**What Makes Pseudomonas aeruginosa a Difficult Microorganism to Kill**

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**Key Words:**

Biofilm, Cystic Fibrosis, Pathogens, Pyocins.

**Abstract:**

**Pseudomonas aeruginosa, an opportunistic bacterium, has been a major point of focus in Cystic Fibrosis research. There are multiple factors that allow for this pathogen to thrive, some of those ways are its motility, protection from other molecules such as antibiotics, or its ability to compete against other microorganisms for resources. This is due to its production of biofilms and pyocin, (a bacteriocin that inhibits the growth of other microorganisms). In the document by Olubukola Oluyombo, Christopher N. Penfold, and Stephen P. Diggle, “Competition in Biofilms between Cystic Fibrosis Isolates of Pseudomonas aeruginosa Is Shaped by R-Pyocins”, there were three major strains of pyocins that were observed. This included S-pyocin type, R-pyocin type, and F-pyocin type. It has been shown that R-pyocins are a factor in the survivability between strains. The goal of the study was to better understand the role played by these pyocins play in the competition between P. aeruginosa, in other words what makes them survive over others as they compete amongst themselves. The authors continue to state they want to, “further demonstrate the potential of exploiting R-pyocins for therapeutic gain”.**

**Introduction**

*Pseudomonas aeruginosa* is a pathogen commonly found in Cystic Fibrosis patients. It is a highly damaging pathogen that can cause tissue damage and produce harmful byproducts. The major problem is that this pathogen can accelerate the mortality of CF patients when in the lungs. They are also particularly difficult to treat with antibiotics due to their ability to produce biofilms.

Biofilms are produced to protect the pathogen from molecules that may kill it. They also can be used to adhere to certain parts of the host. Without these biofilms it is likely that *P.* aeruginosa may not be as difficult to kill as it is in its current state.

Though not very well understood why some strains of *P. aeruginosa* are more prevalent than others, it is speculated that the competition amongst strains of the pathogen has been caused by the production of molecules called pyocins. There are different types of pyocins, discussed later in the document.

These molecules, pyocins, are synthesized bacteriocins that are meant to eliminate, kill, competitors of the same species. This means that *P. aeruginosa* has created the tools to ensure that it can outlive the competition and inhibit their growth and reproduction. Pyocins are also speculated to have a potential role in therapeutic and industrial fields with its potential bactericidal properties. As mentioned earlier without the production of biofilms or being able to degrade them, *P. aeruginosa* would be easier to deal with as far as treating or completely clearing them.

**Recent Progress**

From the 24 strains of *P. aeruginosa*, from Cystic Fibrosis patients, that were screened for pyocin killing, the researchers were able to identify reciprocal activity among 9 strain pairs that were mediated by different subtypes of pyocin. 8 strain pairs with one common strain partner. Since this was broad and reciprocal killing could have been caused by any one of the variations of the pyocins. The researchers took a closer look at the classes that were previously observed.

 “The diversity of S-Type pyocins did not proportionally translate better survival in the face of competition”, states the document Meaning that S-type pyocins may not be what is allowing certain strains to outlive others. It did however show that in the strains A026, which had the most competitive ability, did not have any of the S-pyocin type. Again, confirming that S-type may not be the absolute factor in survivability of a strain over another. This somewhat shows that perhaps, though important for some function, S-pyocin type may not be the main player when it comes to competition and survivability of the pathogens when faced off against other strains.

 Removal of killing ability of certain clinical isolates was only done in the R-pyocin mutant, “even if a strain had an excess of S-pyocin”, states Oluyombo. This showed that R-pyocins play a role in strain survival. when two competing strains were exposed to one another, it showed R-pyocin dependent killing in the biofilm over a period of time. This strongly backs up the importance of R-pyocin as an essential player in the competitive edge of *P. aeruginosa* and as a bacteriocin.

 R-pyocins have also been seen to promote competition in biofilms within their pieces. With the use of differently labeled green fluorescent protein or mCherry in microfluid channels in a BioFlux device, while allowing them to form biofilms overtime, they were able to somewhat emulate the biological ecosystem. Over time they counted viable cells before and after treatment and noticed that R-pyocins caused a significant drop in viable cell. Even if kept longer in the BioFlux the trend continued.

**Discussion**

Certain stains of *P. aeruginosa* is hard to kill in the lungs because the biofilm production may be higher and protect the pathogen more than another variant. S-pyocins did not display a significant role in the competitiveness of the strains nor in the increased survivability of on strain of *P. aeruginosa* over another. This was tested in various manners and each time there was little to no change between the growth and death of strain colonies. R-pyocins, however did display a growth advantage of certain strains over others. It also displays the killing of the biofilms of strains when grown with other strain variants. The researchers speculate that R-pyocin can be used as an antibiofilm or in antibiofilm strategies. The researchers also believe that it can “effectively eradicate biofilms of a susceptible strain”, as stated by Oluyombo. I assume that this would be done so that the *P. aeruginosa* is exposed to an antibiotic or to some other bactericidal molecule. This can also potentially be used as a way to make *P. aeruginosa* even more competitive and have them kill each other so that there is less to deal with when it comes to treatment. This is an exciting discovery, though not solid in its current state, but this could lead to a potential treatment or therapy for Cystic Fibrosis patients. Seeing as biofilm and *P. aeruginosa* are the biggest hurdle to get over within their lungs. The document states that there is still work that needs to be done as far as understanding how the mechanisms and the production of R-pyocins and their role in the survivability and competitiveness of these pathogens. Although R-pyocins have in fact shown an advantage in growth and the killing of biofilms for other strains. I believe though with the current understanding, that this is an important pursuit. It seems plausible that is could help reduce *P. aeruginosa* or even lead to the complete removal from the lungs of the Cystic Fibrosis patients.

**References**

Oluyombo, Olubukola, Christopher N. Penfold, and Stephen P. Diggle. "Competition in Biofilms between Cystic Fibrosis Isolates of Pseudomonas aeruginosa Is Shaped by R-Pyocins." mBio 10.1 (2019): e01828-18. Web. 07 Feb. 2019.