

BIOFILMS: innovative ways to eliminate these bacteria

The adhesion of bacteria to surfaces in the form of biofilms is a universal phenomenon. The adhesion property is a survival strategy.

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Bacteria have adapted to a 'biofilmed' state to survive unfavourable environmental conditions such as those which are poorly oxygenated, have extremes in temperature or are lacking in nutrients. In the natural environment, biofilms act as a reservoir for microbial species and guarantee ecological balance. But in livestock buildings, they constitute a source of permanent contamination that is particularly difficult to eliminate.

Biofilms in the breeding house

A livestock rearing house is a closed space with a dynamic microbial ecosystem due to the high concentrations of organic matter, high temperatures, and high humidity levels. The characteristics of the microbial ecosystem are determined by the microbiota of each animal and that of the herd.

Animal excrement regularly enriches the microbiota of the building, especially with strains of

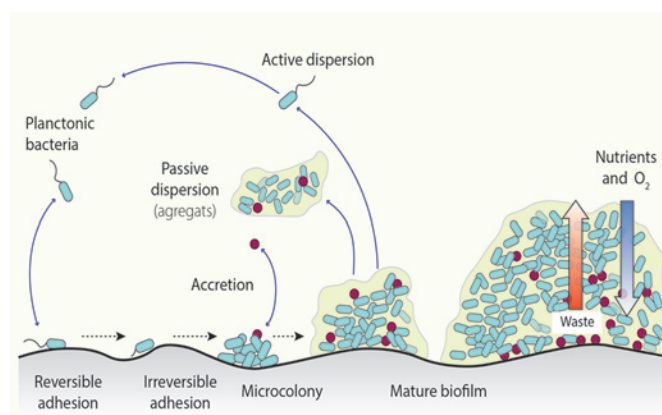


Fig. 2. Sectional diagram of biofilm formation/excretion.

Enterococcus, coliforms, lactobacilli, and Bacillus which are all found in the digestive tract of the animal.

The presence of animals in the barn causes an increase in the temperature and humidity of the ambient air. This warm air rises to the top of the building, carrying with it many micro-organisms in the form of bioaerosols. Thus, all surfaces of the building become contaminated and biofilms are formed (Fig. 1).

Formation and evolution of a biofilm

Biofilms are complex structures, constituting a considerable bacterial reserve. They are formed on surfaces through the accumulation of stacked

bacteria which secrete a polysaccharide or Extracellular Polymeric Substance (EPS) during the maturation phase. This mucous matrix is excreted through a network of channels in which the medium can circulate.

The thickness of the biofilm does not increase indefinitely. The curve of establishment of a biofilm reaches a plateau when a balance is achieved between the rate of accumulation and the rate of detachment of contaminating cells to the environment (Fig. 2).

The detachment of parts of the biofilm is partly due to variations in

temperature and humidity inside the building. These detachments contribute to airborne bacterial spread, causing the infectious pressure to increase and new animal contaminations.

Properties of biofilms

Bacteria in a biofilm are organised within the EPS mucous matrix through a network of pores and circulation channels which allow communication and exchange between cells (Fig. 3). The cells at the outer part of the biofilm, those at the interface with the air or water, have a larger amount of nutrients, oxygen and water and their metabolism is active.

The bacteria in the deeper part of the biofilm, those at the interface with the support, are in micro-aerophilic or anaerobic conditions and their metabolism is inactive or dormant, thus particularly persistent and resistant.

The biofilm is therefore a mosaic of micro-niches containing different species but also different phenotypes of the same bacterial species. The cohesion of this microbial community relies on synergistic interactions and homeostatic mechanisms.

The architecture and organisation of a biofilm is similar to that found

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Fig. 1. Bioaerosols and biofilm formation in livestock buildings.

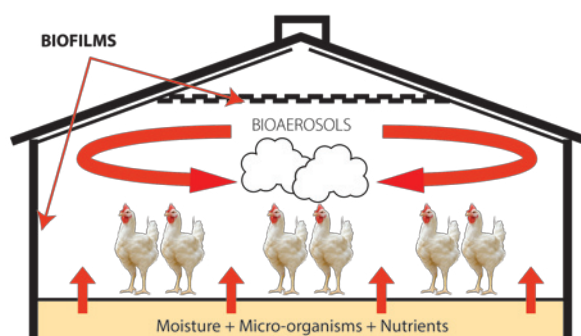
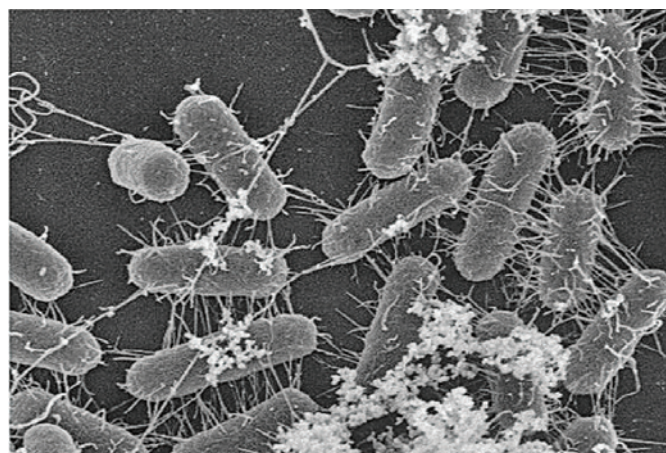


Fig. 3. Biofilm structure with communication channels.



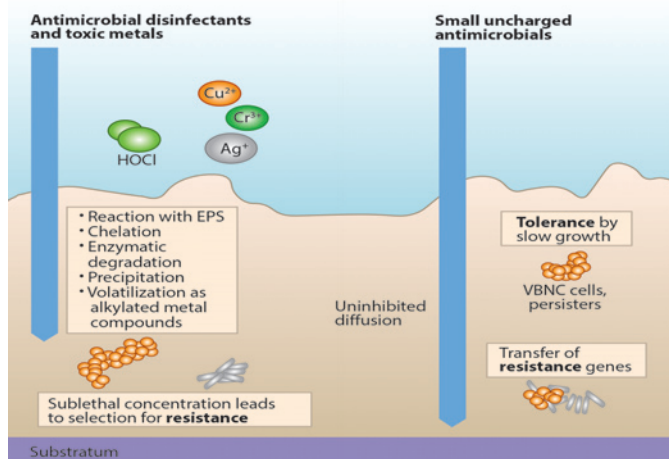


Fig. 4. Barrier role of biofilms EPS.

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in a tissue, highlighting their
remarkable evolutionary importance.

The impact of biofilms on animal health

Bacteria in a biofilm can be 1,000 times more resistant compared to individual bacteria. They acquire increased resistance to antimicrobial agents in general in two main ways:

1. Physico-chemical resistance:

As illustrated in Fig. 4, the biofilm mucous matrix (EPS) has several functions including:

- Providing protection as a physical barrier.
- Acting as a filter.
- Acting as an electrostatic barrier chelating antimicrobial.
- Preventing the penetration of disinfectants into the centre of the biofilm.

2. Extra-chromosomal resistance:

Bacterial resistance to disinfectants is much higher when bacteria are in biofilms. This is due to the acquisition of specific resistance genes carried by plasmids (circular periplasmic chromosomes).

In a biofilm, the plasmids are transferable between bacteria via intercellular bridges (Fig. 5). Thus, the acquired resistance can be quickly spread to all bacterial species via horizontal transfer.

Epidemiological consequences of biofilms

Numerous bacterial species and genera that cause infections in animals and which may or may not have zoonotic potential, can form biofilms. Some examples are:

- Salmonella.
- Campylobacter.

- E. coli.
- Pseudomonas.
- Staphylococcus.
- Streptococcus.

Biofilms increase infectious pressure, bacterial resistance to antibiotics, disinfectants, and the immune response of the host. In animal husbandry, contamination of surfaces, air conditioning, ventilation, and water distribution system, with biofilms, is a huge problem. However, several of these bacterial species also have an impact downstream, in food industries, because of their ability to diffuse into the environment and colonise all kinds of media. Their resistance to extreme conditions, including disinfection procedures in livestock houses only makes matters worse.

Solutions from Huvepharma

Trying to disinfect without breaking biofilm is useless and the best and most economical way to break the

biofilm is to use detergent. Before the disinfection step, it is imperative to carry out a cleaning step with a detergent to dissolve and eliminate both the visible organic deposits and most of the exopolysaccharidic matrix of the biofilm.

Adherence to this procedure and to general biosecurity management rules guarantees increased effectiveness of the disinfectant and decreasing contamination of the surfaces before placing a new flock or herd in the building.

Huvepharma, through its expertise in biosecurity and animal health, provide a range of innovative and efficient detergent and disinfectant products to prevent contamination.

Each Huvepharma detergent perfectly suits the specific needs in livestock breeding, as well as for the cleaning and disinfection of transportation vehicles or equipment:

- DT Foam: Best in class biofilm breaker dedicated for poultry farms.
- DT Smart: Non-foaming cleaner for water pipes and feeding systems.
- DT Move: Virucidal and bactericidal cleaner.

Fig. 5. Inter cytoplasmic bridges allowing cellular communication and transfers of plasmids between different bacterial species.

