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Managing food safety of leafy vegetables before harvest

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Ensuring food safety of leafy green vegetables

Leafy vegetables (LV) are an important component of a healthy diet, providing essential nutrients that can help prevent chronic diseases. In the past 5 years, Australian production has increased by 40% to nearly 79 000 tonnes per year (valued at $600 M). However, LV are susceptible to contamination by human pathogens. Industry currently relies on food safety management plans to manage food safety risk. These plans are implemented as best agronomic practices in the field and washing including sanitisers after harvest. This project has reviewed the published literature and industry practices on emerging and current pre-harvest risk management strategies. In particular, the project assessed the feasibility of sanitising irrigation water and/or crops in the field to prevent pathogen transfer from the field to the packhouse and to reduce the risk to the consumer.

Sources of microbial contamination

Contamination of LV in the field can originate from the faeces or carcases of wild and domestic animals including birds. They can contaminate plants directly, or indirectly from soil splash, water and dust. People can also pose a risk through direct contact with the LV in the field or at harvest. *Post-harvest sanitisation* alone, cannot be relied on to fully eliminate pathogenic microorganisms on field grown leafy vegetable crops.

Pre-harvest factors that influence the risk of contamination

- Environment - temperature, rainfall, humidity, wild and domestic animals
- Production system - conventional or organic
- Vegetable species and variety - plant shape and form
- Agronomic practices such as crop rotation, fallowing, soil management, pesticides, direct sown or transplants
- Water management and irrigation systems (whether overhead or drip, water quality and quantity or rainfed)
- Nutrition management - use of organic and animal manure, compost and amendments and inorganic fertilisers
- Harvest system - mechanical harvesting or manual
- Post-harvest treatment in paddock - sanitiser, transport and storage
- **New and emerging sanitation technologies?**

KEY POINTS

- **Leafy vegetables are susceptible to microbial contamination as they are often eaten raw.**
- **Minimising pathogen contamination in the field is critical.** The study compiled and reviewed the best agronomic practices and protocols to minimise risk of pathogen contamination pre harvest.
- **Feasibility of using pre-harvest sanitisers was examined in a 'desktop' literature review and through consultation with industry.** The study considered the benefits and economic viability of pre-harvest sanitisation of the crop via irrigation water or sprayers, and/or sanitation of the irrigation water.

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Do sanitisers in irrigation water reduce microbial load in the water and on the crop?

The first step in reducing this risk is to remove the source of contamination This can be difficult as soil movement can easily occur as dust blown by the wind, by rain splash or by roaming animals or birds.

Can we reduce the risk of contamination by sanitising the crops in the field using treated irrigation water or sanitation sprays?

This is a possible strategy though not currently widely used in Australian industry.

It is technically possible, but is this option feasible or even advisable?

There is a very little information about the efficacy of pre-harvest sanitation on the crop. However, we have drawn from findings of numerous studies that have examined the key physical and chemical factors that influence the efficacy of sanitisers to decontaminate irrigation water including sunlight, organic matter, pH, presence of salts, and exposure time.

Knowledge gaps of applying pre-harvest sanitation – lots of unknowns!

Questions still to be answered

- Cost-benefit of pre-harvest water treatments
- Chemical usage efficacy
- Impact on natural microbial and plant pathogen populations
- Effect of sanitiser residuals on long-term soil and ecosystem health from multiple applications
- Regulatory framework for pre-harvest use of sanitisers is largely absent
- Potential impact of pre-harvest treatments on food safety outcomes

***Table 1* Estimated cost of four common sanitisers if applied in irrigation water for a final crop 'rinse'.** (Does not factor the cost of water as water is already used for irrigation)

Sanitisers	Recommended level (ppm)*	Cost per ha**	Capital costs
Chlorine	25-80	$417 -$1336	Up to $35K***
Peroxyacetic acid	20-80	$448-$1792	Up to $35K***
Electrolysed oxidising water	2-20 (as free Cl)	$8-$75	Up to $37K for a generator
Nylate	5-10 (as free Cl)	$194-$388	$850-1200 for an erosion feeder

*higher end of the recommended level is based on post-harvest conditions.
** Cost was estimated based on dilution of concentrates and assumed that 300,000 L is used per ha (based on 3 mm single spray)
***costs of installation of an automated dosing system

Estimated cost-effectiveness of four common sanitisers

Sanitisers could be applied once just prior to harvest as a final 'rinse' either in the irrigation water or delivered in a similar way to pesticides. Based on recommended commercial dosage rates applied at post-harvest, we can roughly calculate the cost-effectiveness of four commonly used post-harvest sanitisers (Table 1, above).

Recommendations for further research and development

This project considered potential solutions and further R&D needed to assess and optimise pre-harvest protocols and sanitisation for different crops and growing situations.

Overall, it was concluded there are limited opportunities for using pre-harvest sanitisation of the crop under normal conditions, but it could be recommended under high-risk scenarios e.g. extreme weather events.

If irrigation water is not of sufficient hygienic quality, disinfection (e.g. filtration, UV, chemical) of irrigation water may offer an alternative to manage pre-harvest microbial load.

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