongly positive, a weekly positive, a negative serum as well as a buffer (no serum) controls must be included. Results are calculated as percent inhibition against the buffer control (0% inhibition). The C-ELISA is a prescribed test by the OIE for international cattle trade.[4,5] It should be noted, however, that although the ELISAs are more sensitive than the RBPT, sometimes they do not detect infected animals which are RBPT positive.[22] With high specificity for the test. The basic test consists of B. abortus antigen, usually whole cells, incubated with dilutions of heat inactivated serum.

Occurrence of brucellosis in animals

Brucellosis is an economically important disease in production animal's worldwide.[1] The main effects of brucellosis in livestock are abortion, infertility, decreased milk production and costs of replacement animals which contribute to economic losses.[22] Brucellosis in cattle is mostly caused by Brucella abortus. Nevertheless, infection can also be caused by B. melitensis when cattle are kept in close association with sheep or goats.[4] On the other hand, Brucella melitensis is the main causative agent of caprine and ovine brucellosis.[5,28] However, sporadic cases of caprine and ovine caused by B. abortus have been reported.[5,29] Brucellosis is considered as sub-acute or chronic disease. The initial phase following infection is often not apparent and no specific clinical signs could be observed in animals at individual level to indicate the presence of the disease. However, the occurrence of abortion storms during the last trimester of gestation period or premature births and retained placenta is usually a strong indicator of infection.[29] The severity of the disease depends upon many factors such as age, sex, previous vaccination and management such as herd or flock size and density. Abortions are more prevalent in unvaccinated animals and numbers of organisms shed are much greater. The bacteria are found in the udder and the lymph nodes which drain the relevant areas also in tissues and fluids associated with pregnancy.[22] Accordingly, the diagnosis is dependent mainly upon either isolation of the bacteria or detection of their antigens or genetic material, or by demonstration of specific antibody or cell-mediated immune responses.[22] Brucella species does not have classical virulence factors such as capsule, exotoxins, cytolysins, endotoxic lipopolysaccharide (LPS), fimbria and flagellum.[21] The mechanisms of Brucella spicies. Virulence is factors that are required for invasion and intracellular survival which allow the organism to reach its intracellular replication site. An important aspect of Brucella species infection is its ability to persist and replicate within phagocytic cells of the reticuloendothelial system as well as in non-phagocytic cells such as trophoblasts.[30] Therefore, the process of Brucella species to successfully survive and replicate within different host cells explains their pathogenicity.[21] In cattle, the main causative agent is B. abortus which is usually

transmitted from animal to animal by contact following an abortion. Contaminated pasture or animal utilities with aborted materials are probably most potential source of infection. Ingestion, inhalation, conjunctival inoculation, skin contamination and udder inoculation from infected milking cups are other possibilities. Feeding new born calves with contaminated pooled colostrum may also transmit infection.[1,18] Although sexual transmission usually has little role in the epidemiology of bovine brucellosis, artificial insemination can transmit the disease and semen must only be collected from animals known to be free of infection.[30,31] In sheep and goats, B. melitensis is nearly always the infecting species. B. ovis can also infect sheep but is of little significance in relation to human disease. Whereas all breeds of goat are highly susceptible to B. melitensis infection, different breeds of sheep vary greatly in their susceptibility.[13,22] The mode of transmission of B. melitensis in sheep and goats is similar to that in cattle but sexual transmission probably plays a greater role.[1, 31] Mixing of animals from different herds or flocks belonging to different owners especially at the markets contribute significantly in transmission of the disease. Many factors influencing prevalence of brucellosis including production systems, agro-ecological zones, husbandry practices, contact with wildlife, and management factors.[1] However, mixing of livestock species is one of the most important factors that contribulte to spread brucellosis which may cause uninfected animals to easily get exposed to the disease from multiple sources such as exposure to aborted materials and direct contact with infected animals.[32] Mixed farming and especially raising sheep and/or goats along with cattle has been reported to be a risk factor for transmission of brucellosis among different animal species.[4,5,33] However, this transmission is not equally occurring in both directions. Certainly, whereas infection of sheep and goats with B. abortus is seldom reported.[5] B. melitensis infection in cattle has been reported frequently due to mixing of cattle with sheep and goats, and emerged as a serious public health problem a result of the consumption of unpasteurized milk since B. melitensis is capable of colonizing the bovine udder.[4,32,34] Accordingly, any strategy for the control or eradication of brucellosis should begin by establishing the different epidemiological contexts within a country or even a region or district, and must have the support and collaboration of farmers. Above all, the effectiveness of any such strategy will rely heavily on the quality of the veterinary services and administrative organizations involved.[31,32] The infected animal is the principal source of Brucella species antigen. Transmission typically occurs due to ingestion of the products of infective (fetus, placenta, uterine discharge) or ingestion of material contaminated by these products which contain large numbers of organisms.[21] The most frequent ports of Brucella species entrance are the membrane covering the conjunctiva, and vagina, as well as the mucus membranes of the oral, respiratory and gastrointestinal tracts. The incubation period is quite variable, ranging from 2weeks to 1year or longer depending upon the Brucella species strain, inoculums size, as well as upon host factors. The minimum incubation period from infection to abortion is approximately 30days. After ingestion Brucella species spread to the regional lymph nodes where they proliferate within macrophages. Subsequently, they spread via the bloodstream, during bacteremia, to other tissues like spleen, liver, bone marrow, mammary glands, and in sexually mature animals the infection localizes in the reproductive system particularly the pregnant uterus.[30] Brucella species has a strong tropism to the uterus during the last trimester of gestation, which is thought to be due to high concentrations of erythritol and steroid hormones.[1,22] Erythritol favors bacterial survival since it can be metabolized by B. abortus as a source of carbon and energy.[16] In gravid uterus Brucella species multiplies to massive numbers and typically produces placentitis followed by abortion in the pregnant female, usually during the last third of pregnancy, and epididymitis and orchitis in the male.

Human brucellosis

Prevalence and epidemiology of brucellosis in livestock production has been described in many developing countries.[7,10,31,35,36] Brucella abortus has seven recognized biovars, and the distribution of biovars could be important in ascertaining the source of some infections.[4,29] Bovine brucellosis is reported in virtually all countries where cattle are farmed, with some northern and central European countries, Australia, Canada, Japan and New Zealand considered free. Wild ruminants such as elk and lama are considered as a primary source of infection for cattle in New Zealand.[31] B. melitensis is the most virulent species of the Brucella genus and has three biovars 1, 2 and 3.[2] Brucellosis is among the 175 zoonotic infectious diseases listed worldwide. In Malaysia, the first reported case of human disease was the isolation of B. suis biotype 3 in 1980. Brucellosis is one of the most common causes of laboratory acquired infections. It is therefore imperative for laboratory workers to wear protective gears when working with live culture of Brucella. According to the centre for disease prevention and control (CDC) global travel have facilitated greatly the spread of brucellosis and it's considered as travelling related disease (CDC, 2009). Studies have shown that control of brucellosis in animal have helped significantly in the control of brucellosis in humans. Currently in humans, there is no available vaccine against brucellosis. However, efforts are put in place to develop human vaccine. Consumption of unpasteurized milk, handling of aborted materials with unprotected hands, the presence of individuals with brucellosis among family members and living in close proximity to livestock are considered as likely risk factors associated with brucellosis in humans. Syria and Mongolia are reported with the highest annual incidence of human brucellosis worldwide (1603 cases per million).[32] In Southeast Asia, human brucellosis has been reported in Thailand. In Malaysia however, a prevalence of 5.8% have been reported in hospital patients with history of association with animals. Furthermore, a prevalence of 14.24% was reported among veterinarians and farmers in different parts of Malaysia. Thus, indicating that veterinarians and farmers as high risk individuals.

Control and eradication programs of brucellosis

The worldwide trend towards more animal commerce and larger populations, along with limited resources, has made the control of brucellosis very difficult task.[37] Many countries are undergoing a re-emergence of the disease especially in sheep and goats.[18] Bovine brucellosis has been successfully eradicated in many developed countries after significant investment and many years of vaccinating and culling. However, B melitensis infection in sheep and goats has not been efficiently controlled and the disease is traditionally neglected. One of the main reasons is due to the small investments and low-income activity practiced when small ruminants raised especially by landless farmers in the developing world. Therefore, the control and eradication of this infection is extremely difficult.[13,18,20] Many factors must be considered when control or eradication strategies have to be implemented such as the impact of brucellosis on the livestock economy and human health and the costs of the different control or eradication that could be implemented.[18] The main aim of control program of brucellosis is to reduce the impact of a disease on both human health and the economy. Therefore, the main objective of control program is not to eliminate the disease from the population rather than control of the disease and some acceptable level of

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infection will remain in the population.[22] Usually, control programs have an unlimited duration and need to be maintained even after the acceptable level of infection has been reached, so that the disease does not re-emerge. Many activities could be implemented under control procedures mainly test and slaughter, and vaccination. However, other practice such as hygiene, control of animal movement has a significant role in reduction of the disease.[20,22] Few countries consider the test and slaughter policy, and this mainly due to economic factors especially in the endemic areas. Therefore, test and slaughter of positive animals is only successful in reducing the incidence if the herd or flock prevalence is very low e.g. 2%. Strategies for control of brucellosis are currently based on the early detection and removal of infected animals using different diagnostic tests, usually Rose Bengal plate test (RBPT), complement fixation test (CFT) and Enzyme-linked immunosorbent assay (ELISA).[4] The decision about slaughter of test-positive animals is made after regulatory, economic and prevalence factors are considered.[22] In developing countries control by test-and slaughter is hardly achievable because of limited resources to indemnify farmers whose animals are slaughtered during such screening programs.[1] Furthermore, the application of test and slaughter policies is unlikely to be successful with brucellosis of sheep and goats where the diagnostic tests are less reliable than in cattle.[14] Test and slaughter is also unlikely to be successful in cattle if the remainder of the herd is unvaccinated, especially in large populations.[38] Therefore, repeated herd or flock tests are necessary to further reduce the incidence of brucellosis and to confirm elimination.[39] In many countries, vaccination of animals has been found as the most successful method for prevention and control of brucellosis.[22,40,41] Vaccination of animals usually results in elimination of clinical disease and the reduction in numbers of organisms excreted by animals which become infected. Furthermore, animal owners are more likely to accept vaccination as a method of control since they are accustomed to this form of disease control.[13,18,22] While the ideal vaccine does not exist, the attenuated strains of B. melitensis Rev.1 for sheep and goats and B. abortus S19 have proven to be superior to all others.[40,41] On the other hand, B. abortus strain RB51 has been developed with encouraging results. Furthermore, the vaccine strain does not interfere with the serological diagnosis of brucellosis. In addition, it is considered as an official vaccine for prevention of brucellosis in cattle in several countries.[3,16,42] Nevertheless, there is disagreement in regards to how the efficiency of strain RB51 compares to protection induced by B. abortus S19 in cattle.[4] The source and quality of the vaccines are critical, in addition, the dosages and methods of administration, especially with Rev.1, vary and these can affect the results. Consequently, whole herd or flock vaccination can only be recommended when all other control measures have failed.[41,43] It is often recommended that vaccination with S19 and Rev.1 should be limited to sexually immature female animals. This is to minimize stimulation of postvaccinal antibodies which may confuse the interpretation of diagnostic tests and also to prevent possible induction of abortion in pregnant animals.[14,44] However, field and laboratory studies have demonstrated that conjunctival administration of these vaccines makes the vaccination of the herd or flock a practical and effective procedure. When B. melitensis Rev.1 vaccine is administered by the standard method (1-2×109CFU) injected subcutaneously it may induce a long-lasting serological response. In contrast, when this vaccine is administered by the conjunctival route, the immunity conferred is similar to that induced by the standard method but the serological response evoked is significantly reduced.[28,41] There are many technical aspects of brucellosis which frustrate control efforts. Perhaps the most serious is the variable incubation period and inability to identify animals which will later become seropositive. In addition, latency is another problem that complicate the situation, and approximately 5% of the new born of infected dams will retain the infection and become seropositive only after their first parturition. However, the percentage of latency among sheep and goats in largely unknown.[45] Another factor is related to farm management such as commingling of animals from different herds or flocks, purchasing animals from unscreened sources and sharing of male breeding stock between farms will also determine success of the control program applied.[22] Therefore, application of hygiene methods in control programs of brucellosis are effective tools in order to reduce the exposure of susceptible animals to those that are infected, or to their infected materials such as tissues and abortion fluids. Additionally, the control of animal movement is also essential in any programme in order to limit the spread of brucellosis.[18] Importations into clean areas must be restricted to animals that originate from brucellosis-free zone. However, in developing world, it is difficult to control the movement of small ruminants especially those kept under land less farmers. The herds' owners may be accustomed to seasonal migrations which may cross national boundaries.[46–48] Eradication, on the other hand, is very difficult to achieve comparing with control, and a highly organized effort is needed to reach eradication in either a territory and in a population. However, on a long-term basis, eradication programs generally are more economically advantageous compared to control programs.[22] Crucial factors for the success of an eradication programme are the implementation of an effective surveillance system with adequate laboratory support, and the understanding and sharing of objectives for eradication by the decision-makers, farmers, and all other stakeholders.[49,50] Cost-benefit and cost-effectiveness analysis in addition to adequate epidemiological surveillance system would sustain both technical and political decision-making.[51,52]

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Conflicts of interest

The author declares that there are no conflicts of interest.

References

1. Godfroid J, Scholz HC, Barbier T, et al. Brucellosis at the animal/ecosystem/human interface at the beginning of the 21st century. *Preventive Veterinary Medicine*. 2011;102(2):118–131.

2. Banai M, Corbel M. Taxonomy of Brucella. *Open Veterinary Science Journal*. 2010;4(1):85–101.

3. Godfroid J, Nielsen K, Saegerman C. Diagnosis of brucellosis in livestock and wildlife. *Croatian Medical Journal*. 2010;51(4):296–305.

4. OIE. World organization for animal health. *Bovine brucellosis, chapter 2.4.3*. In: *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*. 2009a;1–35.

5. OIE. World organization for animal health. *Caprine and ovine brucellosis (excluding Brucella ovis), chapter 2.7.2*. In: *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*. 2009b;1–10.

6. Department Veterinary Services. *Malaysia: Number of Livestock. 2012–2013*. 2015.

7. Anka MS, Hassan L, Adzhar A, et al. Bovine brucellosis trends in Malaysia between 2000 and 2008. *BMC veterinary research*. 2013;9(1):230.

8. Bamaiyi PH, Hassan L, Khairani–Bejo S, et al. Updates on brucellosis in Malaysia and Southeast Asia. *Malaysia Journal of Veterinary Research*. 2014;5(1):71–82.

9. Bahaman AR, Joseph PG, Khairani–Bejo S. A review of the epidemiology and control of brucellosis in Malaysia. *Jurnal Veterinar Malaysia*. 2007;19(1):1–6.

10. Bamaiyi PH, Hassan L, Khairani–Bejo S, et al. The prevalence and distribution of Brucella melitensis in goats in Malaysia from 2000 to 2009. *Preventive Veterinary Medicine*. 2015;119(3–4):232–236.

11. OIE. *World Animal Health Information Database (WAHID) of World Organization for Animal Health*. 2014.

12. Bamaiyi PH, Hassan L, Khairani–Bejo S, et al. Case–control study on risk factors associated with Brucella melitensis in goat farms in Peninsular Malaysia. *Tropical Animal Health Production*. 2014;46(5):739–745.

13. Alton G. Control of Brucella melitensis infection in sheep and goats–a review. *Tropical Animal Health and Production*. 1987;19(2):65–74.

14. Garin–Bastuji B, Blasco JM, Marín C, et al. The diagnosis of brucellosis in sheep and goats, old and new tools. *Small Ruminant Research*. 2006;62(1–2):63–70.

15. Blasco JM, Garin–Bastuji B, Marin CM, et al. Efficacy of different Rose Bengal and complement fixation antigens for the diagnosis of Brucella melitensis infection in sheep and goats. *Veterinary Record*. 1994;134(16):415–420.

16. Poester FP, Nielsen K, Samartino LE, et al. Diagnosis of Brucellosis. *The Open Veterinary Science Journal*. 2010;4(1):46–60.

17. Nielsen K. Diagnosis of brucellosis by serology. *Veterinary Microbiology*. 2002;90(1–4):447–459.

18. Blasco JM, Molina–Flores B. Control and eradication of Brucella melitensis infection in sheep and goats. *Veterinary Clinics of North America: Food Animal Practice*. 2011;27(1):95–104.

19. Nielsen K, Yu WL. Serological diagnosis of brucellosis. Contributions. Section of Biological and Medical Sciences. *Macedonian Acad Sci Arts*. 2010;31:65–89.

20. Minas A. Control and eradication of brucellosis in small ruminants. *Small Ruminant Research*. 2006;62(1–2):101–107.

21. Seleem MN, Boyle SM, Sriranganathan N. Brucellosis: a re–emerging zoonosis. Veterinary Microbiology. 2010;140(3–4):392–398.

22. Corbel MJ. Brucellosis in humans and animals. *World Health Organization*. 2006;28–35.

23. MacMillan AP. Investigation of the performance of the Rose Bengal plate test in the diagnosis of Brucella melitensis infection in sheep and goats. *World Animal Review (FAO)*. 1997.

24. Garin–Bastuji B, Hummel N, Gerbier G, et al. Non specific serological reactions in the diagnosis of bovine brucellosis: experimental oral infection of cattle with repeated doses of Yersinia enterocolitica O:9. *Veterinary Microbiology*. 1999;66(3):223–233.

25. Munoz PM, Marin CM, Monreal D, et al. Efficacy of several serological tests and antigens for diagnosis of bovine brucellosis in the presence of false–positive serological results due to Yersinia enterocolitica O:9. *Clinical and Diagnostic Laboratory Immunology*. 2005;12(1):141–151.

26. Nielsen K, Smith P, Yu W, et al. Serological discrimination by indirect enzyme immunoassay between the antibody response to Brucella sp. and Yersinia enterocolitica O:9 in cattle and pigs. *Veterinary Immunology and Immunopathology*. 2006;109(1–2):69–78.

27. Nielsen K, Smith P, Widdison J, et al. Serological relationship between cattle exposed to Brucella abortus, Yersinia enterocolitica O:9 and Escherichia coli O157:H7. *Veterinary Microbiolology*. 2004;100(1–2):25–30.

28. Garin–Bastuji B, Blasco JM, Grayon M, et al. Brucella melitensis infection in sheep: present and future. *Veterinary Research*. 1998;29(3–4):255–274.

29. Mathew C, Stokstad M, Johansen TB, et al. First isolation, identification, phenotypic and genotypic characterization of Brucella abortus biovar 3 from dairy cattle in Tanzania. *BMC Veterinary Research*. 2015;11:156.

30. Xavier MN, Paixao TA, Hartigh AB, et al. Pathogenesis of Brucella spp. *Open Veterinary Science Journal*. 2010;4(1):109–118.

31. Díaz Aparicio E. Epidemiology of brucellosis in domestic animals caused by Brucella melitensis, Brucella suis and Brucella abortus. *Revue sci Tech*. 2013;32(1):43–51,53–60.

32. Godfroid J, Al Dahouk S, Pappas G, et al. A "One Health" surveillance and control of brucellosis in developing countries: Moving away from improvisation. *Comparative Immunology, Microbiology and Infectious Diseases*. 2013;36(3):241–248.

33. Ocholi RA, Kwaga JKP, Ajogi I, et al. Phenotypic characterization of Brucella strains isolated from livestock in Nigeria. *Veterinary Microbiology*. 2004;103(1–2):47–53.

34. Kahler SC. Brucella melitensis infection discovered in cattle for first time, goats also infected. *Journal of the American Veterinary Medical Association*. 2000;216(5):648.

35. Al–Majali, Ahmad M. Seroepidemiology of caprine Brucellosis in Jordan. *Small Ruminant Research*. 2005;58(1):13–18.

36. Kaltungo BY, Saidu SNA, Sackey AKB, et al. Sero–prevalence of brucellosis in sheep in North Senatorial District of Kaduna State, Nigeria. *Asian Pacific Journal of Tropical Disease*. 2015;5(2):163–168.

37. Al–Majali, Ahmad M, Majok Aggrey A, et al. Prevalence of, and risk factors for, brucellosis in Awassi sheep in Southern Jordan. *Small Ruminant Research*. 2007;73(1–3):300–303.

38. Godfroid J, Saegerman C, Wellemans V, et al. How to substantiate eradication of bovine brucellosis when aspecific serological reactions occur in the course of brucellosis testing. *Veterinary Microbiology*. 2002;90(1–4):461–477.

39. Garrido–Abellan F. Brucellosis in sheep and goats (Brucella melitensis). *Scientific Committee on animal Health and Animal Welfare*. 2001;1–89.

40. Banai M. Control of small ruminant brucellosis by use of Brucella melitensis Rev. 1 vaccine: laboratory aspects and field observations. *Veterinary Microbiology*. 2002;90(1–4):497–519.

41. Blasco JM. A review of the use of B. melitensis Rev 1 vaccine in adult sheep and goats. *Preventive Veterinary Medicine*. 1997;31(3–4):275–283.

42. Robles CA, Nielsen K, Gall D, et al. Evaluation of three different antigens in an indirect enzyme–linked immunoassay for the detection of antibodies against Brucella abortus SRB51 in vaccinated heifers. *Vet Immunol lmmunopathol*. 2009;127(1–2):153–155.

43. Blasco JM. Existing and future vaccines against brucellosis in small ruminants. *Small Ruminant Research*. 2006;62(1–2):33–37.

44. Aras Z, Ateş M. The first report of isolation and molecular characterisation of Brucella melitensis Rev–1 vaccine strain from an aborted sheep fetus in Turkey. *Small Ruminant Research*. 2011;95(2–3):150–159.

45. Nicoletti P. Brucellosis: past, present and future. Contributions. Section of Biological and Medical Sciences. *Macedonian Academy of Sciences and Arts*. 2010;31(1):21–32.

46. Al–Talafhah AH, Lafi SQ, Al–Tarazi Y. Epidemiology of ovine brucellosis in Awassi sheep in Northern Jordan. *Preventive Veterinary Medicine*. 2003;60(4):297–306.

47. AL–Garadi MA, Khairani–Bejo S, Zunita Z, et al. Isolation and identification of Bucella melitensis in goats. *Journal of Animal and Veterinary Advances*. 2011;10(8):972–979.

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48. Naletoski I, Kirandziski T, Mitrov D, et al. Gaps in brucellosis eradication campaign in sheep and goats in Republic of Macedonia: lessons learned. *Croatian Medical Journal*. 2010;51(4):351–356.

49. Joseph PG. Brucellosis in Malaysia. *Ministry of Agriculture Malaysia*. 1987;4:1–22.

50. Khairani–Bejo S, Ardhy–Adman Bahaman AR. Investigation of canine brucellosis in Klang Valley Malaysia. *Journal of Animal and Veterinary Advances*. 2006;5:42–44.

51. Sam IC, Karunakaran R, Kamarulzaman A, et al. A large exposure to Brucella melitensis in a diagnostic laboratory. *Journal of Hospital Infection*. 2012;80(4):321–325.

52. Shahaza O, Khairani–Bejo S, Zunita Z, et al. In–House Rose Bengal Plate Agglutination Test (RBPT) for a Rapid Diagnosis of Brucellosis in Goats in Malaysia. *International Journal of Tropical Medicine*. 2009;4(3):116–118.

Citation: Yahaya SM, Bejo SK, Bitrus AA, et al. Occurrence of brucellosis in cattle and goats in Malaysia: a review. *J Dairy Vet Anim Res*. 2019;8(2):94–100. DOI: 10.15406/jdvar.2019.08.00249