# Bacterial and Viral Zoonotic Diseases of Yak

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**Abstract**

The yak, *Bos grunniens* or *Bos mutus*, is a long-haired bovine found throughout the Himalayan region of South Central Asia, the Tibetan plateau, Nepal, India and as far north as Mongolia and Russia. There is little differentiation between a Yak and the Highland Cattle. As yak and cattle belonging to same family and share the same habitat, especially during the winter season, many of the cattle diseases were witnessed in yaks. Different bacterial, viral, mycotic and parasitic zoonotic diseases have been encountered in yaks. Different bacterial diseases like anthrax, botulism, brucellosis, calf scours, leptospirosis, mastitis, pasteurellosis, salmonellosis, tetanus and tuberculosis have been reported by different workers are described in this paper. Similarly, information on some of the important viral diseases such as vesicular stomatitis, viral diarrhoea/mucosal disease, rinderpest, infectious bovine rhinotracheitis and foot and mouth disease was provided in this article.

## 1. Introduction

Yak (*Bos grunniens* or *Bos mutus*) is a long-haired bovine found throughout the Himalayan region of south central Asia, the Tibetan plateau, Nepal, India and as far north as Mongolia and Russia. Yak was probably domesticated in Tibet during the first millennium BC, now occur throughout the high plateaus and mountains of Central Asia. There are now more than 12 m domestic yaks in the highlands of Central Asia. Yaks belong to the genus *Bos*, and are therefore closely related to cattle (*Bos primigenius*). There is little difference between yak and highland cattle. Zoonosis is defined by the World Health Organization (WHO) as those diseases and infections which are naturally transmitted between humans and animals. There are more than 300 such diseases with the diverse etiology. Since yak and cattle belong to the same family and share the same habitat, especially during the winter season, many of the cattle diseases are encountered in yak. The incidence of theses diseases are quite higher in yak than cattle because of lack of proper and adequate treatment. Further, poor veterinary practices in yak especially in Himalayan part of India leads to the transmission of many infectious and non-infectious diseases. The general paucity of treatment of disease is a consequence of several factors, including the remoteness of much of the yak territory, low cost-effectiveness of treatment (especially as treatment costs may often be relatively high), the traditional nature of much yak keeping and, possibly, a lack of knowledge or recognition of disease by herdsmen. Almost all bacterial and viral diseases of cattle were reported from yak also.

There are various routes of infections or mode of transmission of zoonoses. On the basis of etiological agents, they can be classified as bacterial, viral, mycotic and parasitic zoonoses. However, parasitic zoonoses are mainly fish borne or meat borne and often they are not fatal. On the other hand, bacterial and viral zoonoses have worldwide outbreaks, for example, plague, the cause of pandemic of "black death" of the past. Viral zoonotic diseases are the group of diseases that are mostly involved in high public risk and high case fatality rate, for example dengue fever, Japanese encephalities, Kyasanur forest disease, nipah virus, hendra virus infection, many hemorrhagic fevers, etc. Wild and domestic animals play a crucial role in the epidemiology of many zoonotic diseases. They carry different pathogenic organisms which can infect to humans. Such reservoir animals are very important as they are fairly resistant to such pathogens and develop a chronic carrier state without affecting themselves. As yaks and other wild animals share the common habitat, many of the viral and bacterial zoonotic diseases are easily transmitted to humans. However, the overall incidence of most of the diseases is not accurately known for

the yaks. In this article information on some of the bacterial and viral diseases is presented.

## 2. Bacterial Diseases

### *2.1. Anthrax*

Anthrax is an acute infectious disease of wild and domestic lower vertebrates (cattle, sheep, goats, camels, antelopes, and other herbivores) caused by the spore-forming bacterium *Bacillus anthracis*. It can occur in any of the three forms-cutaneous (skin), inhalation and gastrointestinal. *B. anthracis* spores can live in the soil for many years, and humans can become infected with anthrax through handling of products from infected animals or by inhaling anthrax spores from contaminated animal products. Wool from yak is commonly used for many purposes which if contaminated with anthrax spore may lead to transmission to humans and other animals. This disease has a long history in China. Herdsmen recognize the clinical symptoms of the disease and its danger to themselves and do not eat the meat of affected yak. Vaccination of yak is used to control it in many areas. In Nepal, Joshi et al. (1997) reported an anthrax outbreak that had occurred in Karnali yak rearing areas during 1990. The outbreak was effectively controlled through vaccination. More than 200 cases of suspected infection were reported and several deaths were linked to the anthrax outbreak, which killed more than 90 hippopotami in the Luangwa River, Zambia. Ministry of Health officials said this outbreak was caused by an infected hippo, and all of the cases were linked to the handling or consumption of hippo meat (news report at http://www.huntingreport.com/worldupdate.cfm?articleid=582).

### *2.2. Botulism*

This condition is caused by a toxin produced by *Clostridium botulinum* (type C identified in Tibet). Botulism was common among yak in China prior to 1955, but the incidence has since declined. However, Vaccination is used as a control in some areas. Carcasses of animals that have died on the range are another source of infection. The disease has been reported in yaks from several other countries also (Haskell, 2008; Joshi et al., 1997).

### *2.3. Brucellosis*

Brucellosis continues to be one of the most widespread zoonoses in developing countries causing serious public health implications and affecting many animal species including yaks and characterized by abortion (usually in 5-8 months of gestation), retained placenta, orchitis, epididymitis, temporarily impaired fertility, and causes considerable economic losses due to loss of progeny, milk yield and animal protein. Wang and Yao (1984) reported that 13-17% of yak in various groups on Haiyan pastures in Qinghai province had positive tests and that there was a significant reservoir of *Brucella* infection among wild animals as well as among sheep and dogs. Besides these, 621 serum samples collected from six counties of Qinghai-Tibet plateau of China were tested by serum agglutination test revealed 9% samples positive (Xulong et al., 2011). It has been reported from other countries like Honyuan County (Sichuan), Nepal and former USSR and in Mongolia. Bandyopadhyay et al. (2009) investigated 374 yak sera samples from Arunachal Pradesh, India for brucellosis using avidin-biotin ELISA, Rose Bengal Plate Test (RBPT) and Standard Tube Agglutination Test (STAT), respectively. The prevalence recorded was highest among yak cows (31.42%) followed by heifer (23.85%) and bulls (8.88%).

S2 vaccine (swine strain vaccine) has been widely advocated for *Brucella* control measures in China since 1982. The results indicated that the number of Brucellosis-positive samples fell from 21% prior to vaccination to 0.4%. Abortion rate in pregnant yak cows also decreased from 18.1% before conducting the program in the Guoluo to 2.8% (Chen and Zhang, 1997). In a similar study in yak herds in west Sichuan, Pen et al. (1997) reported that the rate of *Brucella* infection fell from 56.5 to 6.3% within four years of S2 vaccination. At the same time, abortion rate was reduced from 7.4 to 5.4%.

### *2.4. Calf scours*

Almost all yak calves develop profuse diarrhea during the first few weeks of life. The stools are of a thin, pasty to watery consistency, sometimes containing blood. It is a major cause of death in first few weeks. About 80% incidence has been reported by Yan and Ran (1981) within the first month of life falling to around 20% after that and mortality due to *E. coli* infection is about 20-30% (Lensch, 1996) in yak calves. Of the 149 samples investigated, 73 (78.49%) samples yielded 99 *E. coli* strains including 40 strains from diarrheic yak calves and 59 from non-diarrheic yaks with most predominant sero-group were O101, O172, O60, O1, O5 and O12 (Goswami et al., 2009). In another study, sero-groups O5, O11, O12, O15, O88, O96, O146, O166, O172 of *E. coli* were recovered (Bandyopadhyay et al., 2008). In general, recovery rates are high if anti-bacterial treatment is given, but such treatment is not widespread because of remoteness of places where communication facilities are very poor. Bandyopadhyay et al. (2008) found highest sensitivity to norfloxacin, cefotaxime, gentamicin followed by ciprofloxacin, tetracycline and chloramphenicol to *E. coli* infection.

### *2.5. Leptospirosis*

Leptospirosis is one of the world's most widespread, highly infectious zoonotic diseases caused by a spirochete called *Leptospira interrogans*. This disease, which causes a generalized but serious illness in yak, was reported to have

occurred in parts of Sichuan in the period 1980-1982, according to a report by Cheng et al. (1985). These authors recorded an incidence of 10-20%, and a mortality of 30-50%. Agglutination and complement fixation tests on 187 serum samples were positive in 53 cases. Vaccines were tried against the disease in the former USSR, but results were not satisfactory (Nivsarkar et al., 1997).

*2.6. Mastitis*

Many microbial pathogens are responsible for heavy economic loss due to mastitis to the dairy farmers. There are many zoonotic pathogens isolated from mastitis milk which affects human health in the form of enteritis, fever, respiratory distress and neurological disorders. These pathogens affect the mammary gland, and if not treated immediately leads to fibrosis or hardness of the gland. The milk production from such affected quarter or udder reduces drastically (20-80%). The incidence is very less in yaks than in dairy cattle perhaps on account of the relatively low milk yield of yak and the suckling of calves. An outbreak in Hongyuan county of Sichuan was reported by Weggi (1983) due to streptococcal infection which was similar in epidemiology, clinical symptoms and response to medication to that found in cattle. Joshi et al. (1997) isolated *Staphylococcus aureus*, *Streptococcus agalactiae* and other *Streptococcus* spp. and *Coliform* spp. from yak milk. Besides these, Bandyopadhyay et al. (2012) isolated 31 shiga toxin-producing (STEC) and six enteropathogenic *Escherichia coli* (EPEC) from 87 raw yak milk and 63 'churpi' samples.

*2.7. Pasteurellosis*

The infection caused by *Pasteurella multocida*, a zoonotic pathogen which occurs as a normal flora in nasopharynx or tonsils of animals and man, represents the broadest spectrum of opportunistic infections, particularly under stress conditions. The disease is widely distributed in nature among domesticated as well as wild animals from many countries. This disease is reported to occur every year in yak-producing areas and takes the form of hemorrhagic septicemia. A higher incidence of 2.3% with 89% mortality among animals in Baiyu county (Sichuan) was reported by Yang (1987). Joshi (1982) noted the disease occurrence in many districts of Nepal. Pal (1993) also quoted the occurrence of the disease among yak in India. Lichao et al. (2010) isolated six strains of *P. multocida* which were sensitive to cidomycin, tetracycline, streptomycin, sulfasulfonamides, oxytetracycline, etc.

*2.8. Salmonellosis*

Salmonellosis is an acute infectious disease which remains one of the most widespread direct zoonoses in developed as well as developing countries. It can cause peracute septicemia accompanied with acute or chronic enteritis. The disease is common among yak in China, mostly among calves between 15 and 60 days of age (*Salmonella typhimurium*, *S. dublin* and *S. newport* have been isolated). Between 1960 and 1980, an incidence of 40%, with a mortality rate of 35%, was recorded for five counties of Gansu province (Lu, 1986). Similar studies revealed 10.5% incidence with 56% mortality in Qinghai (Deng, 1983). An infectious disease caused by *Salmonella enterica* with dyspnea and diarrhea occurred on 100 adult yaks from 12 flocks at Luhuo county in June, 2010 (Ying-Hui et al., 2011).

*2.9. Tetanus*

Tetanus is an acute infectious bacterial zoonosis which affects the neuromuscular system characterized by persisting spasmodic contractions of the whole body. The disease is associated with dirty punctured wounds, burns, umbilical stumps or needles. Tetanus occurs occasionally in yak breeding areas. Ma and Kang (1993) reported that during 1959-1989, 32 yaks suffered from tetanus and 31 of them died. The disease has been under control recently because of improvements in yak management.

*2.10. Tuberculosis*

Tuberculosis (TB), a chronic mycobacterial disease characterized by granulomatous caseous lesions in lung and other body parts, is one of the oldest diseases which still remain as the most common infectious cause of death in the world. Yaks are susceptible for the bovine strain of *Mycobacterium tuberculosis*. Although the disease is known to occur in yak, there is little quantified information available and no control schemes are in place. In Nepal, out of 23 tuberculin tests conducted in yak, three were found positive (Joshi et al., 1997).

*2.11. Other bacterial diseases*

Other bacterial diseases reported in yak include black quarter (Joshi et al., 1997), *Coxiella burneti* infection (Geilhausen, 2002), keratoconjunctivitis and camphylobacterosis.

**3. Viral Diseases**

*3.1. Foot and mouth disease*

Foot and mouth disease (FMD) is highly infectious and contagious viral disease of all cloven footed domesticated and wild animals and is characterized by fever, salivation, lameness and formation of vesicular lesions in the mouth, feet and udder. In 1960, an outbreak was recorded in Ganzi county of Sichuan with an infection rate of 72% and a mortality rate of about 4%. Strain 'O' caused the highest mortality. A number of outbreaks in different parts of Nepal among yak and hybrids of yak with local cattle were reported by Joshi (1982) and Joshi et al. (1997). Pal (1993) referred to an outbreak in Sikkim in 1973 caused by the virus of strain 'A'. Prasad et al. (1978) reported an outbreak among yak in the state of Himachal

Pradesh, India. A virus of strain 'O', previously reported from Nepal, was isolated in that outbreak. The disease is mostly occurred in the month of May and August-December in yaks (Annual Progress Report, NRC Yak, 2003-04). In India, the incidence was first recorded in 1977 from Kinaur, Himachal Pradesh (Prasad et al., 1978) and later from Sikkim (Katiyar and Sinha, 1982; Sarma et al., 1985). FMD virus Type 'O' was isolated in Himachal Pradesh while in addition, Type 'Asia 1' and 'A' were isolated from Sikkim. Katiyar and Sinha (1982) reported 40% mortality in yak calves. In another report from Sikkim, 34% morbidity and 11.7% mortality in three outbreaks of FMD in yaks were observed (Katiyar and Sinha, 1981). In Arunachal Pradesh, regular outbreaks of FMD were observed in yaks since 1990.

*3.2. Infectious bovine rhinotracheitis*

The disease is caused by a herpes virus with the manifestation of abortion in severe cases. Qu and Li (1988) tested 126 yak serum samples with 45 samples positive to ELISA and 44 positive to neutralization test. Infectious bovine rhinotracheitis (IBR) designated strain 85-Y was isolated from ocular and nasal discharges of a yak with high fever, conjunctivitis and lacrymation (Wang et al., 1986), which was found pathogenic for young yaks on experimental inoculation. The strain 86-Y1 produced conjunctival form of disease in young calves.

*3.3. Rinderpest*

Yaks are highly susceptible to rinderpest with reported mortality rate of 90-100%. In China, the disease has been eradicated through vaccination since 1955. Prior to that the disease was widespread; around one million yaks are said to have died of it between 1928 and 1941 in the provinces of Qinghai, Gansu and Sichuan alone. A further outbreak in Qinghai in 1944 claimed 20,000 yaks affected within seven months. Joshi (1982) refers to outbreaks with mortality rate up to 90% in parts of Nepal prior to 1966. Rinderpest has also been reported from Nepal (Joshi, 1982), India (Singh, 1987) and from erstwhile USSR (Barrett et al., 1993).

*3.4. Viral diarrhea/mucosal disease*

Gao et al. (1999) collected serum samples from yak herds in the pastoral regions of the north-western and south-western provinces of Shaanxi, Gansu, Ningxia, Qinghai and Sichuan for the detection of antibodies against bovine viral diarrhea/ mucosal disease (BVD/MD). The authors found that the detectable rate of BVD/MD in yak herds reached 30.08% with the infection rate of Sichuan yak herds the highest (38.46%), followed by Gansu (29.41%) and Qinghai (28%).

*3.5. Vesicular stomatitis*

It is also called as pseudo FMD and is characterized by inflammation of mucous membranes of the tongue and formation of vesicles on the mouth. Vesicular stomatitis has been reported in yak (Lensch, 1996). Seroepidemiological study conducted in Nepal revealed that 55% yaks were positive for antibodies to vesicular stomatitis (Joshi et al., 1997).

Among the other viral agents affecting yak, rotavirus has been designated as a causative agent of diarrhea in China. Other viral diseases include pox and rabies (Joshi, 1982), calf diphtheria and arthritis (also listed, unusually, under viral diseases) (Joshi et al., 1997), parainfluenza-3, bovine herpes virus-1 and bovine diarrhea-mucosal disease (Geilhausen, 2002). A survey on 266 sera samples from yak showed BVD/MD virus in 30.08% yak herds (Gao Sguang Di et al., 1999). Interestingly, naturally acquired antibody to $H_3N_2$ human influenza antigen was found in a yak/zebu crossbred in Nepal (Graves et al., 1974). From a serological survey on a herd of 330 white yaks in China, positive reaction was obtained against bovine herpes virus-1, BVD/MD, and parainfluenza-3 in 34%, 18% and 96% cases (Geilhausen, 2002). However, none of the samples was positive for bovine leukosis virus. Bovine herpes virus in yak has also been reported from Mongolia (Barinskii et al., 1993).

## 4. Conclusion

Yak, a long-haired bovine, is found throughout the Himalayan region of India and some other countries. Yak and cattle belong to same family and share the same habitat for prolong period. Therefore, many of the infectious diseases of cattle are transmitted to the yak. However, there is limited information available about various bacterial and viral diseases transmitted from cattle to yak. It is now concluded that the bacterial diseases like anthrax, botulism, brucellosis, calf scours, leptospirosis, mastitis, pasteurellosis, salmonellosis, tetanus and tuberculosis are present and reported in yak. Additionally, some of the viral diseases such as vesicular stomatitis, viral diarrhea/mucosal disease, rinderpest, infectious bovine rhinotracheitis, and foot and mouth disease are also found in yaks. Though the yak is found in very cold climatic condition of Himalaya, even then many bacterial and viral diseases are encountered in this animal which raised the question about the survivability of these bacterial and viral pathogens in this adverse environment. Therefore, there is a need to investigate the pathogenesis of these diseases and survivability and virulence of these pathogens at molecular level.

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