Ultrasound Disinfection

High Power Ultrasound (HPU) refers to soundwaves generated at high power and low frequencies (20 to 100 kHz). Several studies have shown HPU to be an effective antimicrobial agent with potential use for disinfecting produce and food containers [27]. Sound waves are generally considered safe, non-toxic, and environmentally friendly.

During ultrasound applications, thousands of microbubbles are generated in liquid surrounding the produce. The gas within the microbubble is heated to a high temperature (up to 5500 C) and pressure (up to 50,000 kPa), with fluctuations occurring in microseconds. When the bubbles collapse, the generated shockwaves are strong enough to shear and break the cell wall and membrane structures of pathogens [13]. This process is called cavitation and is depicted in Figure 7. The components of the microbial cells are disrupted by the transfer of kinetic energy generated by ultrasound waves. This energy can disintegrate solids and remove layers of material from surfaces and porous interior structures, kill microorganisms, and prevent undesirable materials from adhering to solid surfaces [28].

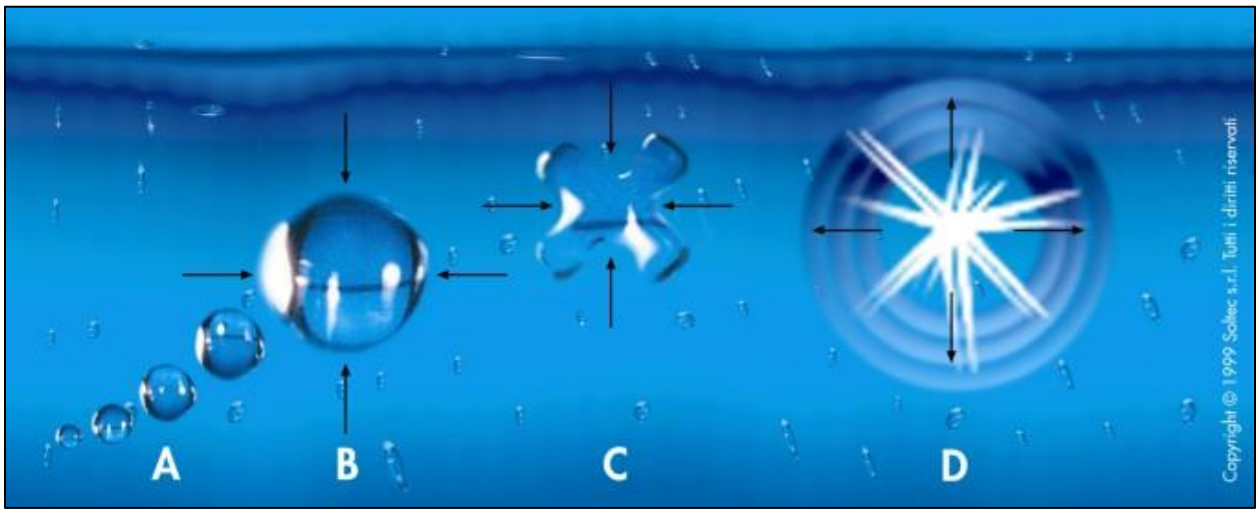

Figure 7: Ultrasound cavitation process, copyright @Saltec S.R.L

Furthermore, the localized temperature increase within a collapsing bubble generates primary hydroxyl radicals. Ultrasonic applications accelerated single electron transfers, which results in hydrogen atoms and hydroxyl radicals recombining to form hydrogen peroxide (H2O2), which has important bactericidal properties. The hydroxyl radical is also able to react with the sugar-phosphate backbone of DNA, which results in the breakage of microbial DNA [13].

Ultrasound treatment was found to provide a 4.4 log reduction of *E coli* count in wash water [27]. In many cases, foodborne outbreaks can be traced back to contamination of wash water. Implementation of ultrasound tech could help avoid this issue. High power ultrasound treatment (patented as Sonoxide) has been used in over 600 applications worldwide for

controlling bacteria and algae in industrial water systems [27]. In addition, HPU has been used in the wine industry since 2006 for the removal of microbiological contaminants and tartrate build-up from wine barrels. The Tom Beard barrel washer operates by filling wine barrels with water and sonicating the interior for 5-12 minutes [28].

A key factor inhibiting the adoption of HPU disinfecting is the lack of case-studies and proofs-of-concept in a real industrial environment. Much more research and testing is necessary to prove whether ultrasound can be an effective replacement for traditional disinfection methods. As of the writing of this paper, there are no companies that currently offer ready-to-go technology for the disinfection of produce via ultrasound treatments. One organic lettuce packaging facility (Earthbound, in California) successfully implemented ultrasonic cleaning [29] in their facility, and the University of Patras in Greece determined that ultrasound can disinfect lettuce and strawberries to a level comparable to chlorine and hydrogen peroxide without affecting the product in any way [30].

Savings:

Though ultrasound disinfection technology is not developed enough for full-scale implementation, it certainly appears to have potential to reduce the amount of water necessary to disinfect produce.

References

[13] S. E. Bilek and F. Turantaş, “Decontamination efficiency of high power ultrasound in the fruit and vegetable industry, a review,” Int. J. Food Microbiol., vol. 166, no. 1, pp. 155–162, Aug. 2013.

[27] D. M. Sango, D. Abela, A. McElhatton, and V. P. Valdramidis, “Assisted ultrasound applications for the production of safe foods,” J. Appl. Microbiol., vol. 116, no. 5, pp. 1067–1083, May 2014.

[28] V. Jiranek, P. Grbin, A. Yap, M. Barnes, and D. Bates, “High power ultrasonics as a novel tool offering new opportunities for managing wine microbiology,” Biotechnol. Lett., vol. 30, no. 1, pp. 1–6, Nov. 2007.

[29] “Sound Barrier: Can High-Power Ultrasound Protect Produce from Pathogens? - Scientific American.” [Online]. Available: https://www.scientificamerican.com/article/ultrasound-to-protect-produce-from-pathogens/. [Accessed: 03-Apr-2018].

[30] A. Birmpa, V. Sfika, and A. Vantarakis, “Ultraviolet light and Ultrasound as non-thermal treatments for the inactivation of microorganisms in fresh ready-to-eat foods,” Int. J. Food Microbiol., vol. 167, no. 1, pp. 96–102, Oct. 2013.