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Pig, Pork and Zoonoses

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Abstract

Pork, known for its taste and texture, is one of the most sought-after meats. It is widely consumed by people around the world, except for a few religious taboos. Pig rearing, the starting point of pork production, is widely acclaimed to be one of the highly profitable livestock options. In spite of its various perks, pig and pork production is often plagued by its own array of disadvantages such as their role in the transmission of various zoonotic diseases and transboundary diseases.

Introduction

Pig rearing is an interesting livelihood option for small-scale and marginal farmers in many countries. It is a good example of low input high output systems as pigs are known for their prolific reproductive traits and can efficiently convert nutrients into edible entities. Pork is the main product of pig rearing and the by-products include sausages, lard, etc. However, pigs serve as the source and reservoir of various zoonotic infections in humans. From a public health perspective, pigs are food animals and the meat is expected to be free of food-borne pathogens in order to ensure safe food for the consumers. Pigs have been associated with zoonotic diseases of varying aetiologies and serve a variety of roles in their transmission (Figure 1). Some of those important diseases of veterinary public health importance include brucellosis, Japanese encephalitis, cysticercosis, toxoplasmosis, trichinellosis, campylobacteriosis, hepatitis E, etc.

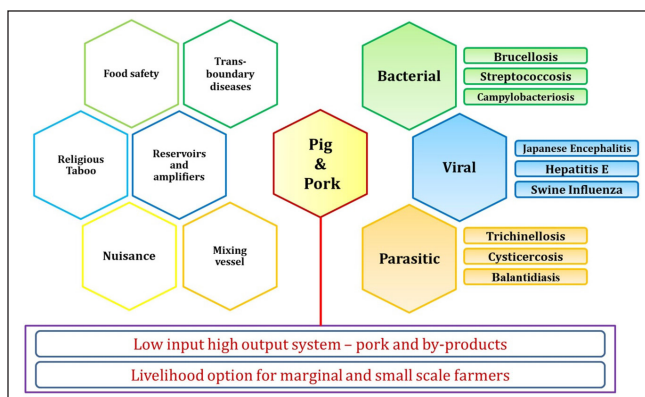


Figure 1: Pig, pork and public health impacts

Swine Brucellosis

Brucellosis is an important zoonotic disease caused by the Gram-negative bacteria belonging to the genus *Brucella*. The swine population serves as the source of *Brucella suis*, which is the second most pathogenic species to humans only after *B. melitensis* (Shakuntala *et al.*, 2021). *Brucella* organisms usually have the knack of reducing the

productivity and reproducibility of animals. In humans, the disease usually is manifested with reproductive loss and systemic illness. Transmission of *B. suis* between pigs is usually by ingestion of contaminated feed or water and venereal transmission is also possible. Whereas, entry into humans is usually by ingestion of contaminated food or exposed mucous membranes. Additionally, this organism poses risk to occupational groups associated with the rearing and slaughter of pigs. The transmissibility of *B. suis* to humans through pork is yet to be consolidated.

Japanese Encephalitis

Japanese encephalitis is an acute viral zoonosis caused by the RNA virus belonging to the family *Flaviviridae*. It is transmitted by the bite of mosquitoes especially belonging to the genus *Culex*; hence the disease is a metazoonosis. Epidemics of JE have been reported from Japan in the early half of the 20th century and are now prevalent among the rice cultivating countries of the Indian sub-continent and the South East Asian region. *Culex* mosquitoes find the paddy fields and stagnant water a suitable environment to breed on. The endemic cycle involves circulating among wild waterbirds and mosquitoes. Pigs play an important role as amplifier hosts for this virus, increasing the titre load for easier dissemination of the virus by the mosquitoes, owing to their high litter size. Horses and humans serve as dead-end hosts and do not further propagate the disease. The clinical signs in pigs are usually subdued except for some reproductive failures. Neurological signs with a febrile illness are a predominant manifestation in humans with high rates of fatality and neurological disability. Children are more affected compared to adults (Das et al., 2020). The virus is not usually transmitted via pork; however, rearing animals for the purpose of pork production could be an important driving force in the maintenance and amplification of the virus.

Cysticercosis

Cysticercosis is caused by the bladder worm stage of the tapeworm belonging to the genus *Taenia*. *Taeniasolium* is the most important species associated with pigs and pork has high public health significance. It is a cyclozoonosis, which means two vertebrate hosts are required to complete the life cycle. Pigs serve as the intermediate host in which cystic forms are found and humans are the definite host where the adult worms are found. The eggs are excreted in the faeces of infected humans. Ingestion of the eggs through contaminated food and water by the pigs further results in the formation of cystic forms known as *Cysticercus cellulosae* in the tissues of pigs. Slaughtering of infected pigs and consuming the meat with inadequate processing or cooking results in the completion of the life cycle. The eggs of *Taenia solium* also have the ability to infect humans again through the faeco-oral route, resulting in the formation of cysts in

various parts of the body such as the brain, muscle, and tissues (Prasad et al., 2020). Neurocysticercosis refers to the clinical condition in which cysts are formed in the nervous system resulting in neurological signs such as focal epilepsy, chronic headaches, etc.

Trichinellosis

Trichinellosis is a food-borne parasitic disease caused by the roundworms belonging to the genus *Trichinella*. Consumption of undercooked pork is an important risk factor for the transmission of *Trichinella spiralis*. The pigs are exposed to the organisms by feeding on garbage or uncooked scraps. Man acquires infection by the consumption of infected meat. The cyst is ruptured by the action of acid in the stomach and the larva escapes out. It undergoes successive molting and mating in the gastrointestinal tract. The larva is produced as a result of mating escape via lymphatics and the bloodstream which distributes the larval stages throughout the body in various organs such as striated muscle, kidney, and liver. The clinical manifestations in humans include fever, chills, swelling of the face, body aches, itchy skin, etc. (CDC, 2020).

Campylobacteriosis

Campylobacteriosis is the leading cause of bacterial gastroenteritis worldwide. It is usually a food-borne disease caused by the Gram-negative bacteria belonging to the genus *Campylobacter* which are thermophilic in nature i.e., they love high temperatures. They are normal inhabitants of the gastrointestinal tract of pigs and poultry and can cause reproductive and gastrointestinal disturbances in some animal species. The two most important species are *C. coli* and *C. jejuni* in the order of predominance in the pig population. The transmission is usually through contaminated food and water. The clinical manifestations in humans range from watery to bloody diarrhoea and the common sequelae are Guillain Barre Syndrome and reactive arthritis (Milton et al., 2017).

Non-Typhoidal Salmonellosis

Salmonellae are Gram-negative bacterial organisms that are known for their ability to produce gastrointestinal discomfort in man. The most common diseases associated with this group of organisms are Typhoid and Paratyphoid caused by *Salmonella* Typhi and *Salmonella* Paratyphi, respectively. Non-Typhoidal salmonellosis refers to the infections caused by serovars other than the two mentioned above. They are usually food-borne and foods of animal origin are one of their important sources (Prasad et al., 2020). They are also responsible for the highest global food-borne DALYs (Disability Adjusted Liveability Years) according to Foodborne Disease Burden Epidemiology Reference Group (FERG) established by World Health Organisation (WHO). The predominant serovars associated are *Salmonella* Enteritidis

and *Salmonella* Typhimurium. Pork serves as a major route for the transmission of salmonellosis to humans. The clinical manifestations in humans are typical of food-borne illnesses accompanied by fever. Salmonella infections are also known to frequently carry antibiotic resistance genes which cause treatment failure in clinical cases.

Hepatitis E

Hepatitis E is caused by a non-enveloped RNA virus belonging to the genus *Orthohepevirus* of *Hepeviridae* family. Similar to other food-borne viruses, it is propagated *via* faeco-oral route predominantly through contaminated food and water. Pigs and pork serve as an important source of infection for humans. There are currently 4 genotypes that exhibit two different clinical forms. The Epidemic form caused by human viruses (Genotypes 1 and 2) is common in developing countries only especially affecting adolescents and young adults. The swine viruses (Genotypes 3 and 4) are common in both developing and developed countries with high infection rates in older adults. Man is infected accidentally by the genotypes 3 and 4, leading to a potential zoonotic transmission. The clinical manifestations depend on the extent of liver involvement. Apart from the common symptoms of hepatitis (nausea, abdominal pain, and vomiting), extra-hepatic and neurological complications are more often observed in infections with Genotype 3 and 4.

Toxoplasmosis

Toxoplasmosis is caused by an obligate apicomplexan parasite namely *Toxoplasma gondii*. Felines are the usual definite host for these organisms where sexual reproduction occurs. Almost all mammals including the felines serve as the intermediate host which harbours asexual reproduction. The parasite exists in three different transmission stages namely, tachyzoites, bradyzoites, and oocysts. Humans are usually affected by the consumption of oocysts compared to that of tissue cyst forms. Consumption of uncooked food such as vegetables, milk, meat, and water has been found to be responsible for the disease in humans. The occupational health importance of this disease is still debated. Pigs manifest a subclinical array of symptoms,

whereas, the clinical signs in humans range from acute flu-like symptoms such as fever and myalgia to fatal and foetal complications. The symptoms are comparatively severe in immune-compromised patients and congenitally affected foetuses, where the affected foetuses are either born with visual impairments, hydrocephaly, or sometimes dead (Prasad *et al.*, 2020).

Conclusion

Pig and pork production are very lucrative livestock options. However, adequate awareness needs to be instilled in various stakeholders in terms of various zoonotic and food-borne diseases that can be transmitted through them.

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