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Control and spread of African Swine fever

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Abstract. The study's objective is to comprehensively understand the mechanism and control of African swine fever through secondary research. The author proposed a range of control measures to reduce the spread of the disease in pigs, aiming to enhance the overall health and well-being of the pig community and extend their life expectancy. The study conducts a detailed analysis of the spread and control of African swine fever (ASF), with a particular focus on pig health. It extensively explores various factors contributing to African swine fever (ASF)and thoroughly examines the associated clinical symptoms. The findings of this review are expected to be clinically relevant for establishing optimal control measures and improving the quality of life for pigs. This, in turn, will help ensure the health and well-being of a wide range of swine fever patients, reduce the transmission efficiency of the disease, increase pork production, and guarantee the quality and safety of pork.

Keywords: African swine fever, control, spread.

1. Introduction

According to the definition given by the European Food Safety Authority(EFSA) [1]. African swine fever is characterized by a virus that affects pigs and wild boar that results in severe animal mortality. The African swine fever virus (ASFV) is the source of the extremely infectious zoonosis[2], which affects farmed pigs of all ages and breeds as well as wild boars (Sus scrofa). The acute form of ASF is characterized by a high temperature, lack of appetite, cramping, severe internal bleeding, and a nearly 100% death rate. ASFV is a large enveloped virus with an average diameter of 200 nm and an icosahedral shape[3]. One single double-stranded, linear, covalently closed DNA molecule makes up the viral genome. Different isolates have genomes that range in length from 170 to 190 Kbp and encode 151 to 167 open reading frames. Although early viral DNA synthesis occurs in the nucleus, the ASFV replication cycle is mostly cytoplasmic. In Kenya, the 1920s saw the discovery of the virus-caused illness. The illness was only found in Africa at the time[4], and it wasn't until the middle of the 20th century that it started to spread to South America, Europe, and the Caribbean. With the exception of Sardinia, it was completely eradicated throughout Europe in the 1990s as a result of strict control and eradication operations. However, the illness returned in 2007 and moved from Africa to the Caucasus, mostly Georgia, before making its way to the eastern region of the European Union in 2014. An increasing number of EU nations, including Poland, the three Baltic States, and most recently Moldova, have reported cases of the illness. ASF outbreaks are becoming a serious hazard to the world's food systems. Food imports and exports, food availability, earnings, and diets might all be impacted by such shocks to food systems, which could also jeopardize the stability of food production along the food

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supply chain. The African swine fever (ASF) epidemic in China is one such shock. The 2018 ASF epidemic in China caused the pig population to drop by 40.5% and 39.3%, respectively and caused an estimated 143 million pigs to either die from the illness or be culled. Given that pig is the most prevalent meat in Chinese cuisine and that it makes up a sizable portion of the country's consumer price index, ASF might result in substantial welfare losses[5]. In 2018, China generated over 55 million tons of pork annually from over 700 million slaughtered pigs. In a scenario where the ASF outbreak is spreading, the decrease in pigs' results in a 10–40 million tons decline in Chinese pork output. In comparison to a reference scenario in which there is no ASF pandemic, this translates into a 9–34% reduction in worldwide production or 120 million in 2018. The reduction in output would cause the price of pork throughout the world to rise by 17–85%. The primary objective of this research is to systematically categorize and synthesize previous studies and experiments to provide a comprehensive overview for advancing the understanding of ASF in the future[6]. The researcher aims to delve into existing literature and research findings to draw insightful conclusions that can assist future researchers in gaining a deeper understanding of ASF, ultimately contributing to the reduction of time required to comprehend this field and providing better help to farmers who suffer from ASF to live in a better life.

2. Spread of ASF

It is essential to review the spread of ASF as it is a highly contagious swine virus. Knowing the ways it can affect the pigs can be useful for the next steps in control and prevention. There are several modes of transmission such as direct contact between susceptible and infected pigs, eating meat from infected pigs, being bitten by infected sampans (Ornithodoros spp.), and coming into contact with materials or objects (feces, animal feed, equipment, clothing, and footwear, vehicles) contaminated with virus-containing substances (e.g. blood, feces, urine, or saliva from infected pigs), those are the most comment ways that the African swine fever virus is spread. According to data released by the Ministry of Agriculture and Rural Affairs of China, outbreaks of African swine fever from August to November 2018 were caused by 34% of food and water, 46% by people and vehicles, and 19% by pigs and pork products; all 100 cases have been reported. 42% of instances of African swine fever virus infection were linked to chyme consumption, 40% to contaminated persons and vehicles, 16% to ill pigs and contaminated goods, and 2% to wild boars[7].

2.1. Oral spreading

The main routes of transmission of ASFV are ingestion of virus-contaminated food, drinking contaminated water, and ingestion of virus particles from infectious sources. A cautious experience was conducted in 2018, the study evaluates the capacity of viral infections to persist in animal feed constituents during transboundary transit. It employs computer models to study viruses like African Swine Fever (ASFV) and others that could survive during the transit of feed components between continents. The results show that some viruses may survive long-term transportation as infectious agents in particular feed ingredients, such as soybean meal and pig sausage casings[8]. This highlights the possibility of viral diseases spreading through tainted feed. Another study investigated the risk of African swine fever virus (ASFV) transmission through animal feed and fluids[9]. The study determined the minimum and mean infectious doses of ASFV orally ingested during feeding and drinking in Georgia in 2007. The study found that ASFV was more easily transmitted through fluids than plant feed, but repeated exposure to contaminated feed significantly increased the risk of infection. This highlights the role that contaminated feed may play in the spread of ASFV. In the result, Pigs infected with Georgia 2007/1 contaminated feed received a median infectious dose of 106.8 TCID50 and a minimum infectious dose of 104 TCID50 for ASFV. Surprisingly, the same study found that the median infectious dose of ASFV in drinking water was 10 TCID50, while the minimum infectious dose was only 1 TCID50. This suggests that ASFV is transmitted more efficiently through drinking water than through feed. Viable ASF virus has been detected in nasal fluids, rectal fluids, urine, and other excreta of ASF-infected pigs.

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2.2. Susceptible animals

Ornithodoros ticks and Suidae animals, including domestic pigs and wild boars[7], are the primary hosts of the African swine fever virus. While warthogs (Phacochoerus africanus and P. aethiopicus), wild boars (Potamochoerus porcus and P. larvatus), and giant forest pigs (Hylochoerus meinetzhageni) are asymptomatic carriers of ASFV and serve as a reservoir for its viral functions, clinical symptoms are limited to domestic pigs, wild boars, and European wild boars. ASFV is very recognized as the only DNA virus that vectors can transmit[10]. Until 2021, only Ornithodoros spp. have been found to spread ASFV spreading, they also are one of the most common vectors of the virus. Because adult Ornithodoros ticks may survive for decades without feeding and prefer to reside in wild boar nests, they are a prime candidate to serve as an ASFV reservoir.

3. Controls of ASF

There are several effective controls against ASF. Still, depending on different situations and conditions, the government should decide on the most efficient methods to recover the most financial losses for the farmer in the shortest time possible. Unfortunately, there is currently no specific treatment or vaccine available for African swine fever. However, some of the controls can play an important role[11], according to a cautious survey done by multiple organizations and experts chosen by snowball sampling methods and the first group is composed of the collaborators of the ASFORCE "Targeted research effort on ASF" project (FP7/2007–2013), which is sponsored by the EU. Therefore, the professionalization and reliability of the survey are ensured. This survey concluded methods such as the biosecurity measures on farms, quarantine and isolation of affected animals, regular disinfection of equipment and vehicles, control of wild boar populations to reduce transmission, proper disposal of carcasses, monitoring and surveillance programs, movement control of pigs and pig products, public awareness campaigns, use of personal protective equipment (PPE) for handlers, genomic research for vaccine development, etc.

3.1. Isolation controls

Solation controls for African swine fever involve biosecurity measures to prevent the spread of the virus by restricting the movement and interaction of potentially infected animals, humans, or materials. These controls are advised by the European Union and are outlined in the important document COUNCIL DIRECTIVE 2002/60/EC of 27 June 2002. According to this directive[12], member countries should strictly follow the rules when the presence of ASF in an area is suspected. The presence of any suspected African swine fever infection in domestic pigs should be reported immediately to the veterinary authorities, and detailed information should be provided to other member countries for confirmation by the Commission. In areas where African swine fever (ASF) is suspected, all pigs must be slaughtered immediately to prevent the virus from spreading during transportation or slaughter. Additionally, all pigs' products from the infected area may not leave until written authorization is obtained from the veterinary authority. Transport vehicles should be carefully disinfected before leaving the pig farm, and hygiene measures must be followed by people entering and leaving the farm. The farm must collect samples to determine how the virus entered and how long it was present before the disease was reported. Pigs slaughtered during this period should be closely monitored. Semen, ova, or embryos collected during this time must be tracked and destroyed. Contaminated materials and waste, including animal feed, must be disposed of, and disposable materials used in slaughter operations must be destroyed under the guidance of a veterinarian. A 3 km protection zone and 10 km surveillance zone will be established, and pigs cannot leave the farm until several disinfections have been carried out for up to 40 days. After 40 days, pigs in the protection zone may be removed to a slaughterhouse with permission. Similar rules apply to pigs in the surveillance zone, with a 30-day limitation. If African swine fever is suspected, the farm will be considered a contact farm, subject to specific regulations until the virus is formally excluded. Sufficient samples must be collected at slaughter to confirm or exclude the presence of the African swine fever virus. These regulations enable EU member states to effectively fight against them. For example, in September 2018, an ASF-infected wild boar was found in the province of Luxembourg. Following

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that, Belgium has taken steps to eradicate the disease, such as deploying an EU Veterinary Emergency team of experts, enhancing passive surveillance, raising awareness among all stakeholders, including forestry officers, farmers, hunters, and private and public veterinarians, as well as working with neighboring countries[13]. There was in 2020 reliable evidence to suggest that the ASF virus had not been in circulation in Belgium for the previous 12 months and that the illness had not spread to the domestic pig population. As a result, all limitations pertaining to Belgium are to be lifted as a result of a vote by the Member States in a Standing Committee and the Commission's adoption of the Regulation in November 2020. Another representative example is Czech. The first case of African Swine Fever (ASF) was discovered in the Czech Republic on June 26, 2017, when a wild pig carcass near Zlín tested positive for ASF. The virus most likely came from Eastern Europe, progressed slowly, and exclusively affected wild boar populations—domestic pig populations were not affected by outbreaks. Strict control measures, such as active carcass searches and hunting bans, were implemented over the next few months. In April 2018, a positive instance of wild boar was identified. In February 2019, the Czech Republic became the first nation in the EU to successfully eradicate ASF [14]. Through these examples, the effectiveness of the policies is ensured to be useful for other countries to learn and repeat. In certain EU nations, the illness is still widespread despite the application of these precautions. 22,360 pigs were culled as a result of reports that between 2014 and 2016, 3,245 wild boars and 480 domestic pigs were infected[15].

3.2. Disinfection

Disinfection is the use of chemical or physical agents to eliminate infectious microorganisms[16];a thorough grasp of ASFV, the right disinfectant, the right disinfection technique, the right working concentration and duration, the right disinfectant temperature, and maybe other factors are all necessary for an efficient disinfection strategy[17]. A thorough post-disinfection monitoring program and a well-thought-out pre-disinfection cleaning should also be taken into account[16]. Routine disinfection is generally necessary for agricultural locations that are in contact with the outside world, such as sow farrowing sites, personnel entrances and exits, livestock pens, and sales sheds. The most crucial step in the disinfection procedure is cleaning before disinfection. Disinfection is mostly useless in pig farms if animals are unable to be moved. Thus, in order to minimize the spread of diseases throughout the farm and clean the sheds during "downtime," it is more practical and efficient to implement an all-in, all-out feeding plan. Hoof baths and wheel baths should not be operated improperly in order to provide the best disinfecting effect. For instance, to prevent ice, the disinfectant should be kept away from snow and refilled every two to three days. It should also be guaranteed to soak the hoof for the full recommended amount of time and to be completely free of dirt, feces, and other debris. To summarize, a thorough examination of multiple aspects is necessary for effective disinfection, yet even minor errors, such as the use of excessively diluted disinfectants, inadequate cleaning, insufficient contact time, and improper temperature, humidity, and pH, can result in disinfection failure. Finally, to track the disinfection effect, ASFV nucleic acid testing needs to be done. Different disinfection methods should be applied to different uses, shown as in the table 1.

Table 1. ASFV disinfection methods and condition

Disinfection methods	Condition
Water	For pig pen cleaning; avoid scalding.
Calcium oxide	Calcium oxide: Used after depopulation to disinfect ground or carcasses.
Chlorine disinfectants	Applied in water and sewage treatment.
Iodine compounds	For general cleaning, e.g., teat dips.
Sodium hydroxide	Used in equipment and sewage disinfection.
Phenolic compounds	Foot bath disinfectant at animal facility entrances.
Organic acids	Foot bath disinfectant at animal facility entrances.
Formaldehyde	For food-related disinfection.
	For fumigating sealed vehicles, rooms, or buildings.

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3.3. Anti-ASF medication

A few substances or commercially available medications with anti-ASFV action in vitro have been reported within the last several decades, with is theoretically impactive in the research state. According to Colpitts et al., aUY11, an aromatic nucleoside derivative, exhibited a dose-dependent inhibition of ASFV proliferation in Vero cells in addition to having a strong inhibitory effect against viruses including the hepatitis C virus (HCV) and influenza A virus (IAV). Additionally, Freitas, Mottola, and others discovered that fluoroquinolones could stop the reproduction of viruses by obstructing ASFV's DNA-Topo II. Polyphenols like resveratrol and oxidized resveratrol, according to Gallardo et al., can stop ASFV from spreading by preventing late viral protein synthesis and viral DNA replication[18]. Amiloride, a medication used in the therapeutic treatment of edematous illnesses, has been shown by Sánchez et al. to have strong anti-ASFV activity on Vero cells in addition to being an efficient inhibitor of macrophagocytosis. Still unknown are these chemicals' possible effects in pigs infected with ASFV; research on them has just stopped at the cellular level in vitro. Polyphenols like resveratrol and oxidized resveratrol, according to Gallardo et al., can stop ASFV from spreading by preventing late viral protein synthesis and viral DNA replication. Amiloride, a medication used in the therapeutic treatment of edematous illnesses, has been shown by Sánchez et al. to have strong anti-ASFV activity on Vero cells in addition to being an efficient inhibitor of macrophagocytosis. Still unknown are these chemicals' possible effects in pigs infected with ASFV; research on them has just stopped at the cellular level in vitro. Scientists around the world have worked tirelessly to study and research pigs resistant to ASF but with limited success. The world's first reports of pigs being resistant to ASFV date back to 1914–1917[19]. Montgomery confirmed through virus challenge experiments that ASFV is completely different from domestic pigs and African wild boars (African wild boars and warthogs); damaged, and the mortality rate reached 100%; while African bushpigs and warthogs have almost no clinical signs and no deaths, except for two people who died of unexplained non-ASF diseases and suffered from mild gastroenteritis (African bushpigs) and bilateral pneumonia (African bushpigs) and warthog, respectively, no other tissue or organ damage. This study shows for the first time that African wild boars and warthogs are resistant to ASF. African warthogs, African bushpigs, and Dalin pigs, as hosts of ASFV, can all be asymptomatically infected with ASF[20]. A Chinese research team discovered that domestic pig LS-2 was immune to ASFV in March 2020. This is a significant development for the screening of pig breeds resistant to ASFV as it is the first instance of a domestic pig with ASFV resistance being effectively discovered on an international scale. The research was carried out in a BSL-3 lab. The examination of the anti-infection response traits in conjunction with the challenge test of the genotype II ASFV strong strain revealed that the LS-2 pigs exhibited clear resistance to oral infection with the 106.0 TCID50 ASFV SY18 strain. The participants also proposed a new possible idea to fight against ASF, which is to reproduce pigs who are naturally immune to the ASF.

4. Conclusion

The text describes African swine fever (ASF) as a highly infectious virus affecting pigs and wild boar. It details the characteristics of the virus, its history, and its spread to various regions, including Europe and the Caribbean. The text also highlights the impact of ASF outbreaks on the world's food systems, including food availability, trade, and stability of food production. Researchers are looking forward to any possible treatment for ASF, such as vaccines. Controlling ASF is made more difficult by the absence of reliable therapies or vaccinations[21]. Historically, the industry has not found the development of vaccines against ASF appealing. ASF is virtually solely endemic in Africa, although in ASF-free nations with developed pig industries, immunization against illnesses that need OIE notification is mandatory. As a result, there is still much effort to be done to ensure the best use of vaccines in the field and to offer safe and effective vaccinations.

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