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DERLEME MAKALESİ REVIEW PAPER

# Diseases Transmission Via Semen in Cattle: Importance and Control Strategies

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**Abstract:** Disease transmission via semen is an extremely adversarial situation in terms of animal husbandry and reproductive productivity. Artificial insemination is the most widely used method in reproductive biotechnology. The main purpose of artificial insemination is to make genetic improvements. Millions of semen doses produce and distributed throughout the world. With this method, semen obtained both domestically and abroad affects animal husbandry throughout the country. Therefore, absolutely semen should be free from all kinds of disease factors. Control strategies should be determined and implemented in the entire process, from semen procurement to storage. Serious measures should be taken in semen production facilities; breeding animals should be checked regularly. Semen obtained from breeding animals in sperm stations should be investigated for various pathogens. Care should be taken to vaccinate the animals, and disease-free herds should be created. The purpose of this review is to review the importance of diseases via semen and the determination of control strategies.

**Keywords**: Cattle, control, disease, semen, transmission.

# Hastalıkların Sperma Yoluyla Bulaşması: Önemi ve Kontrol Stratejileri, Türkiye

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**Öz:** Sperma yoluyla hastalık bulaşması, hayvancılık ve üreme verimliliği açısından son derece olumsuz bir durumdur. Suni tohumlama, üreme biyoteknolojileri arasında yaygın olarak kullanılan yöntemdir. Suni tohumlamanın temel amacı genetik iyileştirme sağlamaktır. Milyonlarca doz sperma dünya çapında üretilmekte ve dağıtılmaktadır. Bu yöntemle hem yurt içinden hem de yurt dışından elde edilen sperma ile tüm ülke genelinde hayvancılık etkilenmektedir. Bu nedenle sperma her türlü hastalık faktöründen ari olmalıdır. Spermanın alınması, işlenmesi ve depolanmasına kadar tüm süreçte kontrol stratejileri belirlenmeli ve uygulanmalıdır. Sperma üretim tesislerinde ciddi önlemler alınmalı, damızlık hayvanlar düzenli olarak kontrol edilmelidir. Sperma üretim istasyonlarında damızlık hayvanlardan elde edilen sperma, çeşitli patojenler yönünden düzenli olarak taranmalıdır. Hayvanların aşılanmasına özen gösterilmeli ve hastalıktan ari sürüler oluşturulması sağlanmalıdır. Bu derlemenin amacı sperma yoluyla bulaşan hastalıkların ve kontrol stratejilerinin önemini değerlendirmektir.

**Anahtar kelimeler:** Bulaşma, hastalık, kontrol, sığır, sperma.

## INTRODUCTION

Cattles, due to their high reproductive capacity, are essential for meat and milk production. Artificial insemination is used for most modern dairy cattle breeding (Givens & Marley, 2008). In cattle, artificial insemination's primary goal is to achieve continuous genetic improvement and prevent or eliminate venereal disease. As the most frequently used procedure today, artificial insemination (AI) has had and continues to have a tremendous impact on the various animal breeding industries. Today millions of semen doses produce and distributed for livestock improvement and easy application of artificial insemination throughout the world. Artificial insemination includes significant advantages such as genetic advancement, disease control, reproductive management, and cost savings. Some of these advantages can also be considered disadvantages. This technology may cause the spread of genetic defects and some infections (Wentink et al., 2000). Diseases of a bull's testicle, epididymis, vas deferens, ampulla, seminal vesicle, prostate, urethra, penis, or prepuce or migration leakage infected blood cells into the male reproductive tract can readily contaminate semen. These conditions may detect the infectious pathogen in the semen, cattle via natural breeding or artificial insemination. Semen used for AI must therefore be free of infectious agents (Givens, 2018). Transmissible diseases that have the potential for severe and rapid spread, irrespective of national borders, are of serious socio-economic or public health consequence, which is of significant importance in the international trade of animals and animal products (Eaglesome & Garcia, 1997). At the international level, guidelines are published by the Office International des Epizooties (OIE) to enable the health of animals in AI centers to be maintained and facilitate the global distribution of semen free of specific pathogenic organisms. National standards for semen production and distribution are usually based on regulatory programs to ensure that diseases of importance are identified and appropriate tests are applied to all sires entering and residing in artificial insemination centers. Therefore necessitates daily testing of frozen semen under the most hygienic conditions (OIE, 2017). This review aims to determine potential semen-transmitted diseases and prevention strategies for these diseases, which play an important role in genetic progression.

***The Role of Sperm in Genetic Development and the Importance of Semen Production Facilities*:** Genetic development to satisfy global demand is put a greater focus on bull semen production facilities in order to increase the reproductive potential of bull. Testicular capability, daily sperm production (DSP) (Amann, 1970), daily sperm output (Amann et al., 1974), ejaculate ability in the laboratory, and timely bull management decisions all contribute to ample product production. Any sperm-producing company's goal is to optimize sperm yield while reducing the risk of injury to bulls and employees. To meet consumer demands for artificial insemination organizations to provide abundant products at a fair production cost and compete globally, it is necessary to taking advantage of bulls reproductive capability. A valid certification can be ensured by a periodic testing program of a representative number of animals in the region for the absence of diseases. When diseases are endemic, however, inquiries into the animals' be free from these diseases one month after semen collection seem to be inevitable. Fresh sperm is extremely dangerous and should be avoided at all costs (Lanyon et al., 2012).

The regular testing of semen donors under official veterinary supervision has been adopted by governments worldwide as a means of avoiding the spread of pathogens and reducing excessive contamination of semen by ubiquitous bacteria. National standards for semen production and distribution are usually based on regulatory programs to ensure that diseases of importance are identified, and appropriate tests are applied to all sires entering and residing in artificial insemination (AI) centers (Sanderson, 2009). These programs take into account the national health status as well as the health status of the herds and flocks of the semen donors. In interpreting health status, prime considerations include the sensitivity and specificity of tests, particularly when they are applied to individual animals, and the risk of latent infections. Testing programs need to be continually improved and updated as new information on the epidemiology, pathogenesis, and control of traditional diseases becomes available (Sibley, 2010). As hew infectious diseases emerge, these additional challenges and risks must also be met. The Office International des Epizooties (OIE) publishes guidelines at the international level to ensure the protection of animals in AI centers and to promote the global distribution of semen that is free of unique pathogenic species (Bayvel, 2004).

***Diseases Transmissible through Semen*:** Several pathogens can lead to various diseases in bulls or result in transmission through semen. The rate at which diseases are transmitted to other animals is determined by various factors, including the pathogen, the host, and the animal-to-animal contact structure. The number of animals infected by one typical infectious animal over the course of its infectious duration is a significant parameter in transmission. This number is highly dependent on the number of effective animal contacts. A contact is effective while the pathogen is transmitted when one of the animals is infectious (above the minimal effective dose excretion titer). These contacts may be direct (animal–animal) or indirect (by air, people, equipment, etc.) (Wentink et al., 2000). Viruses, bacteria, protozoa, and parasites can all be spread by bovine sperm. Infections of the testicles, epididymis, vas deferens, ampulla, seminal vesicle, prostate, urethra, penis, or prepuce, as well as the movement or leakage of infected blood cells into the male reproductive tract, can easily contaminate semen. Major viral pathogens have been researched in terms of transmission by sperm. Below is a summary of viral diseases through semen in Table 1 (Eaglesome & Garcia, 1997; Givens, 2018; Hornizek, 1990; Wentink et al., 2000) and bacterial and protozoon diseases through semen in Table 2 (Benchimol et al., 2008; BonDurant, 2005; Givens, 2018; Karlsson et al., 2010; Peter, 1997).

**Table 1.** A summary of viral diseases through semen.

| Viral Diseases | Etiology | Incubation Period | Characteristic symptoms | Disease Risk via Semen | Diagnosis |
|---|---|---|---|---|---|
| BR/IPV | Bovine Herpes Virus type 1 | 2-5 days | Fever, nasal discharge, Balonopostitis | Transmission by semen is possible | Cornell semen test Virus isolation (SNT, ELISA or PCR) |
| Bovine viral Disease | Pestivirus | 2-15 days | Fever, erosion of the oral and nasal mucosa | The primary source of infection is persistently infected animals present in a herd | Virus isolation (ELISA or PCR) |
| Leukosis | Oncovirus | Up to 35 days | Enlargement of superficial lymph nodes | Transmission by semen is very unlikely | Symptoms and lesions Virus identification (ELISA, AGID, PCR) |
| Blue Tongue | Orbivirus | 3-6 days | Fever, cyanosis on tongue | Temporary infertility in bulls and shedding of BTV in semen may ocur | Symptoms and lesions Virus identification (ELISA or PCR) |
| Foot-Mouth Disease | Aphtovirus | 2-8 days | Fever, viesicles in mucosa of mouth | Transmission by semen is very unlikely | Symptoms and lesions Virus identification (CFT or SNT) Electronmicroscopy |
| Rinderpest | Morbillivirus | 4-15 days | Nasal and ocular discharge, diarrhoea | Transmission by semen is possible | Virus identification (ELISA or PCR) |
| Malignant Catharral fever | Herpes virus (BHV3) | From a few days to year | Fever, keratitis | Transmission by semen is very unlikely | Symptoms and lesions Virus identification (PCR) |
| Akabene virus | Akabanevirus | - | Congenital abnormalities | Transmission by semen is very unlikely | Serology, Culture techniques |
| Schmallenberg virus | Orthobunyavirus | 1-5 days | Fever, diarrhoea | This virus can be detected in seminal plasma early in acute infections | Symptoms and lesions Virus identification (PCR) |

**Table 2.** A summary of bacterial and protozoon diseases through semen.

| Bacterial Diseases | Etiology | Characteristic symptoms | Disease Risk via Semen | Diagnosis |
|---|---|---|---|---|
| CBPP | *Mycoplasma mycoides* ssp. | Fever, dyspnoea, coughing, nasal discharges, and anorexia | Transmission by semen is possible | Culture techniques |
| Brucellosis | *Brucella abortus*, *Brucella melitensis* | Orchitis, epididymitis, seminal vesiculitis, ampullitis, decreased libido, and infertility | Transmission by semen is possible | Serology (CFT or BUA), Specific skin test |
| Bovine Tuberculosis | *Mycobacterium bovis*, *Mycobacterium tuberculosis* | Coughing, lymph nodes develop | Transmission by semen is possible | Serology (ELISA), Specific skin test |
| Johne's disease | *Mycobacterium paratuberculosis* | Diarrhea, emaciation, and submandibular edema | Transmission by contaminated semen or semen from contaminated bulls has never been demonstrated | Serology (ELISA or CFT), Specific skin test |
| Leptospirosis | *Leptospira hardjo* | Fever, icterus, hemorrhages, uremia, and blood-tinged urine | Transmission by semen is possible | Culture techniques, PCR |
| Bovine genital campylobacteriosis | *Campylobacter fetus* ssp. *venerealis* | Infertility | Mating and/or semen are the main causes of transmission | Culture techniques |
| Chlamydiaceae | *Cp. abortus*, *Cp. pecorum*, *Cp. psittaci* | Polyarthritis, encephalitis, intestinal infection, endometritis, vaginitis | Transmission by semen is possible | Serology (CFT or ELISA), PCR |
| Query fever | *Coxiella burnetti* | Infertility | Transmission by semen is limited or unlikely | Serology (CFT or ELISA) |
| Haemorrhagic septicaemia | *Pasteurella multocida* | Fever | Transmission by semen is very unlikely | Culture techniques |
| **Protozoon Diseases** | **Etiology** | **Characteristic symptoms** | **Disease Risk via Semen** | **Diagnosis** |
| Bovine genital trichomoniasis | *Trichomonas fetus* | Infertility | Transmission by semen is possible | Culture techniques |

***Matters to be Considered in Semen Production Facilities and Quarantine Procedure:*** First of all, preventive measures should be broad and applicable. A high transmission ratio in AI stations will be reached when the number of influential contacts is loud and the length of the incubation term is short. For protective measures, only disease-free animals should be admitted, have optimal sanitation for humans entering the premises, do 48-hour storage periods or disinfection of materials before entry into the station, and have to use piped water only and vermin eradication. Entries and exits of the personnel working in the center should be kept under strict control (Villarroel et al., 2007). Working personnel should wear special clothes at the breeding sperm production site, while workers should wear overalls and boots. However, infectious particles carried by air or birds remain a risk factor. In this situation, only long distances (greater than 1 km) between the AI station and other cattle in the region would suffice (Wentink et al., 2000). Care should be taken to ensure that technically competent persons who can control the spread of any disease, properly trained in disinfection procedures and hygiene techniques, are assigned at the production facilities (Collins & Stabel, 2011). Besides, the breed, date of birth, pedigree information of each animal, all health checks and vaccinations in the center will be kept in the health file, and this information should be checked during the inspections by the veterinarian (Mathevon et al., 1998).

The tests for the existence of infectious agents in the sperm are based solely on the sensitivity of the test methods since they are based on a single investigation. Consecutive investigations are used to continuously monitor semen donors for infectious diseases before and after semen collection, increasing the reliability by the application using several tests. Checking for the donor's freedom from infectious diseases 28 days after semen collection is without a doubt the best strategy for ensuring the health protection of the sperm (Sanderson, 2009). In terms of the lengths of incubation and infectious times, the amount of virus excreted, and the number of contacts made, all infectious animals are treated the same (Hage et al., 1996). The next move is to reduce the adverse effects of unintended agent introduction into AI stations. Disease agents that may be transmitted by sperm must be tested regularly , and animals that test positive must be isolated immediately (Wentink et al., 2000). In an AI station, however, this is unlikely to happen because the animals are quarantined for four weeks and serologically checked before entering the stud. If the disease is spread through aerogenic transmissions, such as from a neighboring farm, several bulls can be infected right away (Sibley, 2010). In this situation, the chances of the initial infection spreading by chance are smaller, and more animals would have displayed seroconversion at the following sampling, raising the chances of detection (Colenbrander et al., 1993). The results are highly reliant on seroconversion. Medical symptoms will be apparent in many epidemics, the virus will be detected sooner, and semen will be withheld from trading. Furthermore, when assessing the protection of imported sperm, the endemic situation should be taken into account.

Moreover, diseases with a high transmission rate within the bull herd and an increased risk of transmission through semen should be regularly checked to ensure healthy goods. The best option for this group will be to test the animals before releasing the sperm 28 days after production (Sanderson, 2009). Clinical and serological tests of the health status may be done before release by using this protocol. AI stations in areas where specific diseases are declared to be eradicated should be able to deliver sperm without having to test the bulls (Hage et al., 1996).

## CONCLUSION

Most pathogens can cause a variety of diseases and can potentially be transmitted by sperm. Understanding the specific infectious, bacterial, protozoal, and parasitic pathogens contaminating bovine sperm can help advance animal husbandry worldwide. In bulls, infection is not accompanied by either pathological lesions or modifications in the characteristics of the semen. Therefore quarantine of bulls before herd entry and adequate diagnostic testing during quarantine are wide musts used to avoid pathogen entry when specific pathogens are a concern. Efficient control protocols for entry of new bulls into herds for natural breeding and the importation of helpful novel genetics by artificial insemination can be established due to a thorough study of the characteristics of diseases that may trigger disease transmission semen. Adhering to disease control recommendations provided by CSS and the OIE can prevent pathogen transmission via semen.

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