

## Food Safety



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## Food Safety Technology: A Potential Role for Ozone?

Ozone, a form of oxygen commonly associated either with its ability to guard against the sun's harmful ultraviolet radiation or with smog, recently gained approval for use in the U.S. food processing industry to help rid food of dangerous pathogens (bacteria, parasites, fungi, and viruses). In July 1997, ozone was deemed "generally recognized as safe" (GRAS) as a disinfectant for foods by an independent panel of experts sponsored by the Electric Power Research Institute.

For any substance commonly used in the U.S. prior to January 1, 1958, the Food and Drug Administration (FDA) allows its use in other products if an independent panel of experts deems the substance and its use as GRAS. The GRAS determination in treating food products was an expansion of uses already approved for ozone.

Ozone has long been recognized as a disinfectant for water, first used in a U.S. water drinking plant in 1940. Today, nearly 200 municipal water treatment plants, from Orlando to Los Angeles, employ ozone to help cleanse their drinking water. Most bottled water is treated with ozone as well, a practice stemming from a 1982 FDA affirmation of ozone as GRAS in this product.

Prior to July 1997, however, the only approved use of ozone in food products was for the storage of meat in gaseous ozone, granted by USDA in 1957. Now, processors of fresh fruit, vegetables, poultry, and red meat are examining ozone as one of several new technologies to ensure food safety.

### *Potential Benefits*

The strength of the case for using ozone may rest with its versatility and environmental benefits over some existing food sanitizing methods. Ozonated water can be used on food products as a disinfectant wash or spray. When dispersed into water, ozone can kill bacteria—like *E. coli*—faster than traditionally used disinfectants, such as chlorine.

Ozone also kills viruses, parasites, and fungi. The U.S. Environmental Protection Agency, in conjunction with the Safe Drinking Water Act of 1991, confirmed that ozone was effective in ridding water of hazardous pathogens, including chlorine-resistant *Cryptosporidium*.

Coupling two processes—washing food with ozonated water and the subsequent ozonation of the recaptured water—reduces the amount of water needed in the

food washing system (which lowers costs, particularly for high water users such as fruit and vegetable packers and processors). In addition, any wastewater discharged by an ozonation process used as a substitute for conventional chlorine-based food washing and spraying systems, is free of chlorine residuals, a growing environmental concern in groundwater pollution.

Food products treated with ozone are also free of disinfectant residues. Because it is an unstable gas, ozone decomposes in about 20 minutes into simple oxygen, leaving no trace of the ozone disinfectant on the food.

Ozone also acts as a disinfectant in its gaseous state. It can be applied to sanitize food storage rooms and packaging materials, which may help to control insects during storage of foods and prevent spoilage of produce during shipping. Gaseous ozone is also listed as an alternative disinfectant for water-sensitive produce, such as strawberries and raspberries, in the *Guide to Minimizing Microbial Food Safety Hazards for Fresh Fruits and Vegetables* (a document forthcoming from FDA and USDA).

The Electric Power Research Institute is examining the use of ozone as a fumigant in food storage beyond the already approved use for meat. Methyl bromide has commonly been used as a fumigant to

**Ozone** is only one of many food sanitizing ingredients and processes being used, examined, or proposed to improve food safety. Chlorine is the most commonly used chemical to kill pathogens on food, but chlorine dioxide, hypochlorite, and trisodium phosphate also have been studied for use in washwater to disinfect food products. Irradiation of meat, through low-dose radiation or electron beams, was approved by the Food and Drug Administration in December 1997. Steam pasteurization, flash pasteurization, and ultraviolet radiation are additional methods that can sanitize food. Each method has its advantages and disadvantages, and research continues on which methods or combinations of sanitizing processes work best for specific foods.

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prevent insect infestation of commodities such as grapes, raisins, cherries, nuts, and grains, but its use is being phased out under the Clean Air Act (Amendments of 1990). The phaseout prohibits U.S. production and importation of methyl bromide starting January 1, 2001. Interest-ingly, the phaseout is intended to halt the depleting effect of methyl bromide on the Earth's protective ozone layer.

### *Interest in Ozone Systems Builds . . .*

The food processing industry has faced mounting concerns in recent years about its ability to provide a consistently safe food supply. Food passes through many hands—from growing, picking, boxing, shipping, to final processing—prior to reaching the consumer. Most past efforts to avoid contamination of food centered on preventing exposure to sewage or animal manure early in the production process.

Because of the incidence of food contamination along the entire chain of production, and the recognition that many pathogens—some have recently emerged—are found in even healthy animals, the industry has realized that some form of disinfection, perhaps at multiple points, is necessary. Each year in the U.S., an estimated 6.5-33 million illnesses and up to 9,000 deaths are caused by food-borne diseases (*AO* July 1996).

Centuries-old methods of treating food, such as drying, smoking, and use of simple substances like salt, no longer adequately prevent spoilage in today's food marketing system. These methods to prevent contamination can also alter a food's taste.

Food processors have turned to other technologies to both decontaminate and preserve products without substantially changing the appearance, taste, texture, or nutrient content of the food. These methods include steam pasteurization, used principally in meat processing where beef carcasses are exposed to steam for short periods of time; flash pasteurization, a heating process to kill bacteria in juice; and irradiation, which uses low-dose radiation to treat meats, fruits, vegetables, and spices.

As a nonthermal method of disinfecting food, ozonation reportedly alters taste lit-

tle, unlike some heat-based steam and flash pasteurization systems that cook the product. Further, in some foods, ozone proponents indicate flavor is enhanced by ozone's ability to neutralize chemicals, pesticides, and bad tastes from gases produced by ripening or decay.

In 1995, the National Live Stock and Meat Board and various universities conducted research that showed an ozone wash reduced bacterial contamination on beef carcasses to a level equal to conventional carcass trimming and washing methods. (Under specific conditions, hot-water washing, an alternative process, resulted in consistently lower bacterial populations on beef carcasses.) In mid-May 1998, research was completed by California Polytechnic State University which revealed ozone reduced pathogens on surfaces of lettuce, meat, and poultry.

Now that ozone has received a "generally recognized as safe" designation, a few firms have adopted or begun testing ozone-based systems. Recent televised news reports highlighted a Florida citrus grower washing oranges and grapefruit in ozonated water. The Vermont Department of Agriculture is examining the potential of ozone to wash apples used in the apple cider industry.

Industrial gas-producing companies are developing mechanical systems for processing poultry that filter out biological waste material in poultry chiller water and then add ozone to disinfect the washwater. In January 1998, two New York-based companies, one an all-natural chicken processor, announced pilot tests of an ozone system in their processing plants. (Before a firm adopts an ozone system, a pilot test is required by the USDA's Food Safety and Inspection Service—FSIS—conducted under FSIS protocols.) And in April 1998, an agricultural corporation in California contracted to install an ozone system that is intended to replace a combined chlorine wash and steam pasteurization process.

### *. . . But Adoption May Be Slow*

Having achieved GRAS status, will ozone be widely adopted in the food processing sector? As with any new technology, the lack of commercial experience in disin-

*The designation of ozone by an independent panel (i.e., nongovernmental) as "generally recognized as safe (GRAS)" in food processing allows for its use unless proven unsafe by the FDA, the principal government agency that regulates the safety of food ingredients. However, any new uses of a substance, such as the direct application of ozone as a disinfectant on food products, would benefit from formal FDA approval in gaining commercial acceptance. Presently, the FDA has formally approved ozone to treat only one "food" item, bottled water.*

A requirement for GRAS status is that a panel of experts undertake a detailed study of the ingredient and present its findings to the FDA. Panel members are not chosen by the FDA, which does not have a seat on the panel. In the case of ozone, experts from food science, food technology, nutrition, toxicology, and ozone chemistry served on the panel.

fecting food with ozone may hinder its implementation. Although the potential benefits of ozone are being identified, complete industry specifications (e.g., treatment lengths, concentration levels) have not been developed for the application of ozone to the array of foods that may be treated with this technology.

Associated with the lack of commercial specifications is the absence of government guidelines and standards on ozone use in food processing. As most food processing plants are government-inspected, processors are reluctant to use ingredients that are not explicitly government-approved. Further, as ozone is a toxic gas and respiratory irritant, issues of accidental discharge and worker safety are a concern.

And how much will an ozone system cost? Ozone must be produced onsite because of its short life before converting back to oxygen; thus, ozone generators and diffusers are necessary at the food processing plant. According to one manufacturer, ozone generators, which produce the gas by passing dry air or pure oxygen between parallel electrodes, may cost between \$10,000 to \$100,000, depending on the size needed for the processing operation.

The amount of ozone needed to disinfect various foods also figures in the cost equation. Manufacturing ozone requires substantial electricity—about ten times more than for the production of chlorine.


Little cost analysis has been done yet, but based on initial activity in the industry, ozone technology may be economically competitive with other disinfecting processes. Upfront costs are similar for ozone and conventional washing systems, for example, but they are significantly lower than for others such as irradiation. Cost factors for chlorine-based systems, such as transportation and storage of the gas, may offset higher onsite costs for ozone gas production.

Ozonation of water supplies, bottled water, and food is a virtually unknown process to most U.S. consumers. If regulatory and commercial hindrances are resolved, consumer acceptance of ozonation of food may be a final obstacle before food processors adopt ozone technology. Consumers are often slow to accept new products or even traditional products that are manufactured with a new and unfamiliar process. Therefore, most companies are unwilling to be first in offering innovative products, which often require costly marketing efforts.

Consumer preferences may offer some insight about the acceptance of new prod-

ucts. Test market surveys by an independent marketing research firm in early 1998 indicated acceptance of ozonated foods when consumers are knowledgeable of various processing methods. Three food processing methods—existing chlorine rinses, newly approved irradiation, and ozonation—were explained to consumers, who were then asked if they would purchase products treated by these methods. Eighty percent of consumers indicated a preference for products treated with ozone when given the choice of chlorine, irradiation, or ozone processes (other disinfecting processes such as steam pasteurization and hot-water rinses were not included in the survey).

The disinfecting ability of ozone is evidenced by its generally accepted use in treating water supplies in the U.S. and Europe, where the first commercial application of ozone to cleanse drinking water was in France in 1906. However, disinfecting food with ozone is only now emerging. The development of ozone technology in the U.S. food processing industry is dependent upon its economic competitiveness with existing and emerging technologies that sanitize food, proper safeguards in its use to assure worker safety, as well as its effectiveness in enhancing food safety.

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### Upcoming Reports—USDA's Economic Research Service

The following reports will be issued electronically on dates and at times (ET) indicated.

#### June

- 23 *U.S. Agricultural Trade Update*  
(3 p.m.)  
*Free Trade in the Americas\**
- 30 *China\**

#### July

- 13 *Cotton and Wool Outlook*  
(4 p.m.)\*\*
- Feed Outlook* (4 p.m.)\*\*
- Oil Crops Outlook* (4 p.m.)\*\*
- Rice Outlook* (4 p.m.)\*\*
- Wheat Outlook* (4 p.m.)\*\*
- 16 *Livestock, Dairy, & Poultry*  
(3 p.m.)
- 20 *Agricultural Outlook\**
- 23 *U.S. Agricultural Trade Update*  
(3 p.m.)  
*Vegetables and Specialties Yearbook\**

\*Release of summary, 3 p.m.

## Food Safety and Fresh Fruits and Vegetables

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Find out in the  
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