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STREPTOCOCCUS SUIS, FROM PEN TO THE FOOD CHAIN

Aleksandar Stanojković[1*], Nikola Stanišić[1], Marija Gogić[1], RadmilaPivić[2], Dušica Ostojić-Andrić[1], Violeta Mandić[1], Aleksandra Stanojković-Sebić[2]

[1] Institute for Animal Husbandry, Autoput 16, 11080, Belgrade–Zemun, Republic of Serbia.
[2]Institute of Soil Science, Teodora Drajzera 7, 11000, Belgrade, Republic of Serbia
*Corresponding author: izs.aleksandar@gmail.com

Abstract: *Streptococcus suis* infection is one of the major health problem in the swine industry worldwide.During the last decade, the numberof reported human cases due to *S. suis* has dramatically increased, andwhile most sporadic human cases of infection appear to be due to closeoccupational contact with pigs/pork products, particularly in Westerncountries (farmers, veterinarians, butchers, food processing workers, etc.), two epidemics were recorded in China in 1998 and 2005. Slaughterhouse pigs are a major reservoir of *Streptococcus suis* serotype 2 capable of causing human infection. Consuming of uncooked or partially cooked pork meat in Asian countries is major risk factor for infection. Different from Asian countries infected persons in Western countries are usually adult males and this can be readily explained, since many acquire the disease following occupational exposure to pigs or pork products. Affected humans had usually close contact with pigs or meat, but the real route of infection is still unknown. It is very difficult to implement effective preventive measures for persons that come into close occupational contact with pigs and pig products, especially employees of the meat industry. Therefore it is suggested that scientific laboratories do regular monitoring of possible antimicrobial resistance until some protective measures can be implemented and measures that prevent infection can be established.

Key words: *Streptococcus suis, pigs, meat, infection*

INTRODUCTION

*Streptococcus suis*infection is one of the major health problemin the swine industry worldwide. This pathogen is the most prominent cause of meningitis and septicemia in the porcineindustry, however, otherpathological conditions have also been described, such as arthritis, endocarditis, pneumonia, and septicemia with suddendeath.

(13.8%), *Streptococcus salivarius* (5.6%), *Streptococcus mitis* (5.6%), *Streptococcus parasanguinis* (2.7%) and *Streptococcus oralis* (2.7%) and *S. bovis* (5.6%). *S. suis* strains are very good colonizers of the palatine tonsils of both clinically ill and apparently healthy pigs (Mwaniki et al. 1994).

The sow is also a source of infection. Gilts and sows mayharbor *S. suis* in the uterus or vagina, but no male reproductive organs have beenshown to be infected. Piglets born to sows withuterine or vaginal *S. suis* infections become infected at birth, before birth, or soonafter birth (Robertson and Blackmore 1989), but mostly when passing through the birth canal.

Transmission of virulent strains betweenherds usually occurs by the movement of healthycarrier animals. The introduction of carrier pigs harboringvirulent strains (breeding gilts, boars, weaners) into a noninfected recipient herd may result in the subsequentonset of disease in weaners and/or growing pigs (Higginsand Gottschalk 2005). Horizontal transmission is important especially during outbreaks when diseased animals shed higher numbers of bacteria, increasing transmission by direct contact or aerosol (Cloutieret al. 2003).

S. suis typeis an important contaminant of feces, dust and water. In water, theorganism survives for 10 min at 60°C and for 2 h at 50°C. At 48°C, *S. suis* cansurvive in carcasses for 6 weeks (Clifton-Hadley et al. 1986). At 0°C, the organism cansurvive for 1 month in dust and for over 3 months in feces, whereas at 25°C, it can survive for 24 h in dust and for 8 days in. Dee and Corey (1993) have also been shown that to transmition of *S. suis* strains can be with fomites, such as manure-covered work boots and needles. *S. suis* can be inactivated using many disinfectants, such as diluted bleach. Organic matter reduces effectiveness of chemical disinfectants and should be completely removed with thorough washing prior to application. Even though *S.suis* survives in water up to 2 hours at 50°C butonly 10 minutes at 60°C, use of heated pressure washers compared with nonheated is of limited valuesince water cools rapidly on surfaces negating potential benefit (Clifton-Hadley and Enright 1984).

Vectors of *S. suis* can play a role in disease transmission. Houseflies can carry *S. suis* strains for 2 for 5 days, and have been shown to easily transmit the disease migrating between farms (Enright et al. 1987). Mice can be experimentally infected orally or intranasally with *S. suis* type 2, and the transfer of organisms from orally infected mice to uninoculated mice has been established (Williams et al. 1988, Robertson and Blackmore 1990). Transmission of disease between mice and pigs is believed to occur (Williams et al. 1988).

All categories of pigs can be affected by the disease caused by *S. suis*, including suckling piglets, older piglets and fatteners. *S. suis* carriage rates mayvary between herds and can range from 0% to up to 80–100% (Amass et al. 1997). More thanone serotype of *S. suis* often colonizes individual pigs. In one study, 31% of pigs had only one serotype of *S.suis* in

reported many human cases of disease but strains isolated from pigs only refer to slaughterhouses and healthy pigs. Similary, in Japan there have been reported 10 human *S. suis* cases reported but studies on the distribution of isolates from ill pigs have not been reported lately and all of the research dates before 1987 year. In Cambodia, Philippines, Laos and Singapore, human cases were diagnosed recently but there are no data avilable on the epidemiology of *S. suis* infections in pigs.

In Europe the largest number of *S. suis* serotypes isolated from clinically ill pigs belongs to serotypes 1 to 8 (Reams et al. 1996, Higins and Gotschalk 2001). Most of the *S. suis* serotype distribution reports date before year 2000. *S. suis* serotype 2 was the most common in clinical cases in Italy, France and Spain, whreas serotype 9 was more frequent in the Netherlands, Germany and Belgium. Recent conducted reaserch on serotype distribution in Spain suggest that serotype 2 is no longer the most prevalent serotype, and that serotype 9 is the one most frequently isolated from diseased pigs. Behind serotype 9 is serotype 2, followed by serotypes 7, 8 and 3 (Luque et al. 2010). In Netherlands, serotype 9 was the most prevalent in data collected between 2002–2007 followed by serotypes 2, 7, 1 and 4. Contrary to the fact that serotype 9 becomes most prevalent in some countries, there were no human cases reported that were associated with this serotype. In Belgium and United Kingdom serotype 1 was the predominant in ill pigs while in Denmark serotype 7 was the most frequent one. In Southern Europe serotype distribution was done in Serbia where serotype 2 was the only serotype found in piglets that had clinical symptoms of meningitis (Stanojkovic et al. 2012). Beside that various *S. suis* serotypes were found in healthy animals (Stanojković 2012).

STREPTOCOCC SUIS IN SLAUGHTERHOUSES AND MARKETS – DANGER TO HUMAM HEALTH

Streptococcus suis infection is often mentioned as an „oldneglected zoonotic infection" (Gotschalk et al. 2010b), and the scientific community still considers *S. suis* one of the most important emerging infectious diseases in Asian countries, where the majority of people have regular contact with raw pork meat. In Western countries, *S. suis* diseasehas been considered a rare event inhumans. Most cases of human infection are related to close contact with meat or live animals: pig farmers, abattoir workers, persons transporting pork, meat inspectors, butchers, and veterinarian practitioners (Tang et al. 2006). Two countries in Europe consider *S. suis* infections in humans an industrial disease: France and the United Kingdom (Gotschalk et al. 2010b). According to Arends and Zanen (1988) the annual risk of developing *S. suis* meningitis among abattoir workers and pig breeders has been estimated to be 3.0 cases per 100,000 population while the risk is lower for butchers, at 1.2 cases per 100,000 population in developed countries.

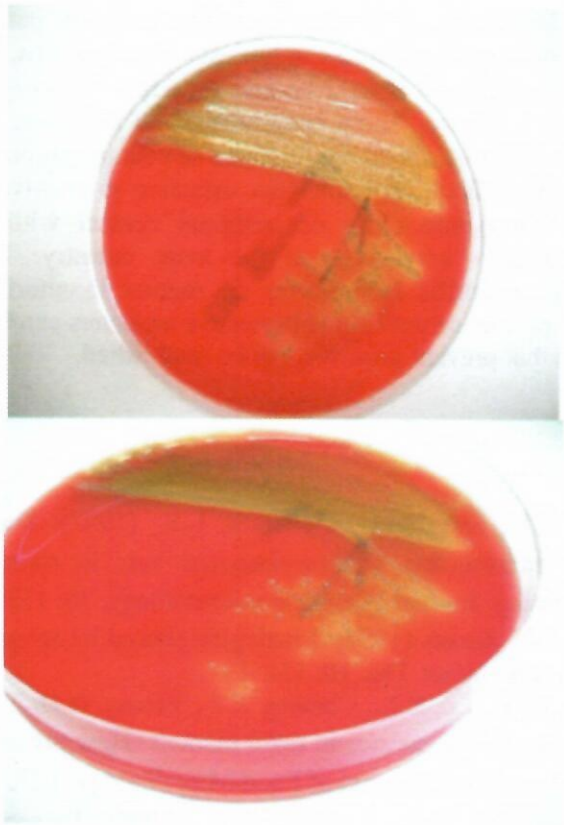
mentioned authors research hog head was highly contaminated with *S. suis* serotype 2 strains (prevalence of 25%). That kind of result is maybe expected since *S. suis* is normal inhabitant of respiratory system such as tonsils, and also slaughtered pigs are held in that kind of position that allows water to spread bacteria from hind part of the body to the head. Same authors found that presence of *Streptococcus suis* serotype 2 in liver, kidneys, shoulder, ham, loin and belly was 20%, 12%, 5%, 5%, 5%, and 10% respectively. Noppon et al. (2014) have found overall prevalence of *S. suis* serotype 2 in pork of 12,8%. Same authors mentioned that prevalence of *S. suis* serotype 2 in fresh meat was 10,8% but it was not clear referring to the part of the body that fresh meat was taken from. These authors detected 15,4% prevalence of *S. suis* serotype 2 in liver and other offal. Nakayama et al. (2011) demonstrated that *S. suis* accumulates in the kidney during *S. suis* infection.

It can be concluded that processing and consuming of uncooked or partially cooked pork meat in Asian countries is major risk factor for infection. Local cuisine specialties such as raw or half-cooked intestines, uterus, tonsils or fresh pig blood can be important sources of infection. In Thailand for example there is an increasing trend of the incidence of the disease, mainly because of consumption of half-cooked/baked meat. Wangsomboonsiri et al. (2008) determined that the majority of *S. suis* infected patientshad a history of eating under-cooked pork or internal organs which is a major route of transmission of *S. suis* from pig to human. Because of the local culture, people in Thailand usually eat raw or under-cooked pork, internal organs and fresh pig's blood.

Different from Asian countries infected persons in Western countries are usually adult males and this can be readily explained, since many acquire the disease following occupational exposure to pigs or pork products. Affected humans had usually close contact with pigs or meat and very often small cuts on their hands (Stanojkovic 2012). Stanojkovic et al. (2012) found that *S. suis* can readily isolated from butchers knives. Also, there are reports that confirm carrier state in humans, especially abattoir workers (Sala et al. 1989, Rohas et al. 2001). Strangmann et al. (2002) determined nasopharyngealcarriage rate of *S. suis* serotype 2 in the high-risk group (butchers, abattoir workers, and meat processing employees) was 5.3%, while those without contact with pigs or pork consistently tested negative. This kind of nasopharyngealcarriage ratehas also been shown in pigs (Higginsand Gottschalk, 2005).

CLINICAL FEATURES OF THE DISEASE IN HUMANS

In humans, *S. suis* usually produces a purulent meningitis but endocarditis, cellulitis, peritonitis, rhabdomyolysis, arthritis, spondylodiscitis, pneumonia, uveitis, and endopthalmitis have alsobeen reported (Gotschalk et al. 2010b, Wertheim et al. 2009). Also, there have



Picture 1. Alpha haemolitic colonies of Streptococcus suis on CNA 5 %sheep blood agar

This confusion may have led to the misdiagnosis of *S. suis* infections in the past. Serotyping is the only accurate method for definitive diagnosis of *S. suis* infection. This can be done by two methods. First, by serological method that is performed by either co-agglutination, capillary precipitation test or Neufeld's capsular reaction using reference antisera. Second method is serotyping using PCR method in which CPS (capsular) genes are amplified by either simplex or multiplex PCR. Polymerase chain reaction (PCR) tests have been used to directly detect *S. suis* DNA from samples with a high sensitivity. Some *S. suis* isolates do not agglutinate with any of the antisera directed against capsular antigens and these strains are identified asnon-typable isolates.

CONCLUSION

Streptococcus suis is a swine pathogen that causes important economic losses in the swine industry worldwide. This bacterium causes wide range of diseases in pigs, including meningitis septicemia and endocarditis, but also

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