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Managing food safety risks associated with toxic weeds in leafy vegetables

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The Australia New Zealand Food Standards Code requires food producers to ensure their products are safe and suitable for sale and consumption.

A recent foodborne illness intoxication outbreak linked to fresh baby spinach contaminated with the toxic weed thornapple (*Datura stramonium*) is an example of a food safety risk that growers and other supply chain participants may not be familiar with.

Baby spinach, and other products containing spinach, supplied by a single farm were recalled, with many people suffering serious health effects after consuming toxic weeds. The health effects were consistent with the ingestion of a toxic weed, *Datura stramonium* (commonly known as thornapple; Figure 1 to Figure 4). This weed was found in product supplied to supermarkets and on the source farm.

Toxic weeds in leafy vegetables

Weeds are an integral risk associated with leafy vegetable production in open fields. Some weeds such as *Datura* spp. (thornapples, jimsonweed), *Atropa belladonna* (deadly nightshade) and *Hyoscyamus niger* (common henbane) are known to be toxic due to the accumulation of tropane alkaloids (TA) in their leaves, stems, flowers and fruits. TA are the secondary plant metabolites that are distributed in many other species of the genera such as *Solanum*, *Mandragora*, *Brugmansia*, *Duboisia*, and *Scopolia*.

Although over 200 TA are known, atropine, hyoscyamine and scopolamine are the main alkaloids found in TA-producing plants. The concentration of hyoscyamine in the analysed samples is usually expressed as 'atropine', which is the racemic mixture of (-)-hyoscyamine and (+)-hyoscyamine. Growing season conditions, geographical location, plant maturity, plant species and variety, and type of plant tissue can all affect the concentration and proportion of hyoscyamine and scopolamine in plants (FAO and WHO, 2020). These alkaloids are relatively heat-stable and can withstand harvesting, processing and food preparation. If ingested, TA can cause poisoning with adverse health effects, such as anticholinergic syndrome, hallucinations, palpitations, disorientation, dry mucous membranes, skin redness, pupil dilation, dizziness and impaired vision.

Figure 1. *Datura stramonium* foliage. Photo: Bruce Ackley, The Ohio State University, Bugwood.org.

Figure 2. *Datura stramonium* foliage. Photo: Lynn Sosnoskie, University of Georgia, Bugwood.org.

Figure 3. *Datura stramonium* flower. Photo: Lynn Sosnoskie, University of Georgia, Bugwood.org.

Figure 4. *Datura stramonium*. Photo: Jan Samanek, Phytosanitary Administration, Bugwood.org.

Foodborne illness intoxication incidents linked to tropane alkaloids

Internationally, there are several reported intoxication outbreaks linked to TA-contaminated food products.

- In March–April 2019, a large-scale food poisoning outbreak affecting more than 300 people, including 5 deaths, was linked to jimsonweed contamination of a fortified corn-soy blend distributed in the Republic of Uganda. This was the largest documented outbreak caused by food contamination with TA (Mutebi et al. 2022).
- In 2019, 108 people were hospitalised in Turkey after ingesting spinach suspected to be contaminated with TA (ProMED-mail, 2020).
- In July 2020, a family in France mistakenly cooked and consumed jimsonweed leaves (*Datura stramonium*) and suffered food poisoning (ANSES, 2020).
- In March 2021, frozen spinach puree contaminated with TA affected over 100 people in Slovakia and the Czech Republic (Plackova et al. 2022). The outbreak was attributed to the fact that *Datura stramonium* grew with spinach in the field as a weed and contaminated the spinach due to insufficient controls.

Potential causes/sources and routes of contamination with toxic weeds or weed seeds

The industry undertakes a range of weed control methods as part of integrated weed management to minimise the economic losses caused by these unwanted plants. Despite all the advances in weed management, it remains a challenge to control weeds in the leafy vegetable production system. There are several factors that limit weed management strategies, including:

- spinach is a fast-growing, short duration crop (30 to 50 days). Several herbicides have a longer withholding period and do not fit into the weed management system. This could limit growers' ability to undertake effective weed control
- there are limited pre-emergent and post-emergent herbicide options to manage a variety of weeds
- post-emergent selective herbicides could be unable to cover the entire weed spectrum
- herbicide application and efficacy could be affected by rainfall and other factors
- weeds can emerge from below the applied band of pre-emergent herbicide
- contaminated seed could spread toxic weeds in the production field
- some weeds are hard-seeded and plants will continue to emerge over many years regardless of the level of management used
- the production field could be infested with toxic weed seed from the previous crop
- adverse weather such as flooding, run-off and dust storms can transfer weed seeds to leafy vegetable fields
- agronomic practices such as deep tillage could bring the viable weed seed to the topsoil layer. Improper (less) planting density can provide more space for weeds to grow and compete with the crop
- excessive rainfall during the early stages of planting and growth could decrease the efficacy of pre-emergent as well as post-emergent herbicides
- toxic weeds at early growth stages (leaves and stem) could be difficult to distinguish from some crops and can be mixed with leaves during harvest or processing
- labour shortages and costs associated with manual weed control methods.

Management options

- understand the weed spectrum in the production fields and identify the risks associated with toxic weeds in the production field and adjacent blocks
- the production site should be prepared and remediated before each crop, ensuring integrated weed management practices are incorporated
- use weed-free seed to prevent the spread of weeds in the field and minimise the risks
- agronomic practices such as crop rotation, planting/sowing density, tillage, and fertigation should be implemented to achieve optimum weed control
- selection of pre-emergent and post-emergent herbicides capable of targeting toxic weeds should be part of the weed control strategy
- the most important strategy is to visually inspect the fields throughout the cropping cycle, especially immediately before the harvesting decision is made
- producers should train field workers in identifying problematic toxic weeds and reporting to the harvest crew manager or supervisor
- processors should train and educate workers to report any unusual weeds/leaves in the processing line.

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Further information

NSW DPI Primefact on common thornapple

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