Non-Thermal Processing Technologies to Inactivate Foodborne Viruses

Alvin Lee, Ph.D.
Center Director / Associate Professor
Center for Processing Innovation
Institute for Food Safety and Health

Food Processing and Technology
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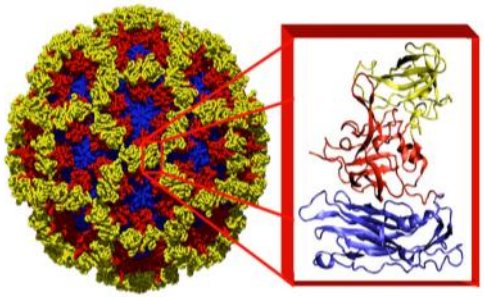
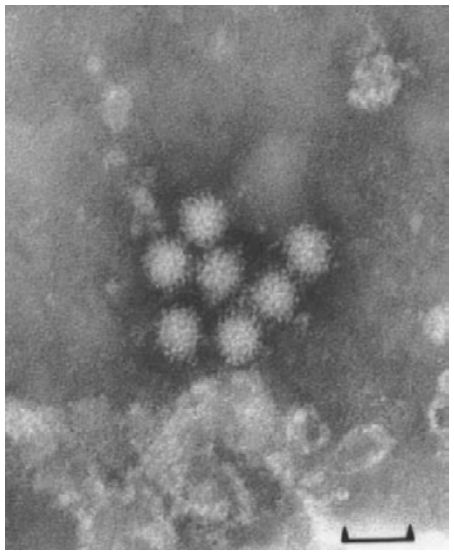
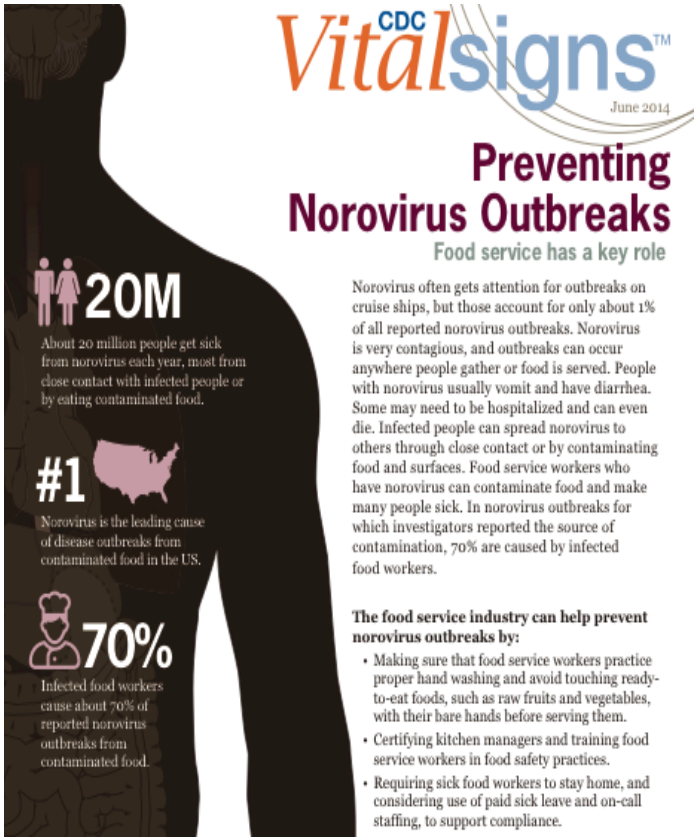
Norovirus

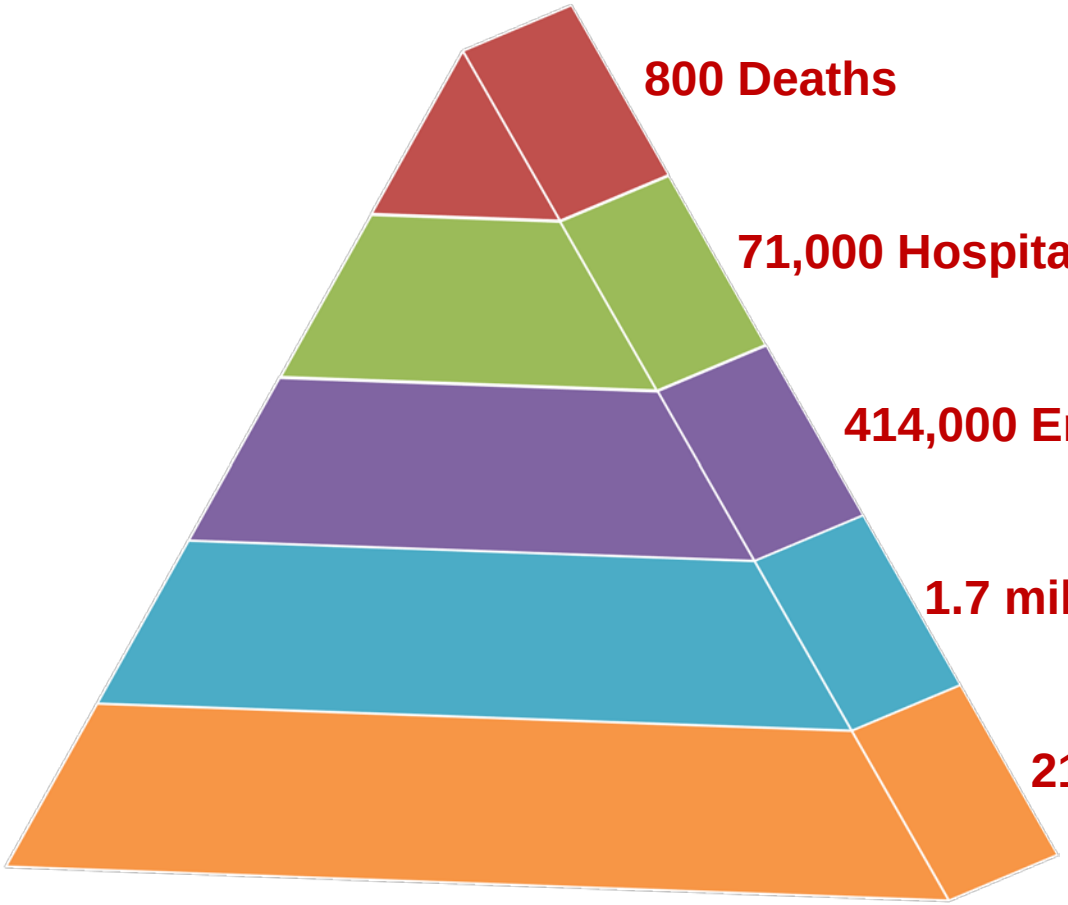
- Transmission via human feces and vomit
  - 30 million virions shed in one vomiting episode
- Infectious dose very low – 2-100 virions
- Incubation period 24-40 hours
- Symptoms: Nausea, vomiting, diarrhea, cramps, occasional headache and low-grade fever
- Duration: 1-2 days





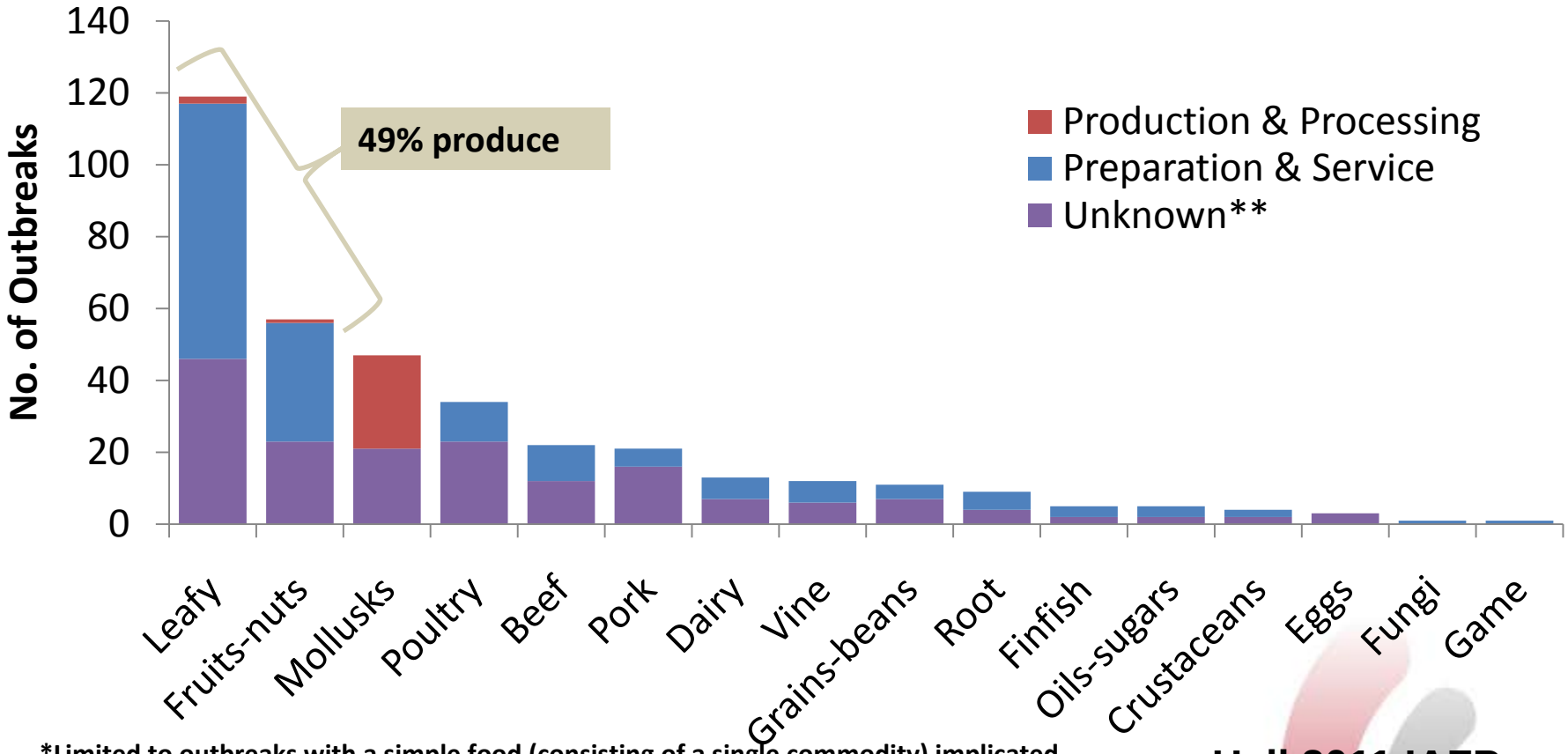


Annual Burden of Norovirus Disease in the United States



Hall 2012 CID; Lopman 2011 CID; Gastañaduy 2012 EIS; Hall 2011 EID; Scallan 2011 EID

Foods Implicated* in Norovirus Outbreaks Reported to CDC by Commodity and Point of Contamination, 2001-2008



*Limited to outbreaks with a simple food (consisting of a single commodity) implicated.

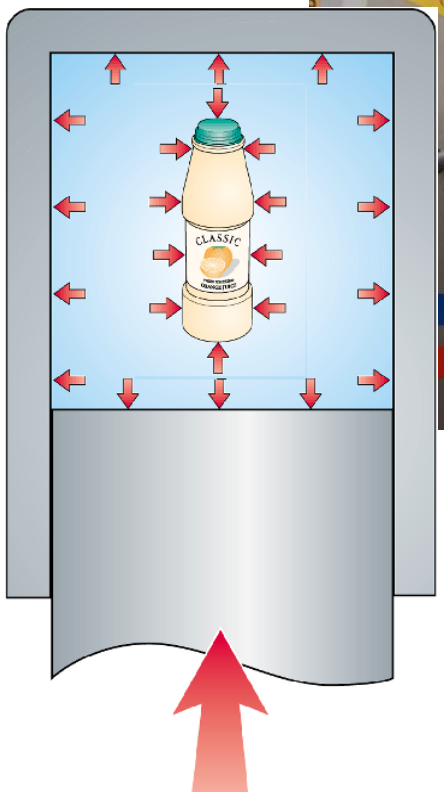
**Insufficient or conflicting information provided in outbreak report.

Hall 2011 IAFP

Intervention/Mitigation Strategies

- Depuration and Relaying
- High Powered Ultrasound
- High Pressure Processing
- Thermal/Heat – Cooking and Pasteurization
- Non-thermal Plasma
- Irradiation
- Freezing
- Drying
- Pulsed Light including UV
- Shockwaves

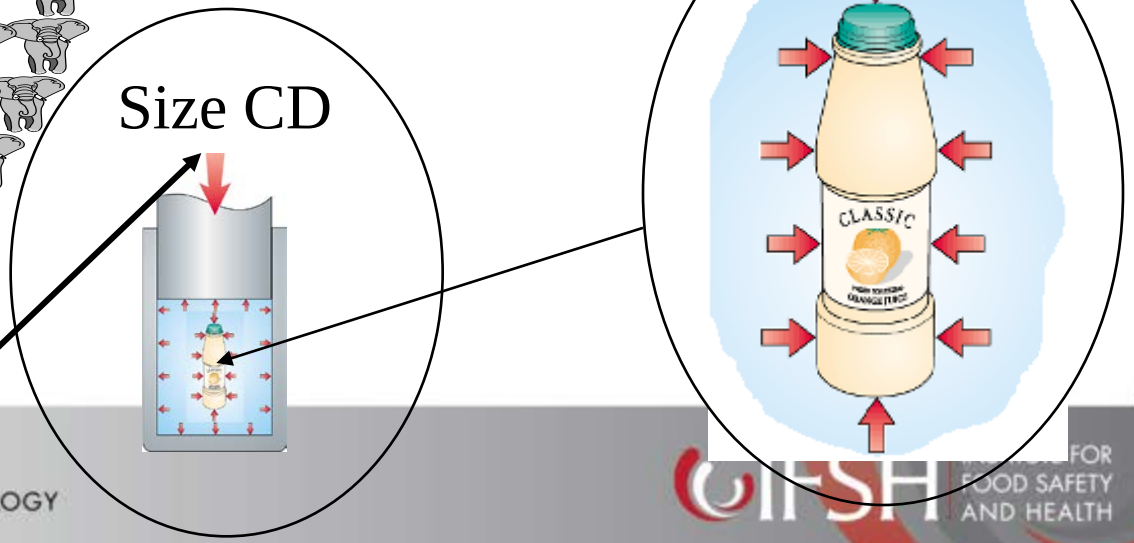
High Pressure Processing (HPP)



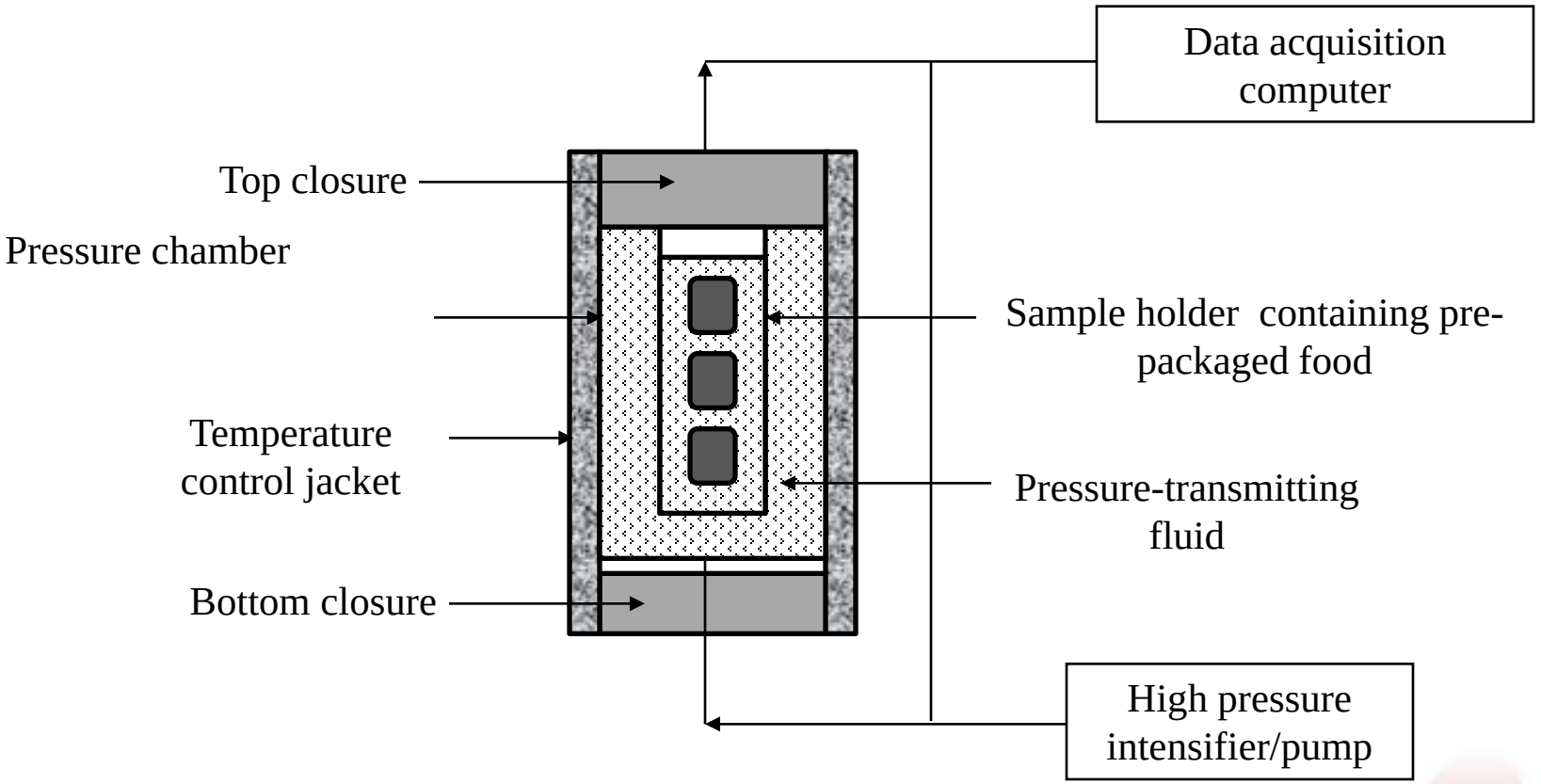
24 L High Pressure Sterilization Unit
Max: 890 MPa @ 131˚C

High Pressure Processing for Food Applications

200 elephants weighing 3000 kg each standing on a piston with a diameter of a CD, create a pressure of 600 MPa, 6000 bar or 90,000 psi



Schematic diagram of a HPP system

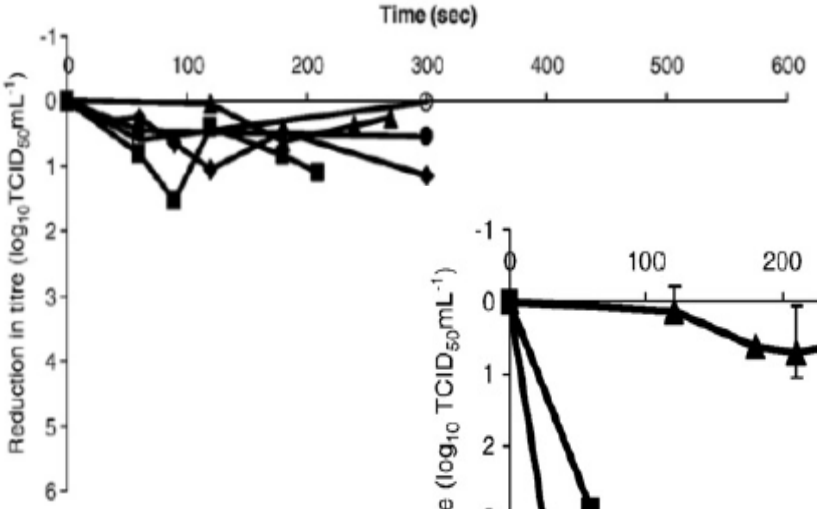


Distribution of study subject infection status among oyster treatment groups in a HPP challenge study

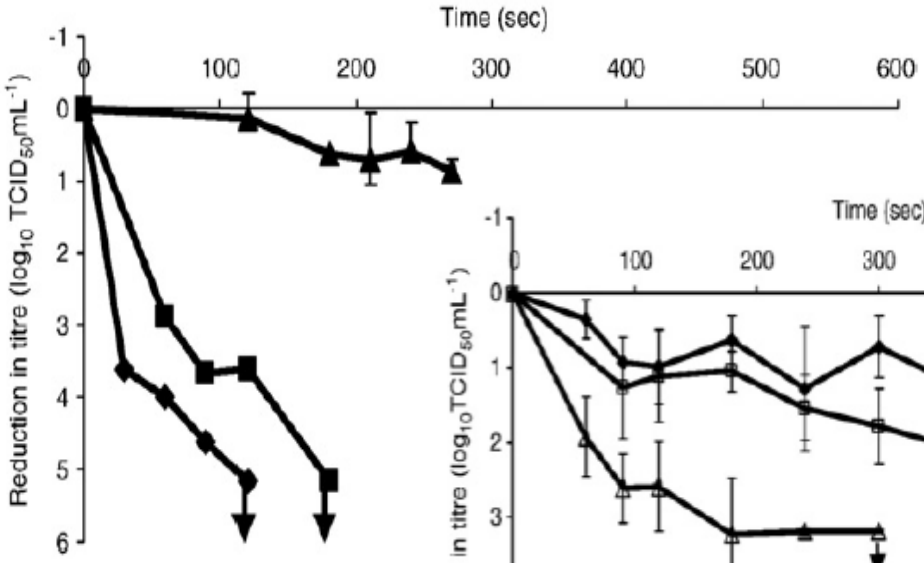
Phase	Treatment conditions	No. of subjects infected/ total (%) postchallenge with:		*P* value[b]
		HPP-treated oysters	Untreated oysters[a]	
1	400 MPa, 25°C, 5 min	3/5 (60)	7/15 (47)	1.0000
2	600 MPa, 6°C, 5 min	0/10 (0)	7/15 (47)	0.0202
3	400 MPa, 6°C, 5 min	3/14 (21)	7/15 (47)	0.2451

Leon *et al*., 2011, AEM (77) 5476-5482

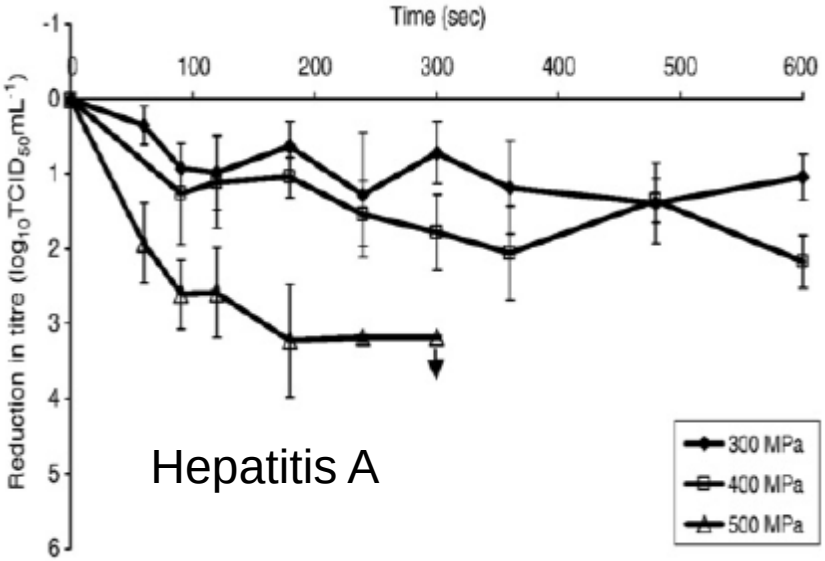
High Pressure Processing and Viruses



Poliovirus



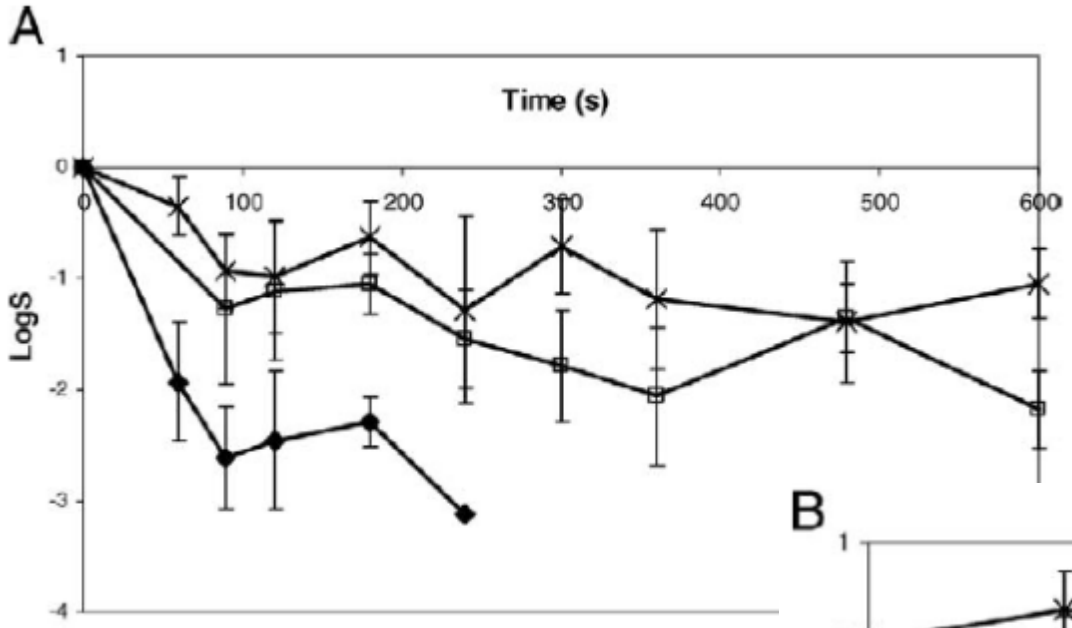
Feline Calicivirus

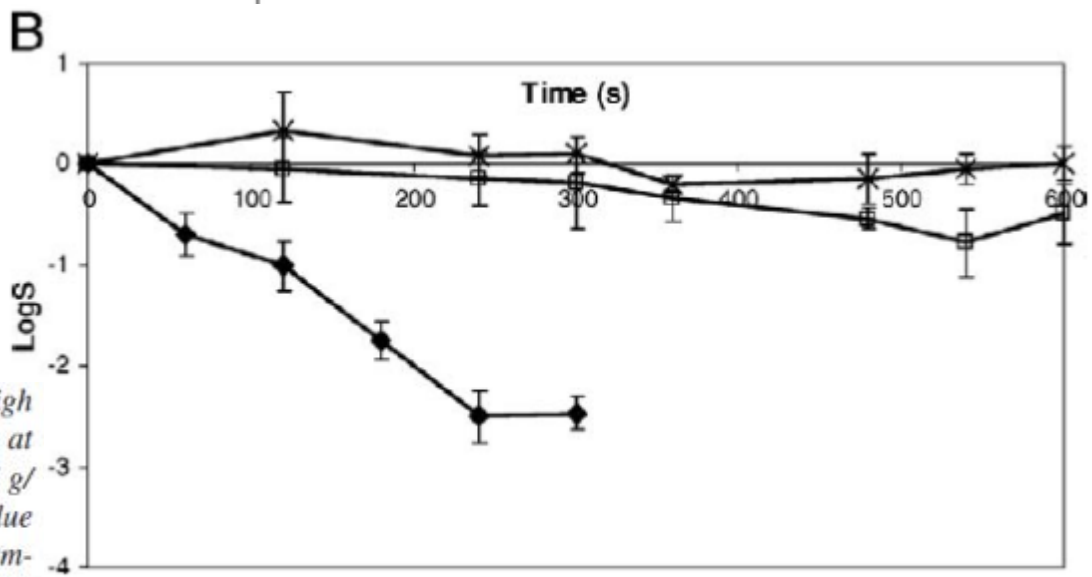


Hepatitis A

Grove *et al*., 2008

HPP and Hepatitis A in various salt



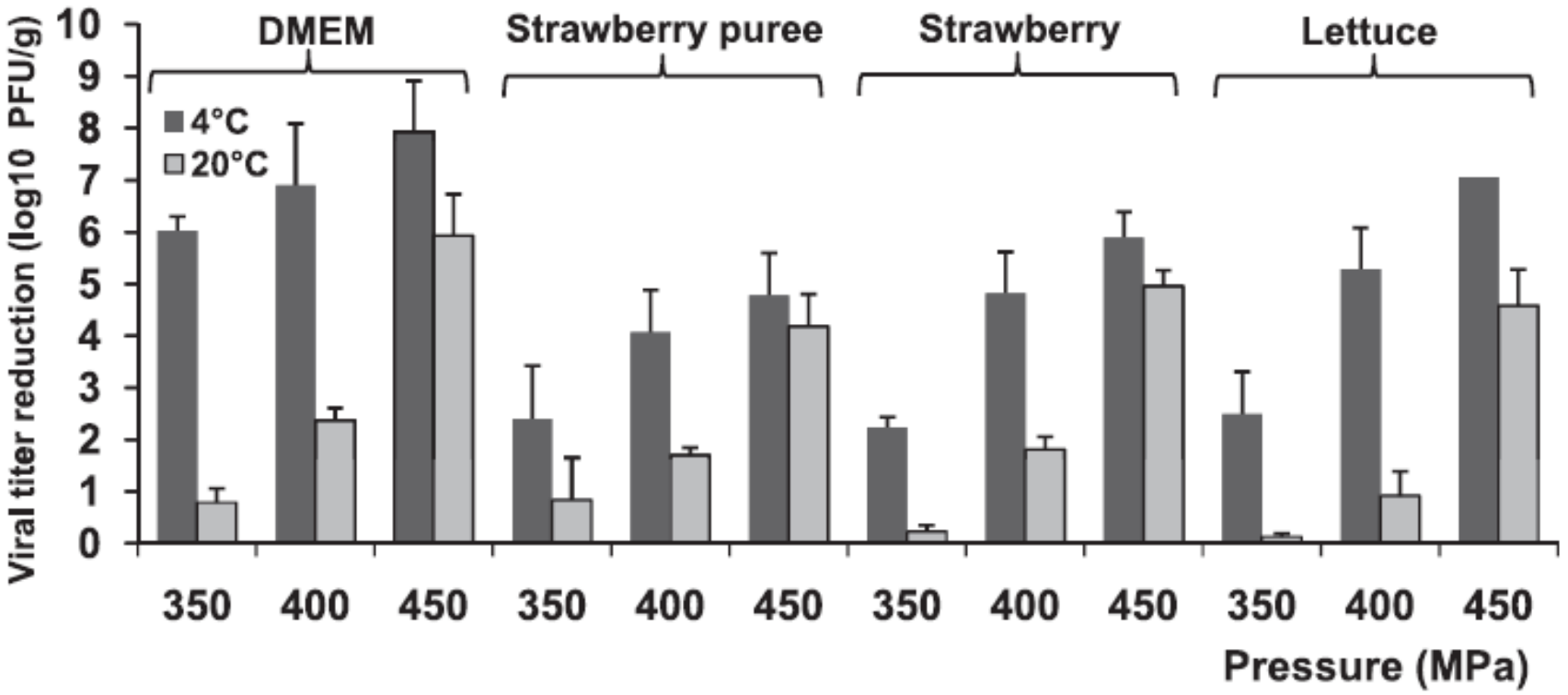


300, 400 & 500 MPa in 15 & 30 ppt salt

FIGURE 1. *Survival curves of hepatitis A virus (HAV) after high pressure treatment with 300 (×), 400 (□), and 500 (◆) MPa at room temperature in buffered medium containing salt at (a) 15 g/liter and (b) 30 g/liter. Each data point is the average log S value of triplicate quantitative assays for duplicate or triplicate samples. No infectious HAV was detected (<1.47 log $TCID_{50}$/ml) after 500 MPa treatment for 300 s in medium with 15 g/liter salt or for 360 s in 30 g/liter salt. Modified from Grove et al. (15).*

Grove et al., 2009

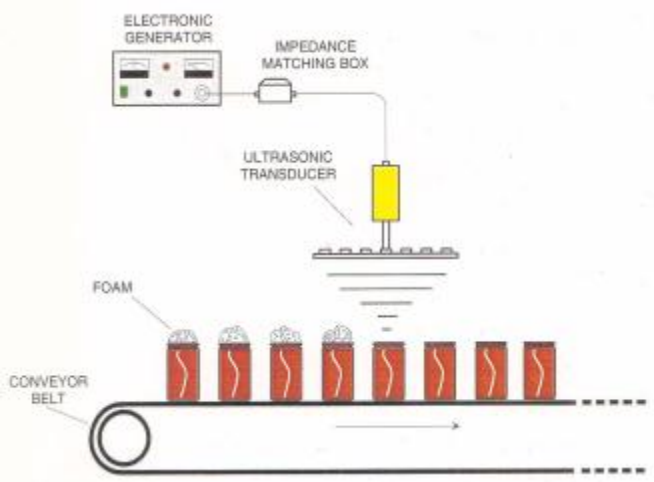
MNV-1 inactivation by HPP in various food matrices

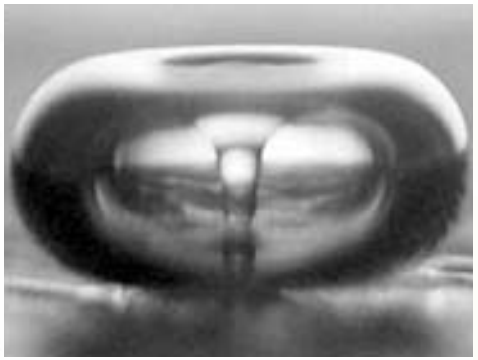


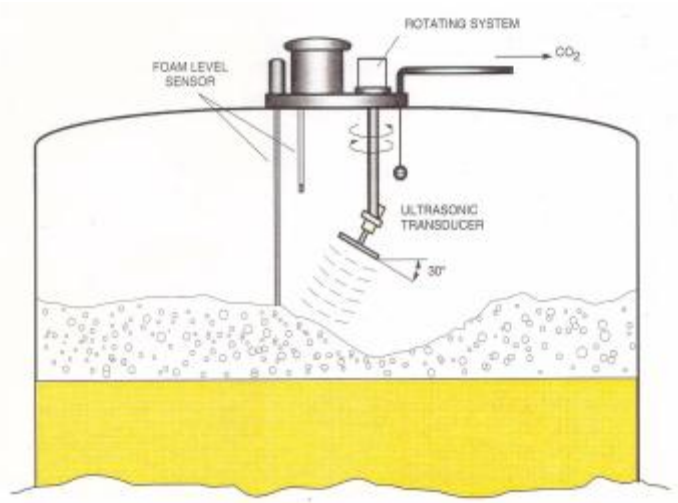
Lou *et al*., 2011, AEM 77(1862-1871)

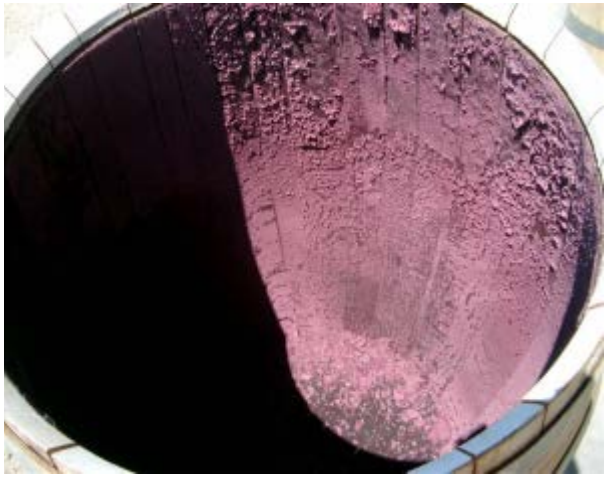
More at IAFP 2014, Indianapolis

High Power Ultrasound





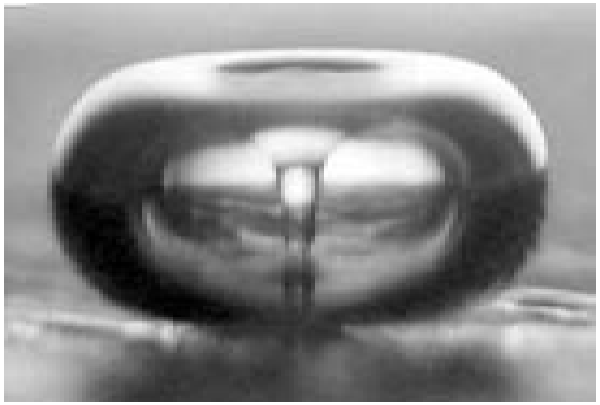




High-Power Ultrasound

Ultrasonic waves form bubbles via expansion and contraction
- Termed ‘Cavitation’

- Temperature 5000 k (4700°C)
- Pressure 2000 atm (30,000 PSI)
- Frequency ~20 kHz



20 kHz — 100 kHz — 1 MHz

Acoustic

Human hearing

Low & High Power Ultrasound

Industrial & agricultural cleaning

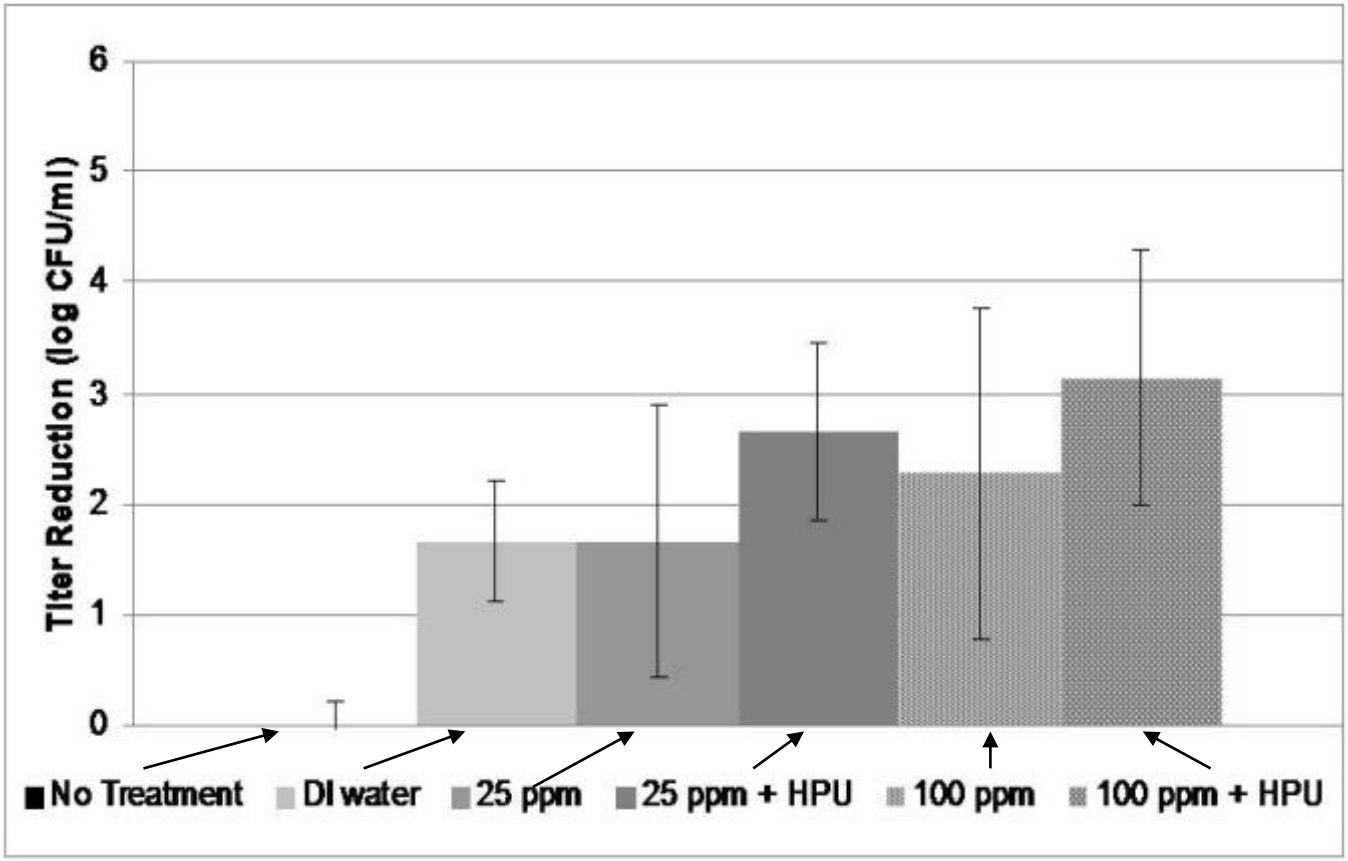
High Frequency Ultrasound

Medical uses

High Power Ultrasonic Transducer and Sonotrode

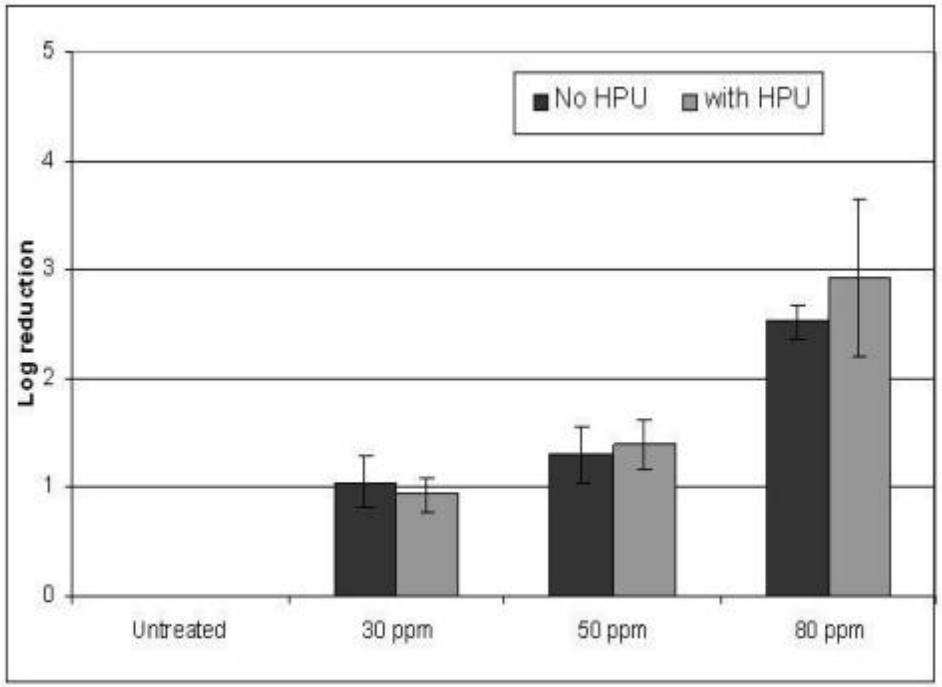
HPU and Produce Washing

Chlorine with High Power Ultrasound on Murine Norovirus (MNV-1)

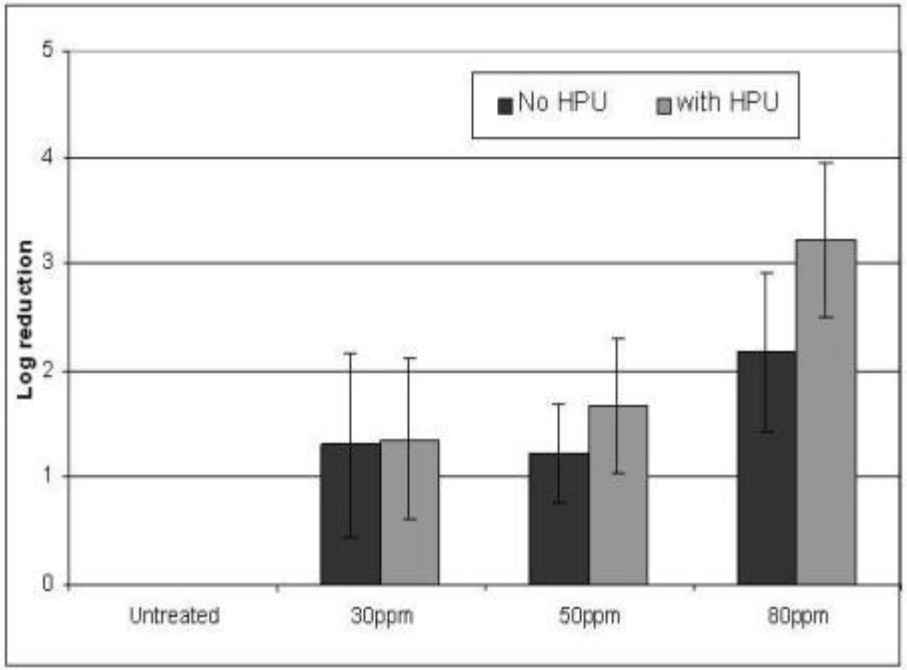


Liu, Grove and Lee, 2009

Sanitizers – POAA on MNV-1



(a)



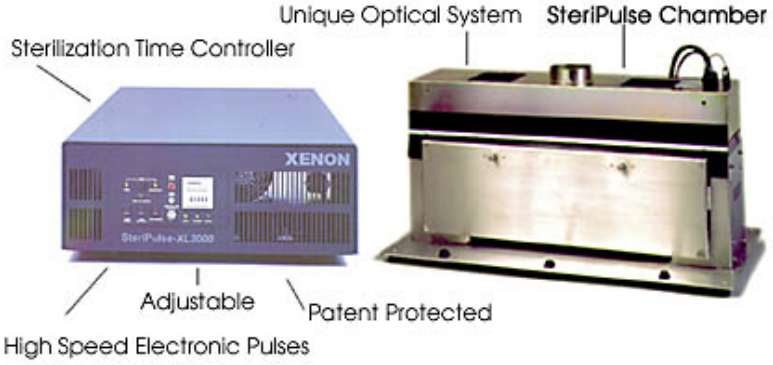
(b)

Log reduction of MNV-1 washed from the surface of inoculated romaine lettuce leaves after treatment with peroxyacetic acid (POAA) alone or with additional high power ultrasound (HPU) at (a) 4° C or (b) 10° C.

Liu, Grove and Lee, 2009

Pulsed Light

Pulsed light is a food processing method that involves the use of intense and short duration pulses of a broad spectrum.



Xenon Steripulse XL-3000TM pulsed light system
1.27J/cm², 3 pulses/second

Pulsed Light

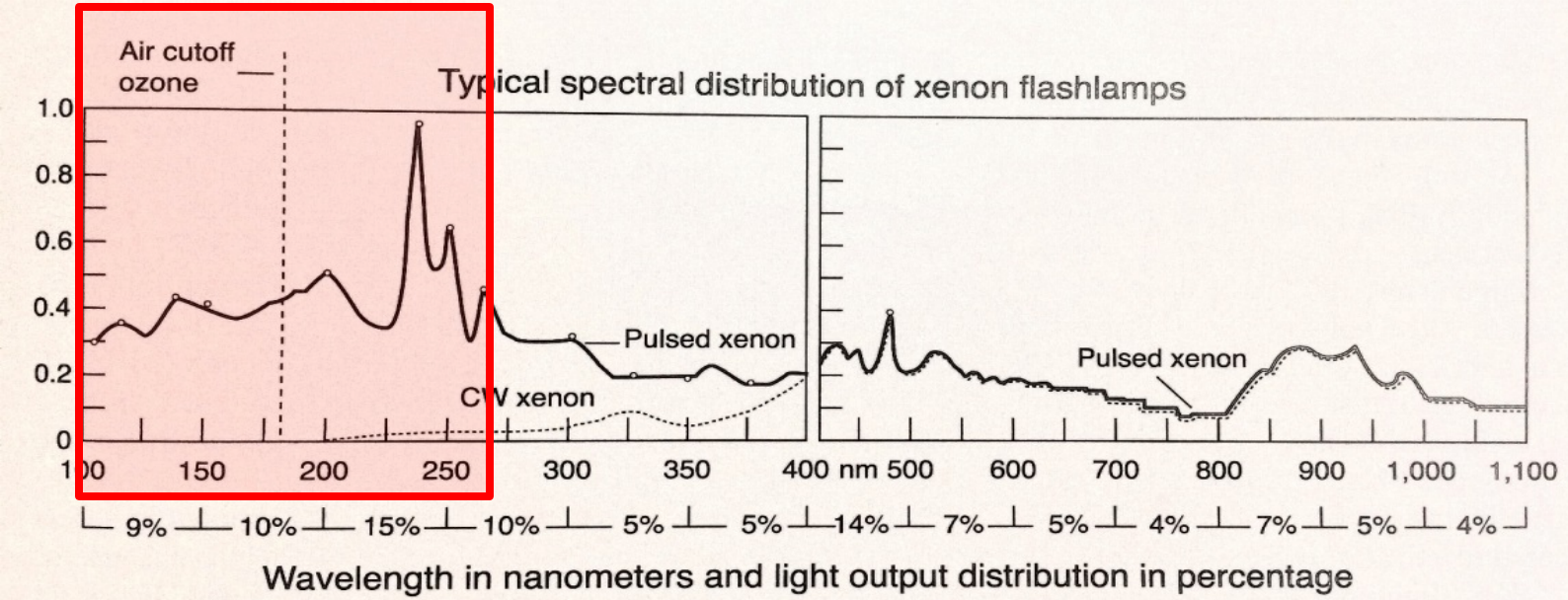


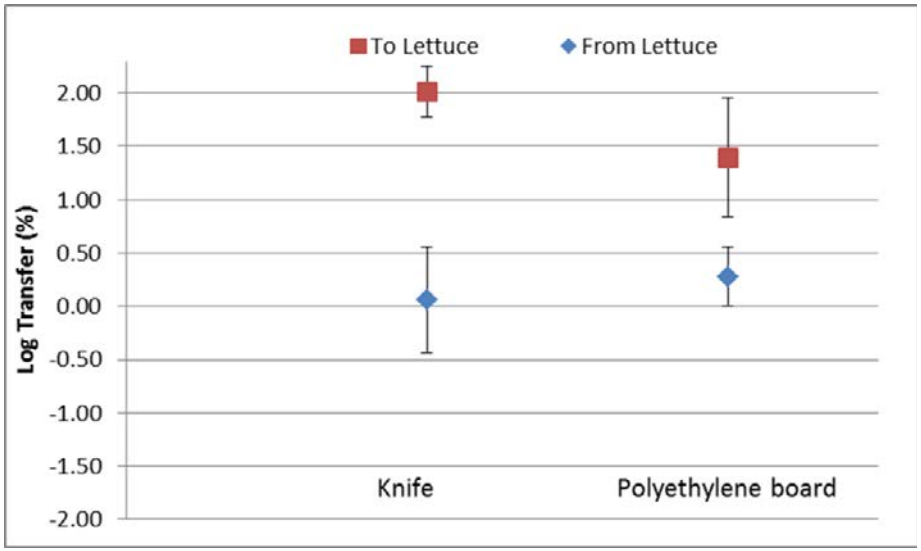
Figure 18.1. Spectral distribution of pulsed UV light (Xenon, 2003).

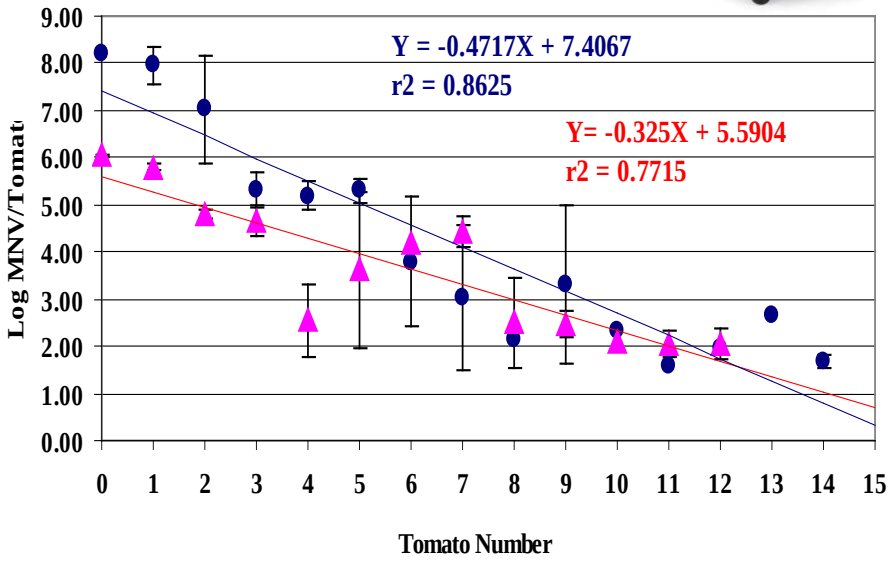
- Broad spectrum(100-1000nm) includes 54%, 26% and 20% of the energy at UV light, visible, and infrared region, respectively.
- Inactivation of pathogenic and spoilage microorganisms on foods and packages **(surface)**

MNV-1 Transfer during Chopping

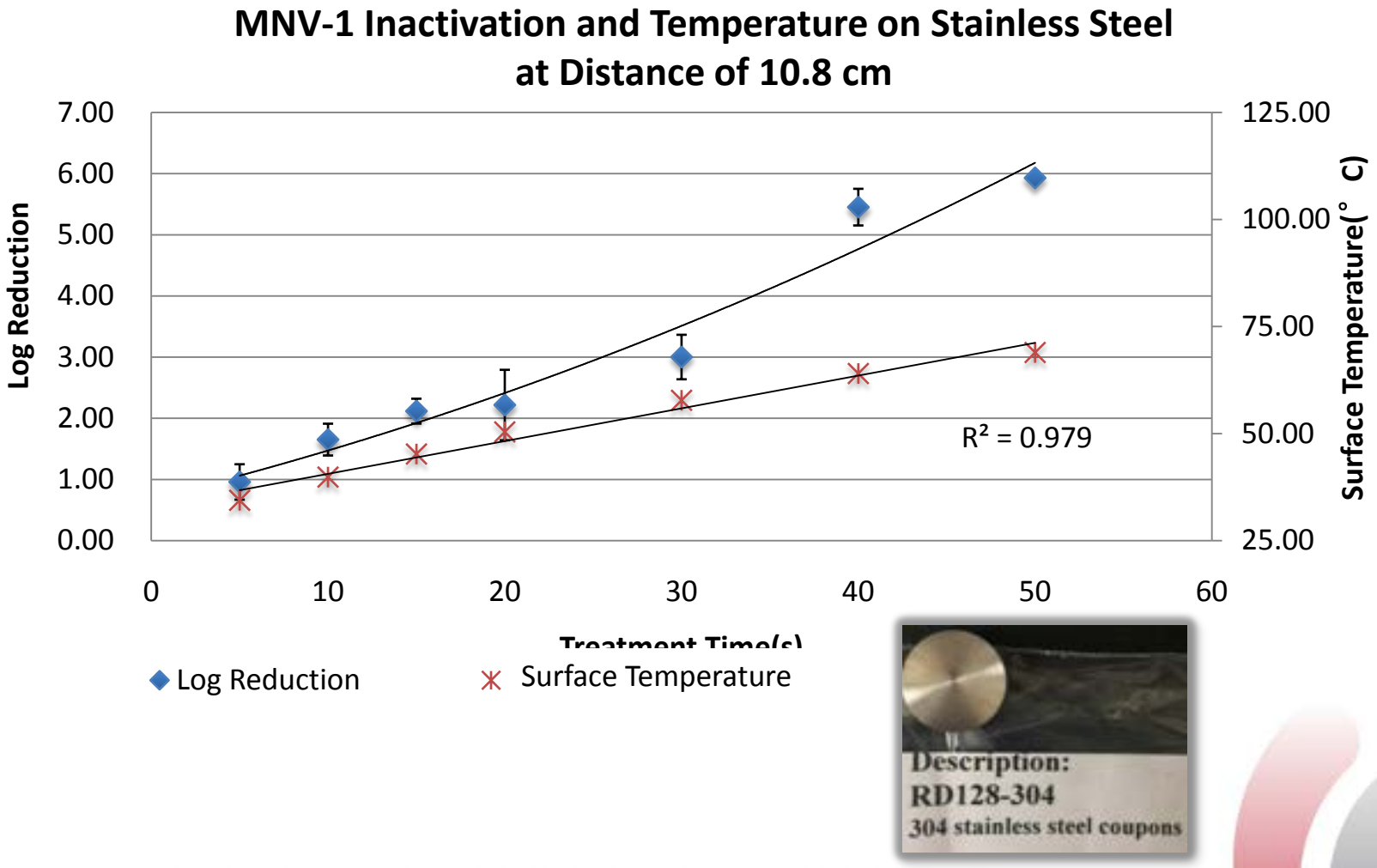
Polyethylene Board

Knife

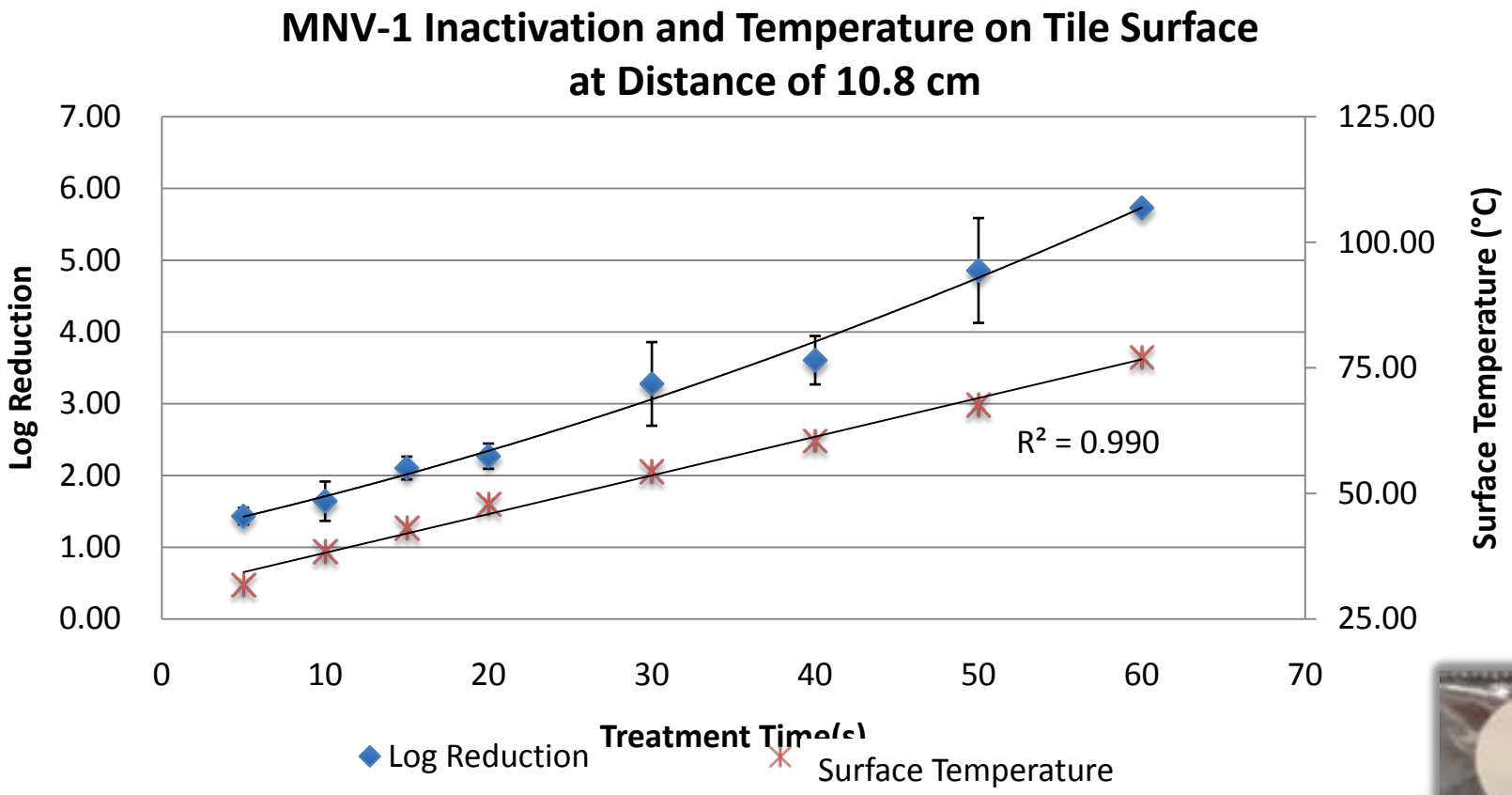




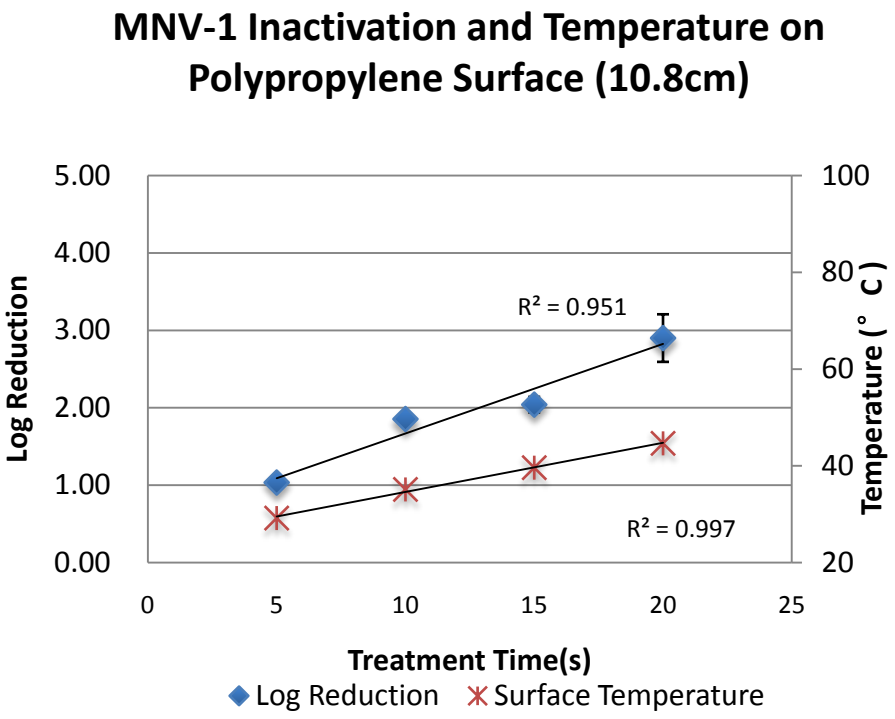
Pulsed Light on Stainless Steel

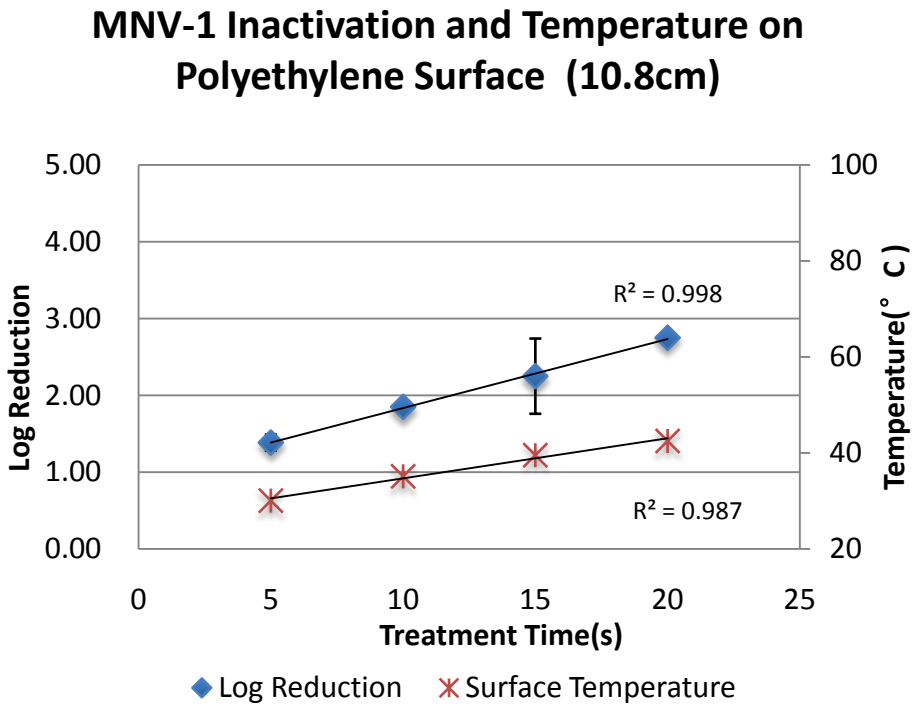


Pulsed Light on Glazed Tile



Pulsed Light on Plastic





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Keeping Food Virus-Free
Collaborative for Outreach, Research & Education

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Thank you
&
Questions