Green and Safe Disinfectants, can these terms really coexist?

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Abstract

Disinfectant products are widely used in Healthcare settings. It is a common belief that these products are somewhat toxic to the user due to their toxicity against microorganisms. The objective of this study was to propose that this notion is not necessarily true, and showcase new technologies that are able to achieve disinfection without harm to the user or the environment. A new technology based on Accelerated Hydrogen Peroxide® (AHP®) was assessed for its antimicrobial activity using EPA approved test methods, as well as its user safety and environmental fate compliance with the DfE Antimicrobial Pesticide Pilot Project.

Background

Disinfectant formulations consist of antimicrobial active and inert ingredients. Antimicrobial active ingredients have inherent toxicity towards pathogenic microorganisms. In most cases, such chemicals also possess high mammalian toxicity, as well as medium to high environmental and aquatic toxicity. In general, the higher the antimicrobial activity of a product, the higher its toxicity will be.

Green chemistry certification organizations such as GreenSeal®, Ecologo®, and EPA's Design for the Environment have developed their own criteria for each of these toxicity endpoints. The inherent toxicity of most antimicrobial substances such as quaternary ammonium compounds, phenols, and chlorines are exemplary actives with direct or indirect environmental fate problems, and therefore do not meet the DfE standards.

Green Criteria

The DfE program has arguably the most stringent criteria accepting only three antimicrobial active ingredients as of date: hydrogen peroxide, lactic acid and citric acid. Table 1 shows the characteristics of these three DfE approved active ingredients. As a result, only a few disinfectants have satisfied DfE criteria and therefore certified as per Table 2.

Table 1. DfE approved antimicrobial actives and their attributes

DfE Approved Actives at Use Dilution	Skin and Eye Irritant or Sensitizer	Mutagen	VOC	Lack of Biodegradability	Aquatic Toxicity	Bio-accumulation	General Antimicrobial Strength	Ease of Formulation
Citric acid	No	No	No	No	No	No	Medium	Easy
Lactic acid	No	No	No	No	No	No	Medium	Easy
Hydrogen Peroxide	No	No	No	No	No	No	High	Hard

Table 2. List of current DfE approved disinfectants

Product Name	Active Ingredient	Contact time & Claims		
		Sanitization	Bactericidal	Virucidal
Square	3.2% L- Lactic Acid	-	**10 min:** Gram+: *S.aureus* Gram -: *C.jejuni, E.coli* O157 :H7 *L.monocytogenes, P. aeruginosa, S.enterica*	**10 min:** Enveloped: Respiratory Syncytial Virus, Rotavirus WA, Avian Influenza A Virus, H1N1 Non-enveloped: Poliovirus
Rosemary T	2% L- Lactic Acid	**30 sec:** Gram +: *S.aureus*, MRSA Gram -: *E.coli* O157:H7, *S. enterica*	**5 min:** Gram+: *S. aureus*, MRSA Gram -: *P. aeruginosa, S.enterica*	**10 min:** Enveloped: RSV 30 sec Influenza A
Consume Bio-Bowl	8 % Citric Acid	-	**10 min:** Gram+: *S. aureus* Gram -: *P. aeruginosa, S.enterica*	**5 min:** Enveloped: Influenza A, Herpes simplex Type 2
B Cleaner	3.7% L- Lactic Acid	**1 min:** Gram +: *S.aureus*, MRSA Gram -: *P. aeruginosa, S.enterica, K. pneumoniae*	**5 min:** Gram +: *S.aureus*, MRSA Gram -: *P. aeruginosa, S.enterica, K. pneumoniae*	**5 min:** Enveloped: Avian Flu Virus, H1N1 Influenza Virus
Toilet Bowl Cleaner	7.2% L- Lactic Acid	-	**5 min:** Gram -: *P. aeruginosa, S.enterica*	**5 min:** Enveloped: Rotavirus
Accel 5 RTU	0.5% Hydrogen Peroxide	**30 sec:** Gram +: *S.aureus*, MRSA, *L. monocytogenes*, VRE Gram -: *P. aeruginosa, S.enterica, A. baumannii, E.coli* O157 :H7	**5 min:** Gram +: *S.aureus*, MRSA, CA-MRSA 300, CA-MRSA 400, *L. monocytogenes*, VRE Gram -: *P. aeruginosa, S.enterica, K. pneumonia, A. baumannii, E.coli* O157 :H7, ESBL *E. coli*	**5 min:** Enveloped: Influenza A H3N2 & H1N1, Avian Influenza HIV Type 1, HBV, HCV, Human Coronavirus, RSV Non-enveloped:, Murine Norovirus, Adenovirus, Human Rotavirus, Rhinovirus, Poliovirus, Feline Calicivirus (Norovirus)

Discussions and Conclusion

It is possible to develop a broad spectrum disinfectant product without compromising either antimicrobial efficacy or product safety, thereby providing healthcare and other facilities safe and effective disinfectant alternatives.

It is challenging to formulate hydrogen peroxide-based disinfectants to meet the DfE criteria as most hydrogen peroxide effective stabilizers have poor environmental footprint. The presented Accelerated Hydrogen Peroxide technology (Accel 5 RTU) is the first hydrogen peroxide-based broad-spectrum hospital grade disinfectant product that meets the DfE criteria. With only 0.5% hydrogen peroxide as the active this formulation carries a 30-second sanitizing claim, and a 5 minute bactericidal and virucidal claim and proven effective against gram-positive & gram-negative bacteria, and enveloped & non-enveloped viruses including Norovirus. It also carries the toxicity rating (Category IV) allowed by the EPA due to its non irritating properties to skin, eyes and respiratory system and therefore does not required the use of PPE.

Effectively combating HAI's while being environmentally preferred will require disinfectant manufacturing companies to shift their focus toward the use of more sustainable actives and inert ingredients. This investigation has showcased several such products which can deliver the needs of infection prevention and control community without compromising the sustainability and environmental fate aspects.

Disclaimer: Authors of this poster are/*were employees of Virox Tech. Inc.