



Conserve Water for Food

Food and Water Safety for One Health Presentation

Background

The food science discipline encompasses all scientific aspects for the development, production, processing, packaging, and distribution of foods. Food scientists study the biology, chemistry, and engineering design for food systems to enhance product safety, quality, stability, nutritive value, accessibility, affordability, and sustainability.

Food safety is paramount and widely realized in the United States. However, illnesses occur due to unintentional contamination that can occur throughout production, processing, and final consumer handling. The U.S. Centers for Disease Control and Prevention (CDC) estimates 48 million foodborne illnesses occur in the U.S. annually.

Foodborne illness is typically characterized by gastroenteritis, symptoms of which include nausea, vomiting, diarrhea (may be bloody), abdominal pain, and flu-like symptoms, although some foodborne microorganisms and their toxins can affect other bodily systems including the hepatic, renal, reproductive, and neurological systems. Illnesses can be short-lived and self-eliminating; however, some can be severe and result in hospitalization, long-term sequelae, or even death depending on individual vulnerability, exposure, and pathogen characteristics.

Many of the microbial pathogens associated with foodborne illness can be found in the intestinal tract and fecal waste of infected humans and animals. Foodborne pathogens are often zoonotic, transmissible between humans and other animals. Some microorganisms that cause disease in humans may be carried asymptotically by an animal. Foodborne pathogens are generally transmitted the fecal-oral route by being shed in the feces of an infected individual and entering the next individual through the oral cavity, generally through consumption of fecally-contaminated food or water. Bacteria, viruses, and parasites can persist in food, water, and the environment for days to months to even years depending on the conditions and microbial characteristics. Bacteria can replicate to increase in number in food and environmental matrices that support their growth. Conversely, viruses and parasites can persist in the environment, but they grow and replicate only in hosts.

Scientists have shared interest and responsibility for food safety to minimize disease transmission cycles involving humans, animals and the environment – a One Health approach to interdependent wellbeing.

Foods that do not receive a terminal microbial inactivation treatment such as thermal processing may be particularly vulnerable for transmission of pathogens. For example, raw agricultural commodities contaminated with microbial pathogens have been associated with foodborne illness outbreaks caused by bacteria, parasites, and virus such as *Escherichia coli* O157:H7, *Cyclospora cayetenensis*, and human norovirus, respectively.

Pathogens can be inadvertently introduced to food products through infected food handlers, contaminated food contact surfaces, and contaminated environmental sources such as soil and water. To minimize risks of contamination, guidelines such as Good Agricultural Practices (GAPs) and regulations such as the Produce Safety Rule (PSR) of the Food Safety Modernization Act (FSMA) have been instituted for the production of produce. One of the regulatory requirements includes evaluation of the microbiological quality of water used to irrigate food crops. Microbiological quality of water is determined by quantifying the presence of bacteria known as fecal coliforms, including generic (nonpathogenic) *Escherichia coli*, as an indicator of potential fecal contamination of water.

Sources of irrigation water can include ground water and surface water (lakes, ponds, streams), although availability of these traditional water resources have become strained due to overall demand, droughts and contamination. Water scarcity is exacerbated by the increased demand to support all water needs for a growing human population. Additionally, changes in climate conditions can increase the frequency of drought conditions in some regions, while increasing flooding conditions in other regions. Drought conditions can impact food crop susceptibility to plant pathogens while flood conditions have a role in pathogen transmission to food crops. To address water scarcity for agriculture, research to safely and sustainably recycle water for food production has become a priority.

Educational Resource: *Food and Water Safety for One Health* Presentation

The Food and Water Safety for One Health presentation provides an overview of topics related to: 1, public health impacts of foodborne illness; 2, microbiology basics; 3, food microbiology and control strategies; 4, surveillance for foodborne illness; 5, foodborne illness outbreak investigations; 6, sources of food contamination; 7, water as a critical resource; 8, food safety and environmental water connection; and 9, changing needs and response for water resources.

Education Content Standards Supported

- **Science (Next Generation Science Standards)**
 - High School Life Sciences: Interdependent Relationships in Ecosystems.
 - HS-LS1-1. Mathematical and/or computational representations to support explanations of factors that affect ecosystems
 - HS-LS2-2. Mathematical representations of populations in ecosystems
 - HS-LS2-6. Effects of changing conditions on ecosystems
 - HS-LS2-7. Design, evaluate, and refine a solution for reducing impact of human activity on the environment
 - HS-LS2-8. Evaluate the evidence for the role of group behavior on survival and reproduction
 - Science and Engineering Practices
 - Cross Cutting Concepts
- **Mathematics (Common Core)**
 - High School: Reason abstractly and quantitatively
- **Social Studies**
 - Geography: Ecosystems, human modification and response to natural environment
 - Civics: Structure and purpose of government

Learning Objectives

The educational resources support cross-curricular instruction on issues surrounding the availability and safety of environmental water needed for food production. This resource will support student understanding of the following:

1. Food and water can serve as transmission vehicles for pathogens that impact public health.
2. Scientific study is conducted to monitor, characterize, and communicate issues related to foodborne illness.
3. Water used for irrigation of food crops is derived from environmental and reclaimed water sources.
4. Data are used to develop strategies to provide for safe irrigation water.

Lesson Essential Concepts

1. Water is critical for food production and is obtained from environmental water bodies such as streams and ponds as well as reclaimed water sources.
2. Contaminated and untreated irrigation water can transfer hazardous biological agents to human food.
3. Environmental water is sampled and tested prior to use for irrigation of food crops.
4. Irrigation water must meet microbiological standards for use on food crops.
5. Various technological strategies can be used to reduce microbial contamination of irrigation water.
6. Actions by scientists, society leaders, and all individuals can impact the safety and availability of water needed for agriculture.

Recommendations for Use

The Food and Water Safety for One Health presentation is part of a multifaceted set of educational resources that also include animations, an interactive investigation, water sampling and testing simulations, digital narratives, infographics, and glossary to support learning styles and degrees of active learning of fundamental concepts and their application for addressing societal needs. The resources are complementary but can be used independently. It is recommended the students view the animations for an overview of issues surrounding water use and scarcity. The presentation provides an overview of fundamental concepts related to the microbiological safety of foods and the role of water for safe food production. Digital narratives feature researchers and the role of laboratory investigations and laboratory processes used to evaluate water quality. The simulations provide students the opportunity to work through the experimental procedures presented in the digital narratives. The interactive illness outbreak investigation is a problem-based and collaborative approach to understanding the connection between water and food safety, and more broadly, the interdependence of human, animal, plant, and environmental health.

Complementary Educational Resources

- Animations
<https://innovativemedia.nmsu.edu/consERVE.html>
- Digital Narratives
<https://www.udel.edu/academics/colleges/canr/departments/animal-and-food-sciences/affiliated-centers/consERVE/digital-narratives/>
- Interactive Outbreak Investigation
<https://www.udel.edu/academics/colleges/canr/departments/animal-and-food-sciences/affiliated-centers/consERVE/outbreak-investigation/>
- Water Sampling and Testing Simulations
<https://consERVE.nmsu.edu/>

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