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Biofilm information

1) ***MagOzone*** has been formulated with specific enzymes that digest biofilm.

A biofilm is a viscous slime layer that develops on almost every surface in contact with water, and microorganisms. It is composed of bacteria, and organic polymers called EPS (Extracellular Polymeric Substances, mainly polysaccharides and proteins) that promote the irreversible adhesion of microorganisms, and create a protective, and evolving structure around them. The biofilm is thus a reservoir of microorganisms that protects them from external aggressions, among which are cleaning, and disinfection.
(Enzymatic removal of biofilms, A report Gauthier Boel, REALCO S.A.; Louvain-La-Neuve, Belgium, Email: gvoels@realco.be;http://dx.doi.org/10.4161/viru.2.5.17317)

Examples of enzymatic removal of biofilms:

The long and narrow endoscope channels are difficult to reach by mechanical devices, and the use of harsh chemical or high temperatures could harm the sensitive materials built into endoscopes. For reprocessing of endoscopes, mild cleaning agents are needed to combat biofilms. One effective approach is to destabilize the biofilm EPS, which contain proteins, polysaccharides, lipids, extracellular DNA, and other substances. Some enzymes such as protease (12,13,), DNase I (12,14), alginate lyase (15,16) amylase (13,17) and cellulase (18,19) have been reported to support biofilm removal. (America Society for Microbiology/Antimicrobial Agents and Chemotherapy, Enzymes Enhance Biofilm Removal Efficiency of Cleaners)

The biofilm matrix is a collection of micro-colonies with water channels in between, and an assortment of cells, and extracellular polymers (polysaccharides, glycoproteins, and proteins) (5,6,8,11). Bacterial extracellular polysaccharides are composed of homo- and heteropolysaccharides of, in particular, glucose, fucose, mannose, galactose, fructose, pyruvate, and mannuronic acid- or glucuronic acid-based complexes (3). The different types of bonds between the saccharides give rise to a multitude of different polysaccharides, including levan, poly-mannans, dextran's, cellulose, amylopectin, glycogen, and alginate.
Enzymes can be used for degradation of biofilm (1,3,29,31) but due to the heterogeneity of the extracellular polysaccharides in the biofilm, a mixture of enzyme activities may be necessary for a sufficient degradation of bacterial biofilm.

It is estimated that more than 90% of all chronic wounds contain bacteria that are biofilm associated (6), making them up to 1,000-fold more tolerant to antibiotics and the host immune response (7). Thus, taking into account the **alarming increase of antibiotic-resistant bacteria**, the added ability of pathogens to reside within the protection of the biofilm matrix all too often makes effective treatment of these infections impossible.

07/03/2020

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In the majority of biofilms, microorganisms make up less than 10% of the dry mass, while the EPS represents more than 90%, with polysaccharides often being a major constituent (8). These polysaccharides provide a variety of functions crucial to the formation and integrity of the biofilm, including, but not limited to, initial surface adhesion, aggregation of bacterial cells, water retention, mechanical stability, sorption of nutrients and ion, nutrient storage, and binding of enzymes, and serve as a protective barrier against antimicrobial agents and environmental stressors (8). Thus, active degradation of polysaccharides may prove to be a promising universally applicable approach to clinically addressing biofilm infections. Glycoside hydrolases (GHs) are enzymes that act by hydrolyzing the glycosidic linkages between two or more carbohydrates (9). They can be individual characterized by the specific type of linkage that they cleave, such as a-1,4 bond hydrolysis by a-amylase, B-1,4 bond hydrolysis by cellulase, or B-1,3 bond hydrolysis by B-1,3 galactosidase.

One glycosidic linkage commonly seen within pathogens is the B-1,4 bond, such as that present in cellulose, an exopolysaccharide produced by many strains of Escherichia coli, Salmonella, Citrobacter, Enterobacter, Pseudomonas, and other bacteria (21). Cellulase is a commercially available enzyme that hydrolyzes these B-1,4 linkages (22) and thus could theoretically serve to break up a host of biofilm exopolysaccharides into simple sugars. It has been shown that cellulase inhibits biofilm growth by Burkholderia cepacia and Pseudomonas aeruginosa on various abiotic surfaces commonly used in medical devices (22,23). Similarly, a-amylase, a GH that acts by cleaving the a-1,4 straight-chain linkage, has been previously shown to both inhibit biofilm formation and disrupt preformed biofilms of Vibrio cholera, Staphylococcus aureus and P. aeruginosa in vitro (24-26).
(American Society for Microbiology/Antimicrobial Agents and Chemotherapy/Glycoside Hydrolases Degrade Polymicrobial Bacterial Biofilms in Wounds)

Enzymes Enhance Biofilm Removal Efficiency of Cleaners
https://aac.asm.org/content/60/6/3647

The use of cellulase in inhibiting biofilm formation from organisms commonly found on medical implants.
https://www.ncbi.nlm.nih.gov/pubmed/14618691

Thermostable xylanase inhibits and disassembles Pseudomonas aeruginosa biofilms.
https://www.ncbi.nlm.nih.gov/pubmed/29616824

Chitinases Are Negative Regulators of Francisella novicida Biofilms
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3963990/

B-1,3-glucanase disrupts biofilm formation and increases antifungal susceptibility of Candida albicans DAY185.https://www.ncbi.nlm.nih.gov/pubmed/29104052

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Biofilm related problems:

Biofilm in Nasal passage
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3836217/
https://www.ncbi.nlm.nih.gov/pubmed/28894821

80% of infections are biofilm related
https://www.ncbi.nlm.nih.gov/pubmed/23025745
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4395855/

Bacteria/Biofilm/GI tract
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4395855/

Biofilms in Chronic suppurative otitis media
https://www.ncbi.nlm.nih.gov/pubmed/24288500

Strep reoccurrence due to biofilm
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC193794/

Biofilm removal lime disease improvement
https://www.ncbi.nlm.nih.gov/pubmed/26903956

Gut biofilm forming bacteria in inflammatory bowel disease
https://www.ncbi.nlm.nih.gov/pubmed/28942174

Fungus/biofilm
https://www.ncbi.nlm.nih.gov/pubmed/28988727

Biofilm and Crohns
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3536164/