Food Safety Risk Attributed to Ionic Bond Between Quaternary Ammonium Sanitizers and Cloth Towels in Nevada

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Abstract

This study examined awareness of food safety risk due to “quat binding,” which occurs when quaternary ammonium is used with a cotton or viscose cloth to sanitize surfaces. A bond is formed, preventing the sanitizer ions from making it onto food contact surfaces at the prescribed concentration, and thus inadequately deactivating all pathogens that could lead to human illness. Standardized interviews were conducted by food safety regulators at restaurants and food processing facilities in Carson City, Nevada (162) and Douglas County, Nevada (133), where 61% and 75.2% respectively use quaternary ammonium for sanitizing food contact surfaces. In Carson City, only six facilities (3.7%) surveyed were aware of the risk that quat binding presents, while in Douglas County no facilities were aware of any risk. The study concluded that knowledge of quat binding and its associated risk was almost non existent.

Recommendations included 1) increasing the education of food safety regulators and chemical supply representatives who may instruct restaurants and food production facilities at the operational level and 2) chemical manufacturers including instructions on product labels targeting quat binding.

Keywords: cotton, food contact surfaces, food safety, ionic bonds, pathogens, quat binding, quaternary ammonium, restaurants, sanitizer, viscose
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**Background**

Properly-sanitized food contact surfaces are critical to minimizing food safety risks associated with the growth of pathogens. According to 4-701.10 of the 2013 U. S. Food and Drug Administration (FDA) Food Code, food contact surfaces must be sanitized in order to minimize cross-contamination (U. S. Food and Drug Association [FDA], 2013). Sanitizing with chemical compounds provides a cost-effective and relatively simple approach to ensure that effectively-cleaned food contact surfaces are free of pathogens and safe for food preparation work. Three types of sanitizers are commonly used in retail food establishments: chlorine, iodine, and quaternary ammonium compounds. Chlorine—once the most prevalent sanitizer due its effectiveness and low cost—has been replaced by quaternary ammonium sanitizers, in part due to a lack of skin irritation and corrosiveness. Quaternary ammonium compounds are positively-charged ions which are highly-effective at inactivating negatively-charged pathogens such as *Staphylococcus aureus*, *Listeria monocytogenes*, and *Escherichia coli* (Ekhtalat, 2012).

There are essentially four factors that affect quat binding: the amount of time that the cloth spends in the sanitizer solution, the volume of the solution, the type of fabric, and the concentration of the solution (Ecolab Inc, n.d.). Researchers have discovered that the use of cotton or viscose cloths as application vehicles may cause degradation of quaternary ammonium sanitizer strength. Food establishments frequently use cotton
or paper cloths to apply quaternary ammonium sanitizer solutions to food contact surfaces. Many facilities will use either a pre-mixed quaternary ammonium solution or a solution prepared according to the manufacturer’s label, using water and concentrated quaternary ammonium. A cloth is then used to transfer the solution from the bucket to a surface to be sanitized. The assumption is that the required concentration of sanitizer is applied to a surface, thus deactivating the viruses and killing the bacteria that are present. However, new research has revealed that “quat binding” decreases the concentration of quaternary ammonium chlorides and ultimately reduces the efficacy of the solution that is applied to food contact surfaces with cotton cloths. Negatively-charged surface fibers, including viscose and cotton, have been shown to bind up to 40% of the positively-charged quaternary ammonium salt, therefore limiting disinfection performance and wasting valuable amounts [of the active compound] (Condon, 2014).

To achieve disinfection, the prescribed concentration of quaternary ammonium must be applied to food contact surfaces. Quaternary ammonium chlorides, the active ingredient of quaternary ammonium sanitizers, are cationic, or have a positive charge, while the cloth fibers of the cotton cloths used to apply the quaternary ammonium sanitizer are anionic, or negatively charged. As a result, when the cloth is dipped into the sanitizer solution, the available quat chlorides form an ionic bond with the cloth, causing less of the sanitizer’s active ingredient to be available to sanitize food contact or environmental surfaces. When food contact surfaces are sanitized with an ineffective level of active sanitizer, pathogens may remain. One study conducted by the U.S. Department of Agriculture (USDA) Agricultural Research Service showed that biofilms of *Listeria Monocytogenes* developed resistance to sanitizing agents, including
quaternary ammonium, when exposed to non-microbicidal concentrations of sanitizer (Breidt, Kathariou, & Pan, 2006).

**Problem Statement**

The risk regarding the misuse of quaternary ammonium-based sanitizers when cleaning surfaces with a cotton cloth is unknown in restaurants and food processing facilities in Douglas County and Carson City, Nevada.

**Research Questions**

1. What is the level of knowledge of food workers in Carson City and Douglas County regarding the reaction that occurs between cotton cloth and quaternary ammonium-based sanitizers?
2. What methods are currently used by restaurants and food facilities in Carson City and Douglas County to reduce the risk caused by the reduction of effectiveness when using cotton cloth towels to apply quaternary ammonium sanitizers?

**Methodology**

Research data was collected via survey by five Environmental Health Specialists while performing their routine investigative duties at restaurants and food production facilities in Carson City and Douglas County. The survey was given to 162 out of 320 total facilities in Carson City and 133 out of 345 total facilities in Douglas County. Target facilities were those who processed, manufactured, or cooked food on-site. The five specialists collected data according to a standardized set of procedures. The data collected included the number of facilities using quaternary ammonium, the knowledge
that managers and persons-in-charge had pertaining to quaternary ammonium, and their knowledge of the consequences of the ionic bond that forms when the sanitizer is applied with a cotton or viscose cloth. Data collected also included job titles of staff members interviewed; whether the facility used quaternary ammonium in their three-basin sink, on food contact surfaces, or both; whether the person-in-charge demonstrated knowledge of ‘quat binding’; whether the facility had any preventive measures in place; and the business’ chemical supply company.

Results

Facilities were found to either be using bleach or quaternary ammonium for sanitizing food contact surfaces. One facility used chlorine dioxide and isopropyl alcohol in combination with quaternary ammonium-based sanitizers.

In Carson City, 99 out of 162 (61%) facilities surveyed used quaternary ammonium for sanitizing purposes. In Douglas County, 100 out of 133 (75.2%) facilities reported using quaternary ammonium as a sanitizing agent.

In Carson City, a person-in-charge at 6 out of 162 (3.7%) facilities surveyed demonstrated knowledge of quat binding. In Douglas County, there were zero out of 133 (0%) facilities where a person-in-charge was aware of quat binding. Table 1 shows that 3.7% of facilities surveyed in Carson and 0% of facilities in Douglas County were knowledgeable on the issue of quat binding.
Table 1

*Use of Quat and Knowledge of Quat Binding in Carson City and Douglas County*

<table>
<thead>
<tr>
<th>Location</th>
<th>Total Facilities Using Quat</th>
<th>Total Aware of Quat Binding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carson City (pop. 55,274)</td>
<td>99 out of 162 (61%)</td>
<td>6 out of 162 (3.7%)</td>
</tr>
<tr>
<td>Douglas County (pop. 46,997)</td>
<td>100 out of 133 (75.2%)</td>
<td>0 out of 133 (0%)</td>
</tr>
</tbody>
</table>

Of the six facilities that demonstrated knowledge of quat binding, five currently used quaternary ammonium on food contact surfaces. These five reported that they tested the quaternary ammonium concentration in the sani-buckets more frequently, and limited the amount of rags that they used with each bucket of sanitizer solution. The other facility stated they circumvented this bonding issue by using quaternary ammonium for sanitizing in the three-basin sink, but used bleach when sanitizing surfaces.

**Conclusions**

Knowledge of the sanitization limitations of quaternary ammonium is virtually unknown at the operational level in restaurants and food production facilities in Carson City and Douglas County, Nevada, despite the fact that the vast majority of restaurants and food production facilities use quaternary ammonium as their preferred sanitizer. With the exception of the restaurant substituting bleach for sanitizing food contact surfaces, there were no other known effective preventive measures in place. More frequent concentration testing of the sanitizer solution in the bucket prior to cloth immersion does not reveal the applied concentration of quaternary ammonium, and is not a strategy that will lead to reduction of quat binding.
While information about quat binding is available, this information is not known or understood at the operational level where preventive measures must be applied. However, when the restaurants and food production facilities were given verbal instructions concerning quat binding and its negative food safety consequences during the course of this study, the vast majority of operators asked for more information on how they could mitigate this issue and still use sanitizers to reduce the risk of foodborne illness in their establishments.

In addition, some anecdotal information from field-level chemical supply representatives encountered during data collection indicated that many did not understand quat binding and the risks this reaction presents. On two occasions, however, representatives referred the surveyor to corporate staff who demonstrated knowledge of quat binding and suggested using microfiber towels in place of cotton cloths. These instances may indicate a potential gap in knowledge within the chemical supply industry.

Similar anecdotal information suggests minimal knowledge held by inspectors in partner food safety regulatory agencies in the region covered by the study. Further research may be needed to determine level of awareness of quat binding within the chemical supply industry and food safety regulatory agencies.

Recommendations

Food safety regulators should better understand quat binding and be trained on how to educate food workers at the operational level with regard to mitigation strategies. Training may be offered in the form of classes that count for Continuing Education
Units. This training should include techniques such as using a spray bottle to apply the quaternary ammonium sanitizer onto a surface and allowing the sanitizer to sit so that the active quat chlorides will bind with pathogens before being swept away with a cloth; soaking the cloth towels in sanitizer, then replacing the sanitizer solution which will push the absorption reaction past equilibrium, thus allowing more positively-charged quats to bind with negatively-charged pathogens; switching from cotton cloths or paper towels to higher polyester blends, which will reduce the effect of quat binding because polyester fiber has less of an ionic attraction (Condon, 2014); using ionized cloths or presoaked quaternary ammonium wipes that have already been balanced; and using bleach or iodine instead of quaternary ammonium if the operation would consider using other sanitizers.

Chemical supply company representatives who set up automated sanitizer processes and provide quaternary ammonium sanitizers to restaurants and food production facilities, should provide better instruction on how to use their products and avoid any of the products’ limitations.

Manufacturers who produce quaternary ammonium sanitizers should add specific instructions on the chemical containers’ label that address quat binding and how to avoid this limitation. Quaternary ammonium sanitizer manufacturers should address the quat binding issue by giving instructions on how to correctly use their product and whether prescribed concentrations change depending on the application process used.
Proper use and limitations of sanitizers, such as quaternary ammonium, should be covered in the new version of the FDA Food Code, which is the model for the vast majority of food safety programs and health organizations throughout the county.

Efforts to reformulate quaternary ammonium sanitizers use salts to compete with quat chlorides for position in the ionic bond with the cotton fibers. This research may lead to a more permanent solution in the future. However, in the interim, practical mitigation strategies need to be implemented at the operational level to reduce risks that result from quat binding.

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References


