AFRICAN SWINE FEVER: AN EMERGING THREAT TO PIG HUSBANDRY IN INDIA

S. KUMAR¹, T. K. DUTTA^{*1}, P. ROYCHOUDHURY¹, H. DAS¹,
F. AKTER¹ AND P. K. SUBUDHI¹

¹Department of Veterinary Microbiology, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University, Selesih, Aizawl-796 014, Mizoram, India

African swine fever (ASF) is a highly contagious and deadly viral disease spreading rapidly in more than 50 pig rearing countries in the world. Warthog and other wild suids act as a reservoir host of the virus and the disease can transmit via direct contact or indirectly through vectors or fomites. Soft ticks under the genus *Ornithodoros* acts as a biological vector, but it can also be mechanically transmitted through *Stomoxys calcitrans* fly. First outbreak of ASF had been reported from China during January, 2019. Since emergence of ASF outbreak has also been reported in North Eastern Region of India, adjoining to China during April, 2020, the possible threat to pig husbandry in North Eastern States of India is discussed in this article.

Key words: African swine fever, Assam, Epidemiology, India

Globally Pork is considered to be the most consumed meat (37%) followed by chicken (35.2%) and beef (21.6%) (FAO, 2013). In the present scenario pork has become a crucial protein food replacer due to fast growth, efficient feed conversion, quick turnover, and prolificacy of pig. The pork industry is considered to have the potential to meet the increasing demand of animal protein at a cheaper price compare to other meat. In India, although the piggery sector is growing at a steady pace, but it is confined to some specific regions of the country. According to the 20th Livestock census, Assam ranked first in pig population although a decline of 12.03% population was observed over the previous livestock census. The decline in pig population may be due to lack of commercial pig farms, marketing chain, good policies related to pig farming etc., but the primary factor for economic

losses in pig husbandry was due to various diseases like classical swine fever, porcine reproductive and respiratory syndrome (PRRS) etc. from time to time. In recent past, another exotic disease, ASF was being reported from NE Region (www.oie.int), which has significantly high morbidity and mortality in pigs leading to economic consequences associated with production losses.

African swine fever (ASF) is a highly contagious and deadly disease of pigs. ASF was first described in Africa in the 1920s (Costard *et al.*, 2009). According to OIE, the mortality rate of ASF may be as high as 100%. ASF is a notifiable disease to the World Organisation for Animal Health (OIE). ASF started its journey from Africa and so far, the disease has reached in more than 50 countries (Fenollar and Mediannikov, 2018)

^{*}Corresponding Author

around the world. The spreading of virus from endemic area to naïve area is facilitated by both legal and illegal movements of live animals, as well as the importation of animal products, byproducts, and animal feed (Brown and Bevins, 2018). As recently, ASF has reported in the North eastern region of India, the possible way of prevention and control of the dreadly disease in Indian context is discussed in this article.

Epidemiology of ASF

ASF was initially reported from East Africa in 1921 and the first outbreak was reported in Portugal in 1957 (Sánchez Vizcaíno *et al.*, 2012). Subsequently, during 1970 and 1980, ASF emerged in several parts Europe (Netherlands, Italy, France and Belgium) and America (Cuba, the Dominican Republic, Haiti and Brazil) (Brown and Bevins, 2018). In the year 2007, major outbreaks had been reported from many countries *viz.* Georgia, Armenia, Azerbaijan and the European parts of Russia, Ukraine and Belarus. In Asian continent, the first ASF outbreak was reported from China in August 2018 followed by Mongolia (January 2019), Vietnam (February 2019), Cambodia (March 2019), North Korea (May 2019), HongKong (May 2019) and Myanmar (September 2019).

Recently, India has also been reported the first case of ASF in the North eastern region adjoining to China (https://www.oie.int/wahis_2/public/wahid.php/Reviewreport/Review? page_refer = MapFull Event Report & reportid = 34283). Subsequently approximately 2500 pigs were reported dead within 15-20 days period from different regions of Assam and Arunachal Pradesh (www.pig-world.co.uk) and the representative specimens from dead pigs of Assam and Arunachal Pradesh were tested positive for ASF by National Institute of High Security Animal Diseases (NIHSAD, Official Communication No. 15-34/20-NIHSAD dated 29/04/2020), Bhopal, India. As per literatures, Warthogs (*Phacochoerus africanus*) were considered to be the original vertebrate host of ASF and the soft tick *Ornithodoros moubata*

was acting as intermediate host for completing the sylvatic life cycle (Jori *et al.*, 2013). This vertebrate host was considered the most important asymptomatic reservoir of ASFV in Africa, besides waterhogs, bushpigs and red river hogs were found to be transmitted ASF virus to other pigs but they were not considered to be important reservoir (Jori and Bastos, 2009; Ravaomanana *et al.*, 2011). ASFV can also infect other wild suids, but their role in the epidemiology of the disease is negligible (Jori and Bastos, 2009; Mur *et al.*, 2012).

ASFV could be transmitted to healthy pigs either through direct contact with infected pigs (domestic or wild) or indirect contact with contaminated fomites, vector, and feeding contaminated pork products (Mazur-Panasiuk *et al.*, 2019). Airborne transmission was also observed under laboratory setting, where animals were densely housed (Lichoti *et al.*, 2017). In Africa, *O. moubata* ticks were major source of infection with ASFV for both domestic and wild pigs (Sánchez-Vizcaíno *et al.*, 2019). Transmission of ASFV in *O. moubata* ticks through transstadial, transovarial and sexual, allows the persistence of ASFV infection even in the absence of definitive hosts (Frant *et al.*, 2017). Apart from *Ornithodoros*, no other hematophagous invertebrate has been identified as a biological vector for ASFV, but mechanical transmission via *Stomoxys calcitrans* has been reported within 48 h of a blood meal on an infected pig (Olesen *et al.*, 2020). The ASFV may also spread through transportation of infected live pigs and pork products. The ASFV persists in nature under different cycles *viz.* sylvatic cycle (wild pig – tick), domestic cycle (pig-pig) and wild boar cycle (Olesen *et al.*, 2020).

Characteristics of ASF virus

ASF virus is the lone organism belongs to genus *Asfivirus* under the family *Asfaviridae*. The virus contains a dsDNA as genome with a genome length of 170-190 kbp depending on the isolate. The genome encodes between 160 and 170 genes and has covalently closed ends and terminal

inverted repeats. An irregular lipoprotein envelope derived from plasma membrane gives the virion an irregular spherical shape measuring about 200-220 nm in diameter. The icosahedral capsid consists of 1892 or 2172 capsomeres. The capsid in turn encloses a second lipoprotein membrane, which surrounds the DNA containing core. Although, this virus is the only member of family, restriction enzyme analysis of DNA of different isolates revealed five groups (clads). All American and European isolates fall in one group (clad), whereas African isolates exhibit significant variation probably due to long time circulation of virus in Africa. Twenty-three genotypes have been described based on the partial sequences of the p⁷² gene (Brown and Bevins, 2018). All 23 genotypes are present in Africa, whereas only genotypes I and II have been found to be present outside of the African continent. ASFV replicates in the cytoplasm of the mononuclear phagocytic cells. The endoplasmic reticulum plays a very important role in viral assembly and envelopment (Romero-Brey and Bartenschlage, 2016). ASFV is a very resilient virus and can survive for a longer period of time under different environmental conditions. Live ASFV could be detected in frozen meat even after 1000 days (FAO, 2013). Virus can sustain in different raw and processed materials including chilled, fried, smoked, offals, blood, skin etc ranging from 11 days to 1000 days (FAO, 2013).

Clinical symptoms and post mortem lesions

The warthogs and bushpigs generally acted as asymptomatic carrier and serve as a source of infection to susceptible pigs and ticks (sylvatic cycle) (Gallardo *et al.*, 2017; Alvarez *et al.*, 2019). Neonatal warthogs develop a asymptomatic viremia which transmit the virus to new ticks (larvae, nymph and young adult) during their engorgement (Netherton *et al.*, 2019). Soft ticks act as the only route of transmission between infected and susceptible warthogs (Golnar *et al.*, 2019). Sexual transmission is not observed in warthogs, however, the ASFV virus is found in seminal secretions (Schulz *et al.*, 2017). To date, there is no conclusive data suggesting a is carrier

state; however, a survey conducted in central Kenya found ASFV in asymptomatic domestic swine and warthogs (Ståhl *et al.*, 2019). Pigs of all the age groups equally susceptible (Brown and Bevins, 2018).

The incubation period varies from 4-19 days. Clinical disease occurs in four forms; peracute, acute, subacute, and chronic (Yoo *et al.*, 2020). In peracute form, affected animals die without any visible clinical symptoms with mortality rate upto 100% (Gallardo *et al.*, 2017). Acute infections are caused by highly virulent strains and are typically characterized by a high fever, anorexia, lethargy, weakness, recumbency, diarrhea and/or constipation, abdominal pain, hemorrhagic signs, respiratory distress, nasal and conjunctival discharge, and abortions in pregnant females. Death often occurs within 7–10 days after the onset of clinical signs. Moderately virulent strains result in subacute infection (often with high mortality in young animals and much lower mortality in older animals), where the clinical signs often include abortion, fever, and transient hemorrhaging with death or recovery occurring within 3–4 weeks (Sargsyan *et al.*, 2018). Chronic infections are characterized by intermittent or low fever, loss of appetite, depression and in some instances, result in a fatal infection (Sargsyan *et al.*, 2018). Domestic pigs are most infectious during the incubation period and may act as source of infection for two days before the presentation of clinical disease and recovered pigs may also act as source of infection for one month after the disappearance of clinical signs (FAO, 2013).

The lesions in acute ASF are similar to classical swine fever (CSF) or hog cholera and often difficult to differentiate on the basis of post-mortem examination. The most consistent lesions include enlarged, friable and dark-red spleen, enlarged haemorrhagic gastro-hepatic and renal lymph nodes, petechial to ecchymotic haemorrhages in the kidney, oedema of gall bladder, interlobular oedema of lungs, petechial

haemorrhages in the urinary bladder, visceral peritoneum and haemorrhages in lymph nodes of abdominal cavity and myocardium. The pigs infected with highly virulent strains of ASFV exhibit localized areas of reddening or cyanosis of the skin on the tips of ears, extremities of tail, legs and/or over the ham region. Moderately virulent strains also show similar lesions but enlarged spleen is not friable and appears normal in colour. In chronic form, the skin lesions are slightly raised and firm hyperaemic areas of 2 cm or more in diameter to areas of necrosis. Swollen joints and generalized lymphadenopathy are common observations. Pulmonary lobules show areas of consolidation with or without pleural adhesions.

Histological lesions in acute form of disease are seen in the antigen-processing cells of the lymphoreticular system, cortical and stromal areas of lymph nodes, red pulp of spleen and kuffer cells in liver sinusoids. Haemorrhages in the lymph nodes, kidney and heart are the most common findings. One of the most prominent features in chronic form of ASF is hyperplasia of lymphoreticular tissues.

Diagnosis of ASF

ASF could not be differentiated from classical swine fever (CSF) by either clinical or post-mortem examinations. As the clinical symptoms and post mortem lesions were apperantly similar with CSF, laboratory techniques should be applied to differentiate the diseases and to provide any definitive diagnosis. In addition, bacterial septicaemias may also be considered for differential diagnosis.

Laboratory diagnosis must be done based on isolation and identification of the virus, detection of genomic DNA by polymerase chain reaction (PCR) or detection of tissue antigen by fluorescent antibody test (FAT). PCR is recognized as the most sensitive technique for detection of ASFV at a very early stage of infection in tissues, blood or sera. The OIE has

validated and recommended three different PCR techniques based upon the previously published reports (Agüero *et al.*, 2003; King *et al.*, 2003; Fernández-Pinero *et al.*, 2013).

In endemic areas, detection of ASF antibodies in pigs could be done through ELISA test, indirect fluorescent antibody (IFA) test, indirect immunoperoxidase test (IPT) are worth as no vaccine against ASFV is available so far (Laddomada *et al.*, 2019).

Laboratory diagnosis of ASF is very difficult at field level due to lack of infrastructure, equipments, reagents, as well as delay in reaching the sample to the laboratory. The rapid pen-side test might be helpful in initial screening of the disease before confirmatory laboratory test.

Prevention and Control

Like most of the viral infections, no specific treatment is available against ASFV infection. In addition, to date, no vaccine is also available due to several key factors, including the lack of identification of protective antigens, incomplete understanding of virus-host cell interactions, and inadequate knowledge relative to the diversity of viral strains currently circulating in natural reservoirs (Sang *et al.*, 2020). Many vaccine options have been tried with varying levels of success, including vaccines with naturally or experimentally deleted genes, subunit vaccines based on recombinant proteins, and DNA vaccines (Sang *et al.*, 2020). Vaccine development for ASFV is ongoing and challenging due to the range of genetic and antigenic variability as well as the myriad of strategies utilized by the virus to evade the host's immune response. Further work is essential to develop a vaccine that is both safe and provides a high degree of protection across virulent ASFV strains (Alvarez *et al.*, 2019).

The most appropriate method to control the disease is slaughter and proper carcass disposal of infected as well as suspected pigs followed

by disinfection of contaminated area. Also, restricted movements of live pigs, their products from an infected area to non-infected area or vice-versa should be adopted as effective control measure. ASF is a vector-borne disease, so elimination of its vector is an important steps in controlling the disease. Care should also be taken for fomites (clothes, utensils, vehicles, shoes, etc.), which play an important role in spreading of infection. Strict biosecurity measures should be adopted in commercial as well as backyard farms to prevent the entry of infection in the non-infected areas. Swill feeding must be regulated by invoking stringent effort. Fences must be installed to block intruders such as roaming wild boar. Strict regulations and controls on food waste from international flights, and ships should be adopted at national level.

Conclusion

African swine fever (ASF) is a highly contagious and severe viral disease affecting domestic and wild pigs and considered as one of the most serious threat to pig husbandry globally. As the outbreak of ASF is reported from Assam and Arunachal Pradesh in India, it may pose a serious

threat to the entire pig husbandry because of its extremely high level of morbidity and mortality. It is already indicated that there is no specific treatment or protective vaccines are available against the disease. The disease transmission is also very stable through various animate and inanimate objects including ticks as biological and mechanical carrier. Therefore, utmost precautions need to be taken by the Governments to protect the pigs and the poor and marginal pig farmers of India to sustain the rural economy. Knowledge gained during the first entry and outbreak of PRRS in pig population in India in general and in the North eastern India in particular in 2011 should be applied in containment and control of the disease. Restriction of movement of animals and animal handlers including vehicles, feeds, processed pork products etc. from affected areas should be strictly restricted by implementation of effective rules and regulations.

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