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Associate Professor at Section of Infectious Diseases Department of Veterinary Pathology, Hygiene and Public Health, Faculty of Veterinary Medicine, University of Milan since 1995. In recent years, its main lines of research have focused on the study of non-specific immune parameters of udder and small ruminants and their interaction with the development and dissemination of various pathological processes. The investigations are witnessed by over 150 publications and scientific communications in journals and national and international conferences.

**Bacterial Biofilm: Characteristics and Mechanisms of Action**

Biofilm can be defined as a structured community of bacterial cells enclosed in a self-produced polymeric matrix and adherent to an inert or living surface. From evolution point of view, the ability to produce Biofilm gives to bacteria the possibility to adapt and to deal with adverse environmental conditions for their survival. In addition to protection against physical and chemical environmental agents, the Biofilm promotes extracellular catabolism and the concentration of nutrients on cell surface.

*Biofilm also makes bacteria more resistant to antimicrobial agents (e.g. antibiotics) and this seems to be related to several factors:*

1. *a) increase the difficulty of the antibiotic to penetrate through the extracellular matrix,*
2. *b) a decrease in rate of cell division (β-lactam antibiotics are effective against Gram positive bacteria active in multiplication),*
3. *c) the presence of resistant phenotypes in a bacterial population genetically heterogeneous and*
4. *d) greater resistance to phagocytosis.*

*Due to these special properties, the Biofilm facilitates the development of chronic infections.*

The production of Biofilm in the environment is ubiquitous, because its presence could be detected at the bottom of rivers, on the surface of stagnant water, in extreme climatic environments (Artic conditions), in water pipelines and domestic bathrooms.

The formation of Biofilm is often involved in the pathogenesis of many human infections caused by various microorganisms such as staphylococci, streptococci, *Pseudomonas aeruginosa, Haemophilus influenzae*, in many urinary infections caused by *Escherichia coli*, as well as in infections in case of use of prostheses and implants (Hall-Stoodley et al., 2004).
The production of Biofilm by *Staphylococcus aureus* is mainly characterized by two steps:

1) In the first step the bacterial cells adhering specifically to a surface, or are attached through a system of physical-chemical interactions. Adhesion of *Staphylococcus aureus* to host extracellular matrix is allowed by self-produced binding proteins: fibronectin, fibrinogen, collagen and bone sialoprotein.

2) In second step, adhering bacterial cells start to multiply, interact and organize themselves in different layers related to an extracellular self-produced matrix.

The main constituent of the extracellular matrix, responsible for intercellular *Staphylococcus aureus* interactions, is the exopolysaccharides poly-N-acetyl-β-1, 6 glucosamine (PNAG) synthesized by enzymes encoded from icaADBC operon.

Some studies have found icaADBC operon, coding for the enzymes responsible for the biosynthesis of PNAG exopolysaccharides, in 94.36% (Cucarella et al., 2004) or in 100% (Vasudevan et al., 2003) strains of *Staphylococcus aureus* isolated from bovine mastitis.

Besides this genetic trait, other studies have also shown a remarkable ability to produce Biofilm *‘in vitro’* by *Staphylococcus aureus* isolated from cases of bovine mastitis. (Vadusevan et al., 2003, Olivera et al., 2007)

The *‘in vivo’* presence of the exopolysaccharides complex was also demonstrated indirectly by observing the production of specific antibodies against PNAG (Perez et al., 2009) and SAAC (Slime Associated Antigenic Complex; Prenafeta et al., 2010) respectively in ewes and cows with experimentally induced *Staphylococcus aureus* intramammary infections.

A study by Prenafeta et al. in cattle (2010) has pointed out the active role of specific antibodies against SAAC. The antibody titer reached after vaccination, was able to actively protect cows with experimentally induced *Staphylococcus aureus* intramammary infection.

One of the benefits of using PNAG or SAAC, as antigenic component of mastitis vaccine, is represented by the fact that have not been highlighted different serotypes of *Staphylococcus aureus* in relation to the production of the two fractions mentioned above. Therefore, the antibodies produced by vaccination with these antigens give cross-protection against several strains of *Staphylococcus aureus*. 
**Bacterial Biofilm: Characteristics and Mechanisms of Action**

1. It can be defined as a structured community of bacterial cells enclosed in a self-produced polymeric matrix (PNAG).
2. Biofilm gives to bacteria the possibility to adapt and to deal with adverse environmental conditions for their survival.
3. It makes bacteria more resistant to antimicrobial agents.
4. icaADBC operon is the responsible for the biosynthesis of PNAG or SAAC and was found in several studies in strains of *Staphylococcus aureus* isolated from bovine mastitis.
5. Antibodies against SAAC after mastitis vaccination can actively protect cows from *Staphylococcus aureus* intramammary infection.
6. Antibodies produced by vaccination with SAAC give cross-protection against several strains of *Staphylococcus aureus*.

**References**


