Brucellosis in a water buffalo (*Bubalus bubalis*) herd in Balikesir province of Turkey: a bacteriological and pathological investigation

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Abstract

Brucellosis, caused by a facultative intracellular bacterium, induces great economic loss in the livestock economy worldwide. In this study, the abortion problem in an Anatolian water buffalo herd was investigated by pathological, bacteriological and serological means. An aborted fetus as well as blood and milk samples from 4 buffalo cows with abortion history were studied. The thoracic and abdominal cavities of the aborted fetus were filled with serohemorrhagic fluid, and abomasum had yellowish brown fluid containing fibrous material in it. Bronchointerstitial pneumonia was recognized in the lung tissues. *Brucella (B.*) abortus* biotype 3 was isolated from the aborted fetus. Blood samples collected from the water buffalo cows with a known history of abortion were found to be positive for brucellosis by the Rose Bengal Plate test and a serum agglutination test. Three out of 4 animals were also positive according to a Milk Ring Test. The isolated *B. abortus* biotype 3 was found to be highly resistant to the tested antibiotics. This investigation is the first study reporting brucellosis by pathological, bacteriological and serological means in Anatolian water buffalo in Turkey. Since brucellosis is an important zoonotic disease it is required that precautions must be taken when handling and consuming milk products of water buffaloes.

Keywords: Water buffalo, brucellosis, pathology, bacteriology, serology

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Introduction

Brucellosis, an infectious and contagious disease of many species including man, is known to cause great economic impact on the livestock industry. The disease is widespread around the world with a few exceptions where severe eradication policies and/or banning of animal movements have been successfully applied (FAO/WHO 1986). Brucellosis is caused by facultative intracellular Gram-negative bacteria of the genus Brucella (B.). Brucella spp. are non-spore forming, non-motile, non-capsulated, aerobic or microaerophilic coccobacilli (FAO/WHO, 1986; Quinn et al., 2011; Dağ et al., 2012). There are many Brucella species namely B. abortus, B. melitensis, B. suis, B. ovis, B. neotomae etc., that are known to cause infection in domestic and wild animals and B. abortus is primarily responsible for bovine brucellosis (Osterman and Moriyon, 2006).

The water buffalo (Bubalus bubalis) is an economically important animal in some areas of the world. It is estimated that there are more than 172 million water buffalo, the majority being located in Asia, mostly India, Pakistan and China (Borghese, 2011). The water buffalo population in Turkey was announced as 178.397 head in 2018, representing only 1% of the total bovine animals. However, the population showed 10.5% increase compared to the previous year (TÜİK, 2018). Water buffalo in Turkey are reared mostly in Samsun province followed by the Eastern Anatolian and Marmara regions. They are raised mainly for milk production because of the high quality of milk fat that is best appreciated for the cream that accompanies the famous Turkish baklava. Less importantly, they are also used for meat production and as draught animals. Water buffalo in Turkey are known to be only of Anatolian breed, which is a river type.

Knowledge about diseases of water buffalo is limited mostly due to comparably fewer being raised as livestock animals in the world. As an infectious disease, brucellosis in water buffalo has been reported in Egypt (Holt et al., 2011), Italy (Guarino et al., 2001), Trinidad and Tobago (Fosgate et al., 2011), Pakistan (Nasır et al., 2014), Argentina (Konrad et al., 2013), Brazil (Santa Rosa et al., 1961), Iran (Nowroozi-Asl et al., 2007), and Mexico (Suazo-Cortez et al., 2012). In Turkey, there has been only one study in water buffaloes that has reported 2.4% (2/82) seropositivity for B. abortus (Albayrak et al., 2012). In this study, brucellosis in an aborted water buffalo fetus and the mother as well as other buffalo cows in a herd with a known history of abortion was investigated pathologically, bacteriologically and serologically.

Materials and Methods

Animals: In January 2019, a water buffalo fetus aborted in last trimester of gestation was presented to Balıkesir University Faculty of Veterinary Medicine for detection purposes of the cause of abortion. According to the owner the herd consisted of a total of 30 water buffalo, 1 male, 15 female and 14 calves. The herd was vaccinated with a vaccine prepared from B. abortus 599 strain. The herd was housed separately from other livestock animals but used the same field for grazing.

Pathology: Necropsy was performed on the aborted fetus and tissue samples were collected and fixed in 10% neutral buffered formalin for routine pathological examination. Tissue samples were routinely stained with hematoxylin and eosin (H&E) and the sections were investigated under a light microscope.

Bacteriology: For bacteriological analysis, swabs from the stomach contents, pharynx, and liver of the aborted fetus were taken carefully and inoculated immediately onto duplicate plates of blood agar base no:2 (Oxoid, Hampshire, England) containing 7% defibrinated sheep blood. All the plates were incubated at 37°C, both in air and microaerobically (5-10% CO2) for 4-6 days. Identification and typing of Brucella strains were performed using standard classification tests, including growth characteristics, catalase, oxidase and urease activity, H2S production, growth in the presence of thionin (40 µg/ml, 20 µg/ml and 10 µg/ml) and basic fuchsine (20 µg/ml and 10 µg/ml) and agglutination with monospecific A and M antisera (Alton et al., 1988; İlhan et al., 2008; Quinn et al., 2011).

Serology: Approximately 15 ml of whole blood (without anticoagulant) was aseptically taken from the jugular vein in sterile tubes. Sera samples were tested by the Rose Bengal plate test (RBPT) and a serum agglutination test (SAT). Antigen prepared from B. abortus 599 strain for RBPT and SAT was supplied by the Istanbul Pendik Veterinary Control Institute. The tests were performed as described previously (Alton et al., 1988). RBPT was scored according to the supplier’s procedure. Serum samples testing positive in both RBPT and SAT were accepted as true positive serologically.

Milk samples were also collected under hygienic conditions from four udders. Approximately 15 ml of the milk were sampled and used in milk ring test (MRT). MRT antigen, which was prepared from B. abortus 599 strain and stained with hematoxylin, was supplied by the Istanbul Pendik Veterinary Control Institute. The test was performed in sterile tubes and the milk samples were tested within 2-5 h after collection. The milk samples were thoroughly shaken and MRT was performed as described; a: 1000 µl milk + 30 µl antigen, b: 500 µl milk + 500 µl PBS (pH: 7.2) + 30 µl antigen, c: 500 µl milk + 500 µl sterile distilled water + 30 µl antigen. The tubes were mixed thoroughly and incubated at 37°C for 1-4 h. When the antigen precipitated at the bottom of the tubes and/or a purple band occurred at the top of milk, those samples were then regarded as positive (İlhan et al., 2008). MRT test results were scored according to the supplier’s procedure.

Antimicrobial susceptibility testing: B. abortus biotype 3 strain isolated in the current study was tested against selected antibiotics (Bauer et al., 1966). Mueller-Hinton agar (CM337, Oxoid) supplemented with 7% defibrinated sheep blood was used. A suspension of the culture was prepared in sterile saline solution (NaCl 0.85%, pH: 7.2) and turbidity was visually adjusted to the 0.5 McFarland Standard (1.5 x 108 cells/ml). The suspension was surface plated within 30 mins after preparation and the following antimicrobial
discs were applied to the surface of the plates: streptomycin (S) 10 µg (Bioanalyse), trimethoprim/sulphamethoxazole (STX) 25 µg (BBL), tetracycline (TE) 30 µg (Oxoid), ampicillin/sulbactam (SAM) 10/10 µg (Bioanalyse), enrofloxacin (ENR) 5 µg (Bioanalyse), amoxicillin/clavulanacacid (AMC) 30 µg (Oxoid), oxytetracycline (T) 30 µg (Bioanalyse), cloxacillin (OB) 5 µg (Oxoid), penicillin/novobiocin (PNV) 40 µg and neomycin/bacitracin/tetracycline (NBT70C) 30 µg/10 U/30 µg (MastDiagnostic). The National Committee for Clinical Laboratory Standards (NCCLS 2007) breakpoints for STX and TE that were for *Haemophilus* (H.) *influenza* were accepted for *B. abortus* biotype 3 in this study. Breakpoints used for S were recommended by the Comité de l’Antibiogramme de la Société Française de Microbiologie (Members of the SFM Antibiogram Committee, 2003). The following bacteria were considered: *Streptococcus pneumoniae* for PNV 40; *H. influenza* for SAM and AMC (NCCLS 2007). For the activity of the other antimicrobials (ENR; T, OB and NBT70C), the interpretations were based on inhibition zone diameter tables for aerobic microorganisms provided by disc suppliers for antibiogram analysis in human and veterinary medicines.

**Results**

In gross inspection of the aborted fetus at necropsy, the subcutaneous tissues were edematous and an excess amount of serobemorrhagic fluid filled the thoracic and abdominal cavities (Fig. 1). The lungs were diffusely enlarged and edematous. The bronchial and mediastineal lymph nodes were slightly enlarged. In the abomasum, a viscous yellowish-brown fluid containing white flecks reminiscent of fibrous material was observed (Fig. 2). No other prominent changes were observed in the other organs. In histopathological investigation of the hematoxylin and eosin stained sections of lung tissues, bronchointerstitial pneumonia was noted (Fig. 3). Bronchial lumens were filled with lymphocytes and alveolar macrophages. The bronchial and alveolar epithelia had degenerated and occasional desquamation was noted. Interalveolar septa were markedly broadened with edema, fibrin and mononuclear cellular infiltrations. Thrombosis of lymphatic and some blood vessels was also noted in lung tissue.

![Figure 1](image)

Figure 1  Sero-hemorrhagic fluid in the thoracic and abdominal cavities of the aborted water buffalo calf
Figure 2  Viscous yellowish-brown fluid containing fibrins in abomasum of the aborted water buffalo calf

Figure 3  Histopathological view of lung of the aborted water buffalo fetus showing bronchointerstitial pneumonia. H&E
In microbiological analysis, *B. abortus* biotype 3 was isolated from the aborted fetus as pure culture. All sera samples collected from the mother buffaloes with a known history of abortion including the current aborted fetus were found positive for brucellosis by RBPT and SAT. For milk samples, 3 were also positive by MRT (Fig. 4). Serological test results were presented in Table 1.

![Figure 4](image-url)  
**Figure 4** MRT test results in milk samples of the water buffalo cows with known history of abortion from the same herd. Tube 1 and 3 are MRT positive samples, and tube 2 and 4 are MRT negative at 37°C in 2 hours.

**Table 1** Serological test results of blood and milk samples of water buffalo mothers with known history of abortion.

<table>
<thead>
<tr>
<th>Animals</th>
<th>Gestation Month of Abortion</th>
<th>RBPT</th>
<th>SAT</th>
<th>MRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6th</td>
<td>+</td>
<td>1/160</td>
<td>-</td>
</tr>
<tr>
<td>2*</td>
<td>9th</td>
<td>++</td>
<td>1/320</td>
<td>++++</td>
</tr>
<tr>
<td>3</td>
<td>9th</td>
<td>++</td>
<td>1/320</td>
<td>+++</td>
</tr>
<tr>
<td>4</td>
<td>10th</td>
<td>++</td>
<td>1/320</td>
<td>++++</td>
</tr>
</tbody>
</table>

RBPT: Rose Bengal plate test, SAT: Serum agglutination test and MRT: Milk ring test
*The mother of the fetus *B. abortus* biotype 3 strain was isolated.

A total of 10 different antibiotic discs were tested in the current investigation and the *B. abortus* biotype 3 strain isolated from the aborted Anatolian water buffalo was found to be highly resistant to all tested antibiotics.

**Discussion**

Brucellosis has worldwide distribution and causes great economic loss in the livestock industry in the Mediterranean basin, the Middle East and Asia where it is endemic. A wide variety of animals such as cattle, sheep, goats, buffalo and camels may suffer from brucellosis (FAO/WHO, 1986). Brucellosis has also been reported in the water buffalo, which in comparison to the other livestock animals is a less economically important animal. However, in some regions it bears great importance because of the high milk quality preference and the animal power it provides. Since water buffalo may better appreciate watery or muddy areas where other livestock animals do not like, it is a choice as an alternative to cattle. In those locations where water buffalo are raised, knowledge of water buffalo diseases is essential to prevent and/or treat the conditions that hamper the profitability.

Brucellosis is a highly contagious disease. While the venereal route is not a major concern for disease transmission contaminated semen can easily transmit the bacteria through artificial insemination (Rankin, 1965). On the other hand, aborted fetuses and contaminated materials are the main sources of bacterial transmission (Büyük and Şahin, 2011). Although *Brucella* agents do not cause clinical mastitis, they can be shed heavily in the milk providing a source of bacteria that may spread. Following exposure, the bacteria enter the host through oropharynx, upper respiratory tract and conjunctiva, and then are phagocytosed mainly by macrophages. The agents can...
survive within the mononuclear cells and be transported to regional lymph nodes. Hematogenous and lymphatic transmission to selected organs such as mammary glands, the pregnant uterus, osteoarticular tissues and male reproductive organs then takes place. Decrease in milk production and an increase in somatic cell numbers are other important outcomes of the disease (Quinn et al., 2011). A dramatic decrease in milk production has also been reported by the owner in this study.

Bovine brucellosis causes osteoarticular and reproductive problems in animals, resulting in reduced yield. The disease significantly reduces fertility by causing orchitis and epididymitis in males and placentitis in females. It is also manifested in the birth of weak calves and abortion especially in the last trimester of gestation. However, abortions can happen earlier in gestation (Das et al., 1990). In this study, abortions were reported to occur between 6-10 months of gestation. Seropositive herds with no known history of abortion can also be seen (Nicoletti, 1992). Brucella infected animals usually abort only once due to the development of cellular immunity (Sousa et al., 2017). However, in the following pregnancies bacterial shedding through the membranes and fluids can occur due to reinvasion.

In brucellosis associated aborted bovine fetuses, bronchopneumonia and interstitial pneumonia with lymphoid hypertrophy are the most commonly seen lesions. Abnormal abomasal content, fibrinous pleuritis, vasculitis and meningitis are some of the other changes seen in aborted fetuses (López et al., 1984). Mild lesions in the liver, spleen, kidneys and heart have also been occasionally described in aborted bovine fetuses (Sönmez et al., 2004). Although there is a lack of literature describing the histopathological changes in brucellosis associated aborted water buffalo fetuses it is feasible to speculate that similar lesions to cattle cases may occur. In the present study, bronchointerstitial pneumonia, abnormal abomasal content and serohemorrhagic fluid in the thoracic and abdominal cavities were noted.

Brucella species and biotypes may vary in animals from region to region. Bovine brucellosis is mainly caused by B. abortus. In buffalo, B. abortus biotype 1 has been reported in India (Renukardihya et al., 2002), Italy (Borrillo et al., 2013) and Trinidad and Tobago (Fosgate et al., 2002). It is presumed that B. abortus biotype indigenous to the cattle population in one area may also be found in buffalo living in the same area. However, this might not be always true as in Italy B. abortus biotype 6 causes infection in cattle while biotype 1 is seen in buffalo (Di Giannatale et al., 2006). On the other hand, more research is certainly needed since biotype 6 has also been identified in buffalo in Italy, more dramatically in addition to B. melitensis (Di Giannatale et al., 2006). In Argentina, B. abortus biotype 5 was reported in an aborted water buffalo fetus as well (Martínez et al., 2014). In the Eastern Mediterranean region B. abortus biotype 3 is the predominant biotype in cattle (Refai, 2002; Büyük and Şahin, 2011). However, there is also a study in Turkey reporting higher presence of B. abortus biotype 1 in cattle (Sözmen et al., 2004). In the current study, B. abortus biotype 3 was isolated in an aborted water buffalo fetus in Turkey.

Diagnosis of brucellosis can be achieved by direct or indirect methods (FAO/WHO, 1986). Bacterial isolation and identification of the causative Brucella species is the golden standard for direct detection. For serological diagnosis of brucellosis in cattle and sheep RBPT, SAT, ELISA, dot-blot assay, complement fixation test, fluorescence polarization assay, 2 mercaptoethanol agglutination test and etc. are some other indirect methods frequently used (Ramnanan et al., 2014; Sousa et al., 2017). Since there are no specific serological tests for water buffalo currently, RBPT and SAT were used in the present study for detection of brucellosis. Positive results from both tests were accepted as true positive for brucellosis. In the current investigation, detection of 3 out of 4 animals tested by RBPT and SAT showing strong positivity against B. abortus biotype 3 was evaluated as water buffalo produces high titer of antibodies in natural infections.

MRT is a commonly used test for cattle and sheep milk samples for the detection of brucellosis and the milk in this test is used without any treatment (Göktürk et al., 1999; İlhan et al., 2008). Biochemical features of water buffalo milk are quite different from other livestock animal’s milk. Since the fat content of water buffalo milk is very high, milk samples in this study were also tested in different dilutions and diluents as well as not diluted. The best result for MRT was provided by 500 µl milk + 500 µl sterile distilled water + 30 µl antigen treatment with 37°C incubation at 2 hours. This finding suggests that MRT can also be applicable for water buffalo in field investigations.

A wide variety of antibiotics were tested in this study. Since animal brucellosis is not treated by antibiotics (WHO/CDS/EPR, 2006) and the susceptibility testing of Brucella spp. is not routinely used in human medicine (Baykam et al., 2004), the presence of high resistance against B. abortus biotype 3 strain against the antibiotics tested in this study is a remarkable finding. Water buffalo milk is used in many products such as cheese, yogurt, cream etc. Brucella positive water buffalo milks that are not pasteurized properly can be a great risk for human health.

In the current study, B. abortus biotype 3 was isolated and identified from the aborted fetus. As an indirect detection system, serological tests can also be successfully used especially in surveillance studies. RBPT, SAT and MRT were performed to show the presence of Brucella antibodies in the blood and milk of the mother of the aborted fetus as well as another three mothers from the same herd with a known history of abortion in this study. Bacteriological culture, immunohistochemistry, PCR and qPCR are the direct detection methods that have been suggested for detection of Brucella agents (Sözmen et al., 2004; Caiano et al., 2014). Easy, cheap and fast applicability of most indirect tests are the interest of choice especially for surveillance purposes as compared to direct tests that are more costly and require equipped personal and laboratories. However, it must be kept in mind that the tests used for cattle have different sensitivity and specificity in water buffalo (Fosgate et al., 2014).
Brucella species are fastidious and relatively slow growing organisms (Stack et al., 2002). The strain isolated in this study was harvested on the 6th day. In isolation, identification and typing of the current strain, B. abortus biotype 3 showed activity on approximately on the 5th day. This finding may be evaluated as the water buffalo originated strain adapting late to laboratory conditions.

Brucellosis in water buffalo has been previously reported in some countries including Turkey. Most of the brucellosis reports have been based on serological tests. In this study, bacteriological isolation and identification of the B. abortus biotype 3 from an aborted fetus was successfully performed and histopathological changes were described in addition to the seropositive diagnosis from the mother. This study is the first to show brucellosis associated abortion in a water buffalo in Turkey. Brucella agents are well known microorganisms that can cause abortion in livestock animals and therefore attention must be directed against them to prevent the occurrence of such losses in water buffalo where they are raised. Thus, regular serological surveillance can be suggested and may contribute to the control of the disease. Since brucellosis is a zoonotic disease, care must also be taken when handling and using associated animal materials and milk products of water buffalo.

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