Disinfectants and Sanitizers

A 2007 norovirus outbreak at an elementary school was linked to computer keyboards that had not been cleaned.

Public Health Reasons

Environmental surfaces can be a source of pathogens that cause gastrointestinal illnesses. Some pathogens have been shown to survive for long periods of time on surfaces. For example, hepatitis A virus and rotavirus can survive for up to one month on hard, non-porous surfaces, while noroviruses can survive up to 42 days on the same types of surfaces. Surfaces in a child-care center can become contaminated by direct contact with bodily fluids, such as vomit or fecal matter, or through indirect contact with other contaminated objects, such as improperly cleaned wiping cloths, food, or hands. Therefore, cleaning and decontamination of environmental surfaces is essential to preventing gastrointestinal illnesses.

In order to prevent illness, detergent-based cleaning alone is not sufficient to remove pathogens. Research conducted by Barker et al. showed that cleaning with a detergent alone failed to decontaminate tested surfaces in all but one case. When surfaces were treated with a solution containing 5000 ppm chlorine for 1 minute, noroviruses were only recovered from one surface. Therefore, a sanitizer or disinfectant must be used after cleaning.

In order to choose the proper product, it is important to understand the differences and proper uses of disinfectants and sanitizers. Both disinfectants and sanitizers are designed to kill microorganisms, but have different applications. First, sanitizers are used on food-contact surfaces and soft surfaces, such as textiles, fabrics, and carpeting, and disinfectants are used on all hard surfaces that are not considered food-contact surfaces. Another difference is that disinfectants are used to destroy or irreversibly inactivate the microorganisms listed on their label, which may include bacteria, fungi, and viruses, but not necessarily spores. Sanitizers are used to reduce, but not necessarily eliminate, bacteria from the inanimate environment to levels considered safe as determined by public health codes or regulations. Disinfectants also tend to be used at much higher concentrations and usually have a longer contact time. Sanitizers tend to be used at lower concentrations for a shorter period of time. No perfumes are allowed in food-contact sanitizers, whereas perfumes are often used in disinfectants.

In addition, sanitizers for food-contact surfaces must reduce the bacterial count by 5 logs or 99.999%. Sanitizers used on soft surfaces must reduce bacterial counts by 3 logs or 99.9%. The EPA tests the efficacy of some sanitizers by targeting *Salmonella* Typhi on cleaned food-contact surfaces. Examples of sanitizers include halide compounds such as iodophors and chlorine-based chemicals. *Escherichia coli* and *Staphylococcus aureus* are used as target organisms when testing the efficacy of quaternary ammonium compounds. It is important to note that sanitizers are *not* effective against viruses and fungi. The most commonly used sanitizers in food production environments are chlorine, quaternary ammonium, and iodine. The Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) clearly state approved concentrations of sanitizers in their respective regulations. Too high or too low of a concentration is a violation of these regulations.

Both sanitizers and disinfectants are regulated by the U.S. Environmental Protection Agency (EPA). The EPA maintains a list of registered sanitizers and disinfectants on their website. The Pesticide Product Labeling System (PPLS) is at: www.epa.gov/opp00001/pestlabels/

Practices

If a product is registered with the EPA and described as a sanitizer or disinfectant, it can be used in a child-care setting as stated on the label. Check the label to determine the contact time, whether it needs to be rinsed off, and any other precautions to take when handling.

Factors Affecting the Efficacy of Sanitizers and Disinfectants

Number and location of microorganisms

- The amount of time needed to kill microorganisms increases with the number of microorganisms present.
- Food-contact equipment with multiple pieces must be disassembled to ensure that all parts are thoroughly cleaned and sanitized.
- Surfaces with crevices are more difficult to sanitize and disinfect than flat surfaces because penetration to all areas may not occur.
- Fabrics can only be sanitized, not disinfected.

Innate resistance of microorganisms

- Unlike Gram-positive bacteria, Gram-negative bacteria have an outer membrane that acts as a barrier to the uptake of sanitizers and disinfectants making it more difficult to kill these organisms. Gram-negative bacteria include *E. coli, Campylobacter jejunum*, and *Salmonella* spp.
- Non-enveloped viruses, which are hydrophilic and do not contain lipids, are less susceptible to germicides than enveloped viruses, which are hydrophobic and contain lipids in their envelope. Non-enveloped viruses include noroviruses, hepatitis A virus, and rotavirus. Enveloped viruses include influenza, smallpox, and human immunodeficiency virus (HIV).
- Spores are resistant to disinfection because the spore coat and cortex act as a barrier. Spore-forming bacteria include Clostridia and Bacillus species.

Concentration and potency of sanitizers and disinfectants

- The more concentrated the chemical used, the greater its efficacy and the shorter time that is necessary to kill the microorganism, with the exception of iodophors. Because disinfectants are used at a higher concentration than sanitizers, they can achieve complete destruction of microorganisms whereas sanitizers only achieve a 3-5 log reduction.

Physical and chemical factors

- **Temperature**: The activity of most disinfectants and sanitizers increases as the temperature increases, but there are some exceptions. Too great of an increase in temperature can cause the disinfectant or sanitizer to degrade.
- **pH**: An increase in pH improves the antimicrobial activity of some sanitizers and disinfectants (glutaraldehyde and quaternary ammonium compounds), but decreases the activity of others (phenols, hypochlorites, and iodine).
- **Water hardness**: This reduces the kill rate in certain sanitizers and disinfectants.

Organic and inorganic matter

- Organic matter, such as fecal matter, vomit, or food residue, can interfere with the antimicrobial activity of sanitizers and disinfectants by interacting with the chemicals in the germicide and reducing the level of activity or by protecting the microorganisms from attack by acting as a physical barrier.

Duration of exposure

- Sanitizers and disinfectants have a minimum contact time that surfaces must be exposed to the product.
- In general, longer contact times are more effective than shorter contact times.

By law, all applicable label instructions on EPA-registered products must be followed.

Biofilms

- Biofilms are microbial communities that are tightly attached to surfaces and surrounded by an extracellular matrix that protects them from the effects of sanitizers and disinfectants.
- Bacteria within biofilms are up to 1,000 times more resistant than are the same bacteria in suspension.
- No products are EPA-registered or FDA-cleared to degrade biofilms.

Surface Compatibility

- Determine whether the sanitizer or disinfectant is compatible with the surfaces on which it will be used. Mainly, determine that there will be no change in the function or appearance of the surfaces from the use of the product.
- Do not use products that are corrosive such as iodine, especially on metals.
- Plastic can be damaged by frequent or extended exposure to alcohol.

Attributes of Common Sanitizers Allowed in Foodservice Settings

Chlorine (sodium hypochlorite) compounds

- For food-contact sanitizing, the chlorine concentration must not exceed 200 ppm.
- At sanitizer levels, chlorine is effective against all vegetative bacteria.
- They are less effective in the presence of organic matter, such as food soil.
- They are unaffected by water hardness.
- They are effective between a pH range of 6-8. Most water is near neutral pH (7).
- Use at temperatures between 55°F to 120°F (13°C to 49°C).
- The strength decreases over time. (For open buckets, make fresh solutions frequently throughout the day. Sanitizers stored in opaque spray bottles can be prepared once per week if allowed by the appropriate regulatory authority.)
- They may corrode metal surfaces and bleach and damage fabrics.

Iodine

- Iodophors are a combination of iodine and a stabilizing agent or carrier.
- Dilutions of iodophors present more rapid bactericidal action than a full-strength solution.
- For food-contact sanitizing, iodine solutions must have a concentration between 12.5 and 25 ppm.
- At sanitizer levels, iodine solutions are rapidly effective against most vegetative bacteria.
- Gram-negative bacteria may be able to survive or grow in the solution.
- The optimum pH is 5.0 or less.
- It is not suitable in the presence of organic matter.
- Solutions must have a minimum temperature of 68°F (20°C). It decomposes when heated above 104°F (40°C).

- It may stain skin and cause irritation.
- Prepare solutions daily.
- It does not leave toxic residues.
- Do not use on aluminum or copper.

Quaternary ammonium compounds

- Food-contact sanitizing solutions of quaternary ammonium compounds must not have a concentration exceeding 200 ppm.
- They are effective against Gram-positive bacteria and lipid-containing, enveloped viruses.
- They have no activity against spores.
- Solutions must have a minimum temperature of 75°F (24°C).
- Gram-negative bacteria may be able to survive or grow in the solution.
- They are inactivated by proteins, soap, and anionic detergents.
- High water hardness can decrease their activity. Use with water that has a hardness of 500 mg/L or less.

Attributes of Common Disinfectants

Chlorine (sodium hypochlorite) compounds

- They are effective against a wide variety of microorganisms (vegetative bacteria and viruses, including norovirus).
- They are less effective in the presence of organic matter (such as blood). The concentration must be increased to retain action.
- They are unaffected by water hardness.
- They are effective between a pH range of 6-8. Most water is at neutral pH (7).
- The strength decreases over time. (For open buckets, make fresh solutions frequently throughout the day. Disinfectants stored in opaque spray bottles can be prepared once per week if allowed by the appropriate regulatory authority.)
- High concentrations corrode metal surfaces and bleach and damage fabrics.
- They do not leave toxic residues.

Alcohols (ethyl alcohol or isopropyl alcohol)

- They are effective against fungi, vegetative bacteria, Mycobacterium species, and some viruses, including noroviruses.
- They are not effective against spores.
- They are most effective at 60%-90% in water. Activity drops sharply when diluted below a 50% concentration.
- They may swell rubber or harden plastics.
- Do not use near flames due to flammability.

Iodine

- Iodophors are a combination of iodine and a stabilizing agent or carrier.
- It is rapidly effective against most microorganisms (vegetative bacteria, mycobacteria, and viruses).
- Gram-negative bacteria may be able to survive or grow in the solution.
- Dilutions of iodophors demonstrate more rapid bactericidal action than does a full-strength solution.
- The optimum pH is neutral to acidic.
- It is not suitable in the presence of organic matter.
- It may stain skin and cause irritation.
- Prepare solutions daily.
- It decomposes when heated above 104°F (40°C).
- Do not use on aluminum or copper.

Glutaraldehyde

- It is active against vegetative bacteria, spores, fungi, and many viruses.
- It may cause dermatitis. Wear protective gloves when handling materials that have been immersed in glutaraldehyde.
- The shelf-life is 14 days. Discard if turbid.
- It is commercially available as 2% w/v aqueous solution which must be made alkaline (pH 7.5-8.5) to "activate" (e.g. by addition of 0.3% sodium bicarbonate). It is also available in stable glycocomplexed form, which does not require addition of an alkaline buffer.

Hydrogen peroxide

- It is active against a range of microorganisms (vegetative bacteria, yeasts, viruses including norovirus, spores and fungi).
- Fungi, spores and enteric viruses require higher concentration.
- It does not have toxic end-products of decomposition.
- Do not use on aluminum, copper, zinc, or brass.

Phenolics

- They are active against bacteria and lipid-containing, enveloped viruses.
- They are not active against spores and non-lipid-containing, non-enveloped viruses.
- Gram-negative bacteria may be able to survive or grow in the solution.
- They are active in the presence of organic matter.
- They are absorbed by porous materials and the residual disinfectant can irritate tissue.

Quaternary ammonium compounds

- They are effective against Gram-positive bacteria and lipid-containing, enveloped viruses.
- They do not have an effect against spores.
- Gram-negative bacteria may be able to survive or grow in the solution.
- They are inactivated by proteins, soap, and anionic detergents.
- High water hardness can decrease their activity.

Activity of Different Types of Disinfectants

Toxicity Against	Active Disinfecting Ingredient: Phenolics	Chlorine Compounds	Alcohols	Glutaraldehyde	Iodophors
Fungi	good	slight	none	good	good
Bacteria (Gram +/-)	good	good	good	good	good
Mycobacteria	fair	fair	good	good	good
Spores	none	fair	none	good (<20ºC)	slight
Lipid viruses	slight	slight	slight	slight	slight
Non-lipid viruses	variable	slight	variable	slight	slight

Recommended Concentration Levels For Disinfectants

Disinfectant	Concentration or Level
Glutaraldehyde, aqueous	2%
Hydrogen peroxide, stabilized	2%
Iodophors	30-50 mg of free iodine per liter; 70-150 mg of available iodine per liter
Chlorine compounds	500-5,000 mg of free chlorine per liter
Alcohol (ethyl; isopropyl)	70%
Iodine and alcohol	0.5% + 70%
Phenolic compounds, aqueous	0.5-3%
Quaternary ammonium compounds, aqueous	0.1-0.2%

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