Developments and Optimization of Non-Thermal Technologies for Viral Inactivation

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Large multistate outbreak of norovirus gastroenteritis associated with frozen strawberries, Germany, 2012

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Surveillance and outbreak reports

Norovirus: Facts for Food Handlers

Norovirus is highly contagious. It can make you very sick with diarrhea, throwing up, and stomach pain. Anyone who works with food should know about this virus.

Foods contaminated with norovirus can make people sick

Norovirus is a leading cause of illness from contaminated food in the United States. The virus can easily contaminate food because it is very tiny and infective. It only takes a very small amount of virus particles (less than 100) to make someone sick. Food can get contaminated with norovirus when—

- Infected people who have vomited or are throwing up touch the food.
- It is placed on counters or surfaces that have infectious stools or vomit on them, or
- Tiny drops of vomit from an infected person spray through the air and land on the food.

Foods can also be contaminated at their source. For example:

- Oysters that are harvested from contaminated water, or
- Fruits and vegetables that are contaminated in the field.

Food handlers with norovirus illness can spread the virus to others

People who have norovirus illness can shed billions of norovirus particles.

You are most contagious—

- when you are sick with norovirus illness, and
- during the first 3 days after you recover.

If you work with food when you have norovirus illness, you can spread the virus to others. You can easily contaminate food and drinks that you touch.

People who consume the food or drinks can get norovirus and become sick. This can cause an outbreak.

Outbreaks of norovirus illness occur in nursing homes, hospitals, restaurants, cruise ships, schools, banquet halls, summer camps, and even at family dinners. These are all places where people often eat food handled or prepared by others.

About 50% of all outbreaks of food-related illness are caused by norovirus.

Food Safety News

Breaking news for everyone's consumption

Report: Largest Outbreak in German History Caused by Imported Strawberries

By News Desk | February 28, 2015

Research articles

Food-borne diseases associated with frozen berries consumption: a historical perspective, European Union, 1983 to 2013

L Tavoschi (Lara.Tavoschi@ecdc.europa.eu), E Severi, T Niskanen, F Boelaert, V Rizzi, E Liebana, J Gomes Dias, G Nichols, J Takkinen, D Coulombier

Townsend Farms organic frozen berries from Costco and Harris Teeter linked to hepatitis A outbreak

Marler Clark has filed 17 lawsuits in connection with the Townsend Farms frozen berry hepatitis A outbreak: 8 individual lawsuits on behalf of people who contracted hepatitis A and a class action lawsuit on behalf of all people who required vaccination against hepatitis A to prevent infection.

At least 164 people fell ill with hepatitis A infections after eating frozen mixed berries purchased from Costco across seven states in November.
Intervention/Mitigation Strategies

- Thermal/Heat – Cooking and Pasteurization
- High Powered Ultrasound
- High Pressure Processing
- Pulsed Light including UV
- Non-thermal Plasma
- Irradiation
- Freezing
- Drying
High Pressure Processing (HPP)

24 L High Pressure Sterilization Unit
Max: 980 MPa @ 131°C
HPP Applications
Which are HPP treated?
5 pressure shucked oysters

2 hand shucked oysters
E-Nose Analysis

RT = 53.93 Inter

Oyster_CTRL_OMPA_007.Her.xml
Oyster_600MPA_3min_050.Her.xml
E-Tongue Analysis
Effect of Temperature on MNV Inactivation

Table:

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HPP Strawberry

Texture Analysis

Grove et al., 2015
Strawberry Antioxidant Capacity

Oxygen Radical Absorbance Capacity (ORAC)

HPP

Ferric Reducing Antioxidant Power (FRAP)

Tadapaneni et al. (2012), J. Agric. Food Chem. 60, 5795-5802
HPP Frozen and Fresh Strawberry Inoculated with MNV-1
HPP Frozen Blueberry Inoculated with MNV-1

![Graph showing the log reduction of MNV-1 at different pressure levels.](image)
HPP Strawberry Treatment

Suspended in water

Vacuum packed
High Intensity Pulsed Light

Temperature profile with exposure times
MNV-1 on Stainless Steel and Pulsed Light
MNV-1 on Stainless Steel and Pulsed Light
Pulsed Light Treatments (100 pulses/s) of MNV-1 on Strawberry
Efficacy and Mechanisms of Murine Norovirus Inhibition by Pulsed-Light Technology

Allison Vimont, Ismaïl Fliss, Julie Jean
Institute of Nutrition and Functional Foods, Université Laval, Québec, Québec, Canada

FIG 3 Viral particles disrupted by pulsed light. Infectivity of purified MNV-1 dropped by $5.15 \pm 0.18 \log_{10}$ after treatment with $2.07$ J cm$^{-2}$ (3 pulses) and was completely eliminated after treatment with $8.98$ J cm$^{-2}$ (13 pulses). Treated and untreated viral particles were stained with 3% aqueous uranyl acetate and visualized by transmission electron microscopy. (A) Untreated MNV-1; (B and C) MNV-1 treated with 3 pulses; (D and E) MNV-1 treated with 13 pulses. Arrows: 1, intact particle; 2, apparently intact particles; 3, distorted particle; 4, debris; 5, empty particle.
PL Strawberry Treatment

Day 0

Day 7
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

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

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

Liu, Grove and Lee, 2009
Final Conclusions

• Efficacy of non-thermal for viral inactivation and retention of beneficial nutrients and quality
• Optimization is needed for best results
• Processes need to be validated
• Translation of results from surrogates to Human Norovirus
Thank You

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