Good Agriculture Practices for Spinach

Western Kentucky University

General Information

Spinach is a leafy green vegetable commonly consumed in the United States as a raw agricultural commodity, and is found in raw form in many salads and sandwiches. Spinach is classified into three categories: Smooth leaf, savoy, and red veined. Spinach grows quickly and prefers cool temperatures between 45° - 75°F.

Harvest Considerations

- Workers harvesting lettuce by hand should always have access to handwashing facilities, and should wash their hands regularly to prevent cross-contamination.
- The use of sterile disposable gloves is advisable.
- Cut surfaces of spinach should be never allowed to directly contact soil.
- Tools, knives, knife scabbards, and containers should be sanitized between cuts of spinach.
- Any spinach displaying signs of bruising, decay or contamination should be excluded from harvest.

Foodborne Illness Outbreaks

Of all fresh produce, leafy green vegetables, including spinach, cause the most illnesses in the United States. In 2006, an outbreak of *E.coli* from uncooked spinach caused 3 deaths, 31 cases of kidney failure, and 199 cases of dehydration due to diarrhea, across 26 states. In 2012, an outbreak of *E.coli* 0157:H7 from spinach produced in Massachusetts sickened 33, 2 of whom developed hemolytic uremic syndrome.

Bacteria	Year	Food Vehicle	Location	States Affected	Illnesses	Deaths
E.coli O157:H7	2008	Spinach	US	N/A	13	0
Salmonella	2007	Spinach	US	N/A	76	Unknown
E.coli O157:H7	2006	Spinach	International	14	238	5
E.coli O157:H7	2003	Spinach	California	1	46	2

Table 1. Selected Foodborne Illness Outbreaks Attributed to Spinach, 2010-Present (Outbreak Database, 2016)

Pathogenic Behavior on Commodity

Like most produce, damaged skin on spinach can lead to greater risk of contamination. Pathogen cells prefer to collect on portions of spinach leafs which are damaged, as pathogens thrive off of nutrients leaked from the interior tissue of the leaf. Additionally, when pathogenic cells have access to damaged portions of leafs, they can spread to the interior of the leaf and render postharvest cleaning procedures ineffective. Water splash, direct soil contact, uncleaned preparation surfaces, and human touch are the greatest contamination risks to spinach. Studies have shown that bacteria multiply on damaged leafs at optimal growing temperatures, but do not grow on undamaged leafs.

Cooling and Storage Conditions for Commodity

Spinach is extremely perishable and will deteriorate quickly in warm conditions, with an accelerated loss of the folate and carotenoid content which contributes to its nutritional value. Spinach is ideally maintained in storage close to 32°F or 0°C, with high humidity levels. Cooling with top ice is permissible.

Produce	Optimal Storage Temp., °C	Optimal Humidity (%)	Cooling with top ice acceptable	Cooling with water sprinkle acceptable	Ethylene Production	Ethylene Sensitivity to	Storage Life
Spinach	0	95-100	-	-	No	-	10-14 Days

Table 2. Storage and Cooling Conditions for Spinach (Fellow, 2000)

Good Agriculture Practices

- Test water periodically to assure that it is of appropriate microbial quality (e.g., meets U.S. EPA or WHO microbial standards for drinking water).
- Monitor and minimize domestic animal and wildlife activity in lettuce/leafy greens fields.
- Clean and sanitize ice-making equipment routinely
- Sanitize and clean cooling equipment on regular basis.
- Spinach placement and storage should not facilitate cross-contamination.
- Ensure workers follow sanitation protocol and never allow sick workers to handle spinach.
- Inspect all equipment in spinach production to ensure that no biofilm accumulation has occurred.

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