dl 11/22/2019. Original date?

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SANITATION | June/July 2017

Clean Up That Food! An Update on Sanitizers and Disinfectants

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Back in 2011, I talked about sanitizers and disinfectants used on food contact and related surfaces.[1] The common chemicals discussed in that article included hypochlorites, chlorine dioxide, peroxyacetic acid and quaternary ammonium compounds. Since then, there hasn't been much change in the sanitizers applied to surfaces.

In this article, let's move from the surfaces to the food products themselves and the more common sanitizers applied to them. The majority of foods we consume are washed in some manner before packing or processing. During the washing step, sanitizers are commonly employed to reduce the microbial load on the food product and in the wash water. Sanitizers used on foods must, of course, meet the regulations of the U.S. Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA) and the U.S. Environmental Protection Agency (EPA). Regarding foods, USDA is generally responsible for meat, poultry and egg products (not shelled eggs), and FDA is responsible for all other foods. It's not really that simple, but defining who does what would constitute another article by itself.

Regulatory Responsibilities

The responsibility for the regulation of a sanitizer used on a food item is based upon the intended use of the sanitizer and on the status of the food in question. A food can be considered either a processed or raw agricultural commodity as defined by the Federal Food, Drug, and Cosmetic Act (FD&C Act). A raw agricultural commodity "means any food in its raw or natural state, including all fruits that are washed, colored or otherwise treated in their unpeeled natural form prior to marketing" (21 U.S.C. 321). A processed food "means any food other than a raw agricultural commodity and includes any raw agricultural commodity that has been subject to processing, such as canning, cooking, freezing, dehydration, or milling" (21 U.S.C. 321). In other

words, if the food has been modified from its original state, including cutting and mixing, it is considered to be processed. Further information regarding the meaning of "processing" and "processed food" is provided in the *Code of Federal Regulations* (21 C.F.R. 1.227). Generally, if a food is considered to be a raw agricultural commodity, EPA retains jurisdiction over the sanitizer. If the food is considered to be processed, then FDA assumes responsibility regarding the sanitizer.

If the food is being produced for the organic market, then USDA also becomes involved, because the operation must additionally comply with the stipulations of the National Organic Program (NOP).

Raw Agricultural Commodities

In recent years, the focus has been on promoting a diet that includes significant portions of raw fruits and vegetables. Unfortunately, these fruits and vegetables have also been proven to be sources of foodborne illnesses. Every producer, wholesaler and retailer is very concerned about food safety, as is the general public. To minimize the probability of a foodborne illness occurring from contaminated produce, many fruits and vegetables are routinely washed prior to entry into the food chain, if washing isn't detrimental to food quality. The washing procedure usually includes the use of a sanitizer in the wash water to reduce the microbes present.

There are myriad commercial products that can be used as sanitizers in wash water applied to raw agricultural commodities. Fortunately, they can be grouped into chemical types that should appear familiar: hypochlorites, chlorine dioxide, peroxyacetic acid, organic acids, ozone and other chemicals generally recognized as safe (GRAS).[2,3] Of course, all sanitizers must be applied per label instructions. In addition, it is imperative to select

the appropriate sanitizer based upon the commodity, washing procedure and the microbes present.

Sodium hypochlorite and calcium hypochlorite are the most used sanitizers in produce wash water. Both are effective and low in cost. Sodium hypochlorite is considered by EPA to be a GRAS substance (40 C.F.R. 180.2) and has no legal tolerance limit for conventionally grown produce (40 C.F.R. 180.1235). Similarly, calcium hypochlorite is exempted from a tolerance when used in a solution applied to raw agricultural commodities (40 C.F.R. 180.1054).

Hypochlorites have disadvantages such as inactivation by organic solids, water impurities and improper pH levels, plus corrosiveness to metals and possible worker health issues. Of particular concern is the production of toxic chlorinated compounds that can negatively impact the environment. The federal government plus many states and local entities have regulations regarding the composition of commercial wastewater and the disinfection byproducts thereof.

Chlorine dioxide produces microbial mortality at lower concentrations than hypochlorites do. It is also effective over a greater pH range, is inhibited less by organic compounds in the water and lasts longer during the washing cycle.[3,4] Because it does not form chlorinated byproducts, it is more environmentally friendly. On the negative side, chlorine dioxide can impact product quality if the commodity is exposed for too long. Because chlorine dioxide is generated on-site, directions for preparation and storage must be closely followed to avoid potentially dangerous situations. It also can be more costly than other sanitizers.

In recent years, peroxyacetic acid has begun to be used more frequently.[5] It is an equilibrium mixture of acetic acid and hydrogen peroxide.6 Peroxyacetic acid, also called peracetic acid, does not have an EPA tolerance level when used according to the regulations (40 C.F.R. 180.1196). This chemical mixture is effective against bacterial spores, functions in a wide pH range (1–9), is environmentally friendly (degrades to acetic acid, oxygen and water5) and tolerates organic loads.[3] On the downside, the pH needs to be a bit acidic for best performance, and it has a pungent odor, may cause worker safety issues and costs more to use than hypochlorites.[3,5,7]

Organic acids, such as citric acid, lactic acid and acetic acid, can be utilized as sanitizers. They function by degrading the microbial cell membrane, denaturing proteins and causing cell lysis. These chemicals are exempt from tolerance, per 40 C.F.R. 180.950, and are environmentally friendly when used as directed. However, these organic acids are not as efficacious against certain bacteria, yeasts and molds. Since they are acids, care is needed to use them. These chemicals can be irritants to the eyes and skin.

Ozone is employed in the washing of raw fruits and vegetables. This substance is not actually registered by EPA, but rather it is regulated based upon its production by a device (40 C.F.R. 152.500). Ozone generators are required to have an EPA establishment number, not a registration number.[8] Ozone is considered a GRAS substance by EPA and FDA. It is a strong oxidizer and is environmentally friendly (it breaks down into water and oxygen). Care must be taken to ensure that employees are safeguarded from offgassing. In wash water, it is applied at a rate of about 2–4 ppm. The contact time depends upon the microbes present and the commodity being treated. Worker safety concerns must be addressed when using ozone, as threshold limit values apply.

Processed Produce Products

Sanitizers used on fruits and vegetables that are classified as processed fall under the purview of FDA. Processed produce is defined under the FD&C Act and related regulations as a product that has been altered in some manner to produce a distinct commodity. Examples of processing activities include boiling, cooking, slicing, grinding, mixing and canning (21 C.F.R. 117).

Chemicals approved for use in the washing and/or peeling of fruits and vegetables are listed in 21 C.F.R. 173.315. A chemical familiar for the washing of raw fruits and vegetables appears again—sodium hypochlorite. Its use must be followed by a rinse with potable water. Also present is peroxyacetic acid with a restriction that the concentration not exceed 80 ppm in the wash water.

The use of acidified sodium chlorite (ASC), which is produced by mixing an aqueous solution of sodium chlorite with a GRAS acid such as citric acid, is described in 21 C.F.R. 173.325. This combination of chemicals results in a mixture of chlorine dioxide, chlorite and chloride, each having antimicrobial properties.[9] The chlorite concentration must be between 500 and 1,200 ppm at a pH of 2.3 to 2.9. Raw agricultural commodities treated with ASC must be rinsed with potable water.

In 2001, FDA approved ozone as an antimicrobial for foods.[10] Ozone is allowable in the treatment, storage and processing of foods, according to 21 C.F.R. 173.368, which specifies its production by electrical discharge or ionizing radiation through air or oxygen. As noted earlier, ozone is considered a GRAS substance by FDA. Again, care is needed when applying

it to foods to ensure it does not negatively impact quality. Typical concentrations and contact times are as noted previously.

Speaking of GRAS chemicals, FDA has an extensive list of around 10,000 substances [GRAS Substances (SCOGS) Database] in addition to those listed in 21 C.F.R. 182. SCOGS is the Select Committee on Generally Recognized as Safe Substances, a group of independent scientists tasked with reviewing these substances. GRAS status is based upon published scientific information attested to by competent scientists or common substance use prior to January 1, 1958. In addition, the GRAS substance must be used according to the stated conditions for that particular substance. FDA does not necessarily have to approve a GRAS substance, but if FDA questions the substance's use, the scientific documentation showing that the substance is safe must be present.[11]

Organic Produce Products, Raw and Processed

USDA oversees the NOP, which sets the standards for organically grown foods. In general, synthetic substances are not allowed in organic food production, but a few are permitted with use restrictions.

Chlorine-related compounds such as calcium hypochlorite, sodium hypochlorite and chlorine dioxide are approved for use as sanitizers even though they are synthetic. The amount of chlorine-related chemicals used in water used to wash a postharvest commodity must not exceed the levels approved by EPA or FDA for the situation in question. Chlorine is usually present at a concentration of about 100 ppm. However, the final potable rinse water may not exceed the maximum residual chlorine limit or chlorine dioxide limit set forth in the Safe Drinking Water Act of 1974 (SDWA).[12] The current level for residual (available) chlorine is 4 mg/L, whereas the

chlorine dioxide maximum is 0.8 mg/L (40 C.F.R. 141.2, 141.65).

The NOP allows the use of peroxyacetic acid (peracetic acid), another synthetic, on organic produce in dump tanks, flumes and similar situations. The common concentration in wash water is 80 ppm. The label on the actual product used dictates whether a potable water (SDWA standards) rinse is required.

As mentioned previously, the use of ozonated wash water for raw agricultural products is gaining popularity. USDA and the NOP are more restrictive regarding ozone uses. The NOP considers ozone to be a synthetic substance for which approved uses appear in two locations within the regulations—7 C.F.R. 205.601(5) and 205.605(b). The first instance allows its use as a gas solely for cleaning irrigation systems, whereas the second instance permits its use as a synthetic gas in food processing. Thus, processed foods exposed to ozone lose their "100% organic" status and must be labeled as "organic" or "made with organic…."[13] However, confusion existed regarding the use of ozone in postharvest activities that do not include processing. USDA issued NOP Guidance 5023, which states that ozone may be used on fresh fruits and vegetables.[14] As with conventional fruits and vegetables, ozone can be used in organic production for sanitizing food contact surfaces.

Conclusions

As with any sanitizer, the selection must be based upon the commodity in question, the microbes to be addressed, the applicable regulations and the sanitizer label information.

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Categories: Food Types: Produce; Regulatory: FDA, USDA; Sanitation: Cleaners/Sanitizers

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