THAI FREEZE DRY
COMPANY LIMITED

OZONE ANTIMICROBIAL TREATMENT

Time Tested and Approved: As part of TFD's permanent commitment to improve our products, service and food safety we have implemented a state-of-the-art ozone antimicrobial treatment system. Ozone has been used for many years around the world. It has been in practical use since 1893, used in water treatment as early as 1906, and now used in over 2,000 water treatment plants worldwide including more than 40 municipal water treatment plants in the U.S.A. (1) Ozone use in food processing has been accepted in France, Japan, Australia, U.S.A. and other countries for many years.

Ozone has been approved by the U.S.A. F.D.A. as an antimicrobial agent for the treatment, storage, and processing of foods (approval published June 26, 2001 with GRAS approval for direct contact on food by FDA Final Rule 21 CFR Part 173.336)

On Dec. 21, 2001, the U.S. Department of Agriculture's Food Safety and Inspection Service (USDA/FSIS) approved the use of ozone in food processing. In addition to direct contact disinfection of foods, ozone also can be applied to food processing equipment and non-food contact surfaces as part of a food company's sanitation protocol.

Thai Freeze Dry's water system employs a reverse osmosis process to insure the purity of all water used in our factory, but ozone adds a strong antimicrobial function. Should agricultural products come to us having microbial contamination from the fields or acquired during transport, this system should solve the problem. Aqueous ozone will be used in the product chamber during Thai Freeze Dry's proprietary Cellular Fraction-Line premium freeze dry process to treat not only the surface of the product, but the entire product as it breaks up into a fine powder inside the product chamber.

Ozone will also be used for cleaning equipment and for general cleaning of Thai Freeze Dry's factory including food contact surfaces. Ozone is used to its fullest potential in GMP and HACCP plans to reduce food safety risks in the environment surrounding food production, packaging and storage. Ozone has a 50% stronger oxidation rate with a bacteria kill rate over three times faster than chlorine.

Natural and Safe: Ozone is the natural and safest method to provide effective antimicrobial treatment. Extreme heat destroys the integrity of the product and irradiation affects healthy cells, alters the food's chemistry, and (used at approved levels) will not destroy all bacteria present or sterilize food. Surviving spoilage organisms can multiply and grow, and cross contamination resulting from airborne viruses and bacteria can occur. Gamma Radiation has strong negative connotations whether you believe it is harmful or not. The scientific community recognizes ozone as the most effective natural antimicrobial and antiviral of all disinfecting agents. In addition the ozone treatment extends the shelf-life of our products even beyond the shelf-life achieved by our Cellular Fraction-Line premium freeze dry process which results in exceptionally low moisture levels.

Ozone occurs in nature and plays an important role in protecting the environment. Oxygen is released from plants and plankton during photosynthesis. Lighter than air it floats into the upper atmosphere where contact with ultra violet (UV) radiation from the sun and/or lightening during thunderstorms results in O3 (Ozone). Ozone is heavier than air and falls into the lower atmosphere where it oxidizes pollutants and contamination in the air.   When ozone contacts water vapor hydrogen peroxide forms. This is a large part of the reason why plants flourish better with rainwater than with irrigation water. The U.S.A. EPA states that natural ozone background concentration levels at sea level measure 0.03 – 0.05 ppm and can be higher at higher altitudes. Naturally occurring ozone is nature's way of cleaning up the pollution in our environment and safely and naturally purifying the air we breathe.

Ozone is one of the most effective antimicrobial treatments applicable to food processing, yet it leaves no hazardous residues on food or food-contact surfaces. It auto-decomposes rapidly to oxygen adding no residues or chemical by-products to the food being treated or to the food processing water or atmosphere in which the food is produced and stored. Ozone (life span about 20-30 minutes) does not become part of the food product and therefore is not considered an "additive." Just as in nature, it does its work and then disappears (reverts to oxygen). Ozone does not poison microorganisms, but rather, destroys them by oxidation. Microorganisms cannot build up resistance to oxidation.

Scientifically Validated: Ozone inactivates microorganisms rapidly by reacting with intracellular enzymes, nucleic material and components of their cell envelope, spore coats, or viral capsids.

Cell Envelopes: Ozone may oxidize various components of cell envelopes including polyunsaturated fatty acids, membrane-bound enzymes, glycoproteins and glycolipids leading to leakage of cell contents and eventually breaking down the cell membranes. (2) Scott and Lesher 1963;(3) Murray and others 1965. Ozone acts on bacterial cell membranes by oxidation of their lipids and lipoproteins altering multiple chemical bonds into incompatible configurations that can impair bacterial procreation (Ishizaki 1987).(4)

Bacterial spore coats: Foegeding (1985) found that Bacillus cereus spores were rapidly inactivated by ozone due to removal of coat proteins.(5)

Enzymes: Ozone acts as a general protoplasmic oxidant destroying the dehydrogenating enzyme systems in the cell. Ingram and Haines (1949) proposed that ozone kills E. coli by interfering with its respiratory system. (6)

Nucleic material: Aqueous ozone damages nucleic material inside the cell.

DNA Fragmentation: Ozone opens the circular plasmid DNA and reduces its transforming ability, producing single- and double-strand breaks in plasmid DNA (Hamelin 1985),(7) Fragmented DNA will prevent cell duplication and reproduction.

Viruses: Viruses, unlike mammalian cells, have no enzymatic protection against oxidative damage. Sproul and Kim (8) and CK Kim and others (9) found that aqueous ozone inactivated bacteriophages by attacking capsid protein. Yoshizaki and others (10) and Shriniki and others (11) concluded that the major cause of tobacco mosaic virus inactivation by ozone was the inability of the treated virus to uncoat. Damage to viral envelopes is the main cause of inactivation of viruses by ozone. Analysis of viruses showed damage to polypeptide chains and envelope proteins that impaired viral attachment capability as well as breakage of viral RNA and damage to the viral protein capsid (Riesser 1977) (12). Lipid-enveloped viruses are particularly damaged by ozone, suggesting that lipid alteration is a salient mechanism for viral death.

Pathogens Ozone is Commonly Used to Inactivate

- Salmonella enteritidis
- E.coli O157:H7
- Listeria monocytogenes
- Shigella dysenteriae
- Micrococcus aureus
- Clostridium botulinum
- o Mycobacterium tuberculosis
- o Bacillus anthracis
- o Streptococcus sp
- Molds
- o Botrytis
- o Rhizopus
- o Penicillium
- o Aspergillus

Healthy cells have enzyme coatings protecting them from oxidation by free radicals. These enzymes constitute our endogenous antioxidants: catalase, reductase, superoxide dismutase and glutathione. Ozone distinguishes between friends and foe attacking only invading pathogens and cells that have been damaged or infected (having lost all or part of their enzyme coatings). It will destroy microbes that have no enzyme coating and it will destroy cells damaged or infected that have lost their enzyme cell wall coating. Healthy cells will not be damaged or destroyed.

Immediately after the ozonated water treatment Thai Freeze Dry's products are processed by Cellular Fraction-Line Technology , packaged in vacuum sealed bags, and stored in master cartons for full protection and long shelf-life.

End notes:

1. http:// www.familyhealthnews.com/articles-useful-appliction of ozone.html : p. 9/9
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4. Sunnen, Gerard 2009, “Ozone Enters Its Age of Enlightenment: Ozone therapies today and tomorrow” paper presented at the AEPROMO International Congress, Ponteverde Gallacia, Spain, June 5-6, 2009.
5. Foegeding PM. 1985. Ozone inactivation of Bacillus and Clostridium spore population and the and the importance of spore coat resistance. Food Microbial 2:123-134.
6. Ingram M, Haines RB. 1949. Inhibition of bacterial growth by pure ozone in the presence of nutrients. J Hyg 47:146-158.
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9. Kim CK, Gentile DM, Sproul OJ. 1980. Mechanism of ozone inactivation of bacteriophage f2l Appl Environ Microbial 39: 210-218.
10. Yoshizaki T, Miura K, Ueda T. 1988. Mechanism of inactivation of tobacco mosaic virus with ozone. Water Res 22(7):933-938.
11. Shriniki N., Ishizaki K.,Yoshizaki T., Miura K., Ueda T. 1988. Mechanism of inactivation of tobacco mosaic virus with ozone. Water Res 22(7):933-938.
12. Riesser V, Perrich J, Silver B, McCammon J. Possible mechanism of poliovirus inactivation by ozone. In: Forum on Ozone Disinfection. Proceedings of the International Ozone Institute. Syracuse, NY, 1977:186-192