EMERGING RISK IDENTIFICATION SYSTEM
Enhancing Food Safety in New Zealand

New Zealand FOOD SAFETY SCIENCE & RESEARCH CENTRE

ESR Science for Communities He Pūtaiao, He Tāngata

Cadmium in flaxseed products

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Supported by: Kate Thomas (New Zealand Food Safety), Abhishek Gautam (ESR)

ERIS funders:

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT HĪKINA WHAKATUTUKI

Ministry for Primary Industries Manatū Ahu Matua

mia Meat Industry Association

PIANZ

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Oceania DAIRY

Dairy for life

Westland Milk Products Hokitika · New Zealand

United Fresh New Zealand Incorporated

Horticulture New Zealand Ahumāra Kai Aotearoa

Zespri KIWIFRUIT

AsureQuality Kaitiaki Kai

The food: Flaxseed/linseed

Image: **Cloutier (2016)** https://doi.org/10.1016/B978-0-08-100596-5.00031-7

Linum usitatissiumum (family Linaceae)

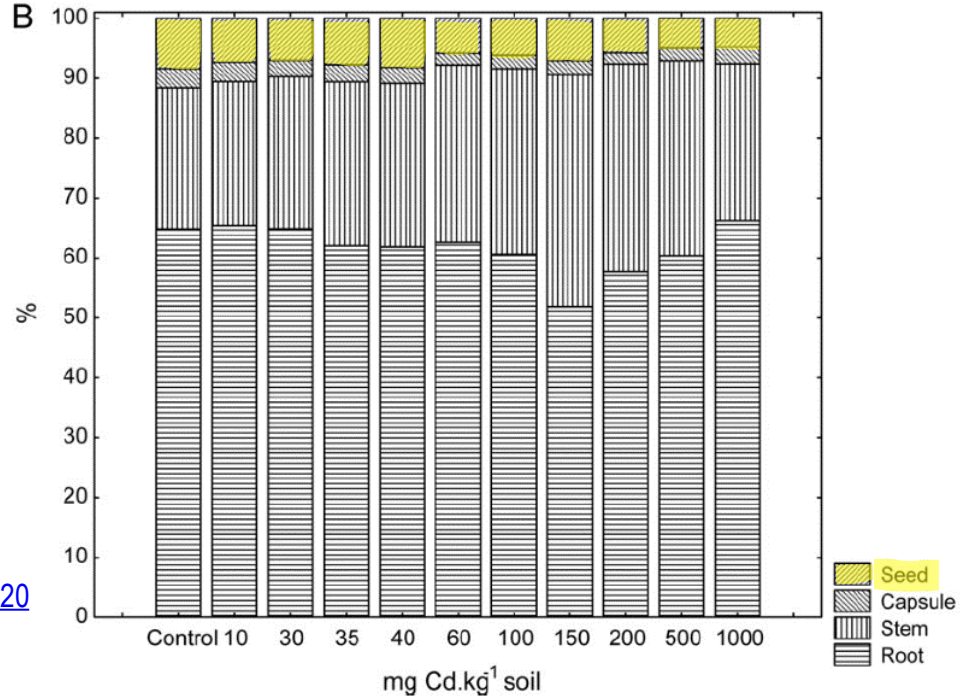
Varieties used for different purposes: Edible seeds and oils, textiles, animal feed, industrial oils.

"Superfood" – digestible proteins, lignans, essential fatty acids

Consumer demand for functional foods: Demand for flaxseed products expected to increase

Cd readily taken up by plants, even at low soil concentrations

Cultivar dependent



Graph: **Bjelková et al (2011)** https://doi.org/10.1016/j.indcrop.2011.01.020

The hazard: Cadmium (Cd)

Free ion Cd^{2+} but often bound to inorganic or organic substances

No known biological function
Long biological half-life (10+ years)
Bioconcentration

Cadmium poisoning (acute): Lungs, GI

Chronic exposure (main endpoints):
- Affects kidney function (renal tubular dysfunction)
- Weakened bones (lower bone mineral density)

Other adverse health effects (animals, humans):
Cancer, liver function, cardiovascular, endocrine, iron deficiency, hyperuricemia (elevated uric acid), neurological, reproductive, haematology, gastrointestinal, immune/skin, oxidative stress…

Schaefer et al. (2022) https://doi.org/10.1016/j.yrtph.2022.105243

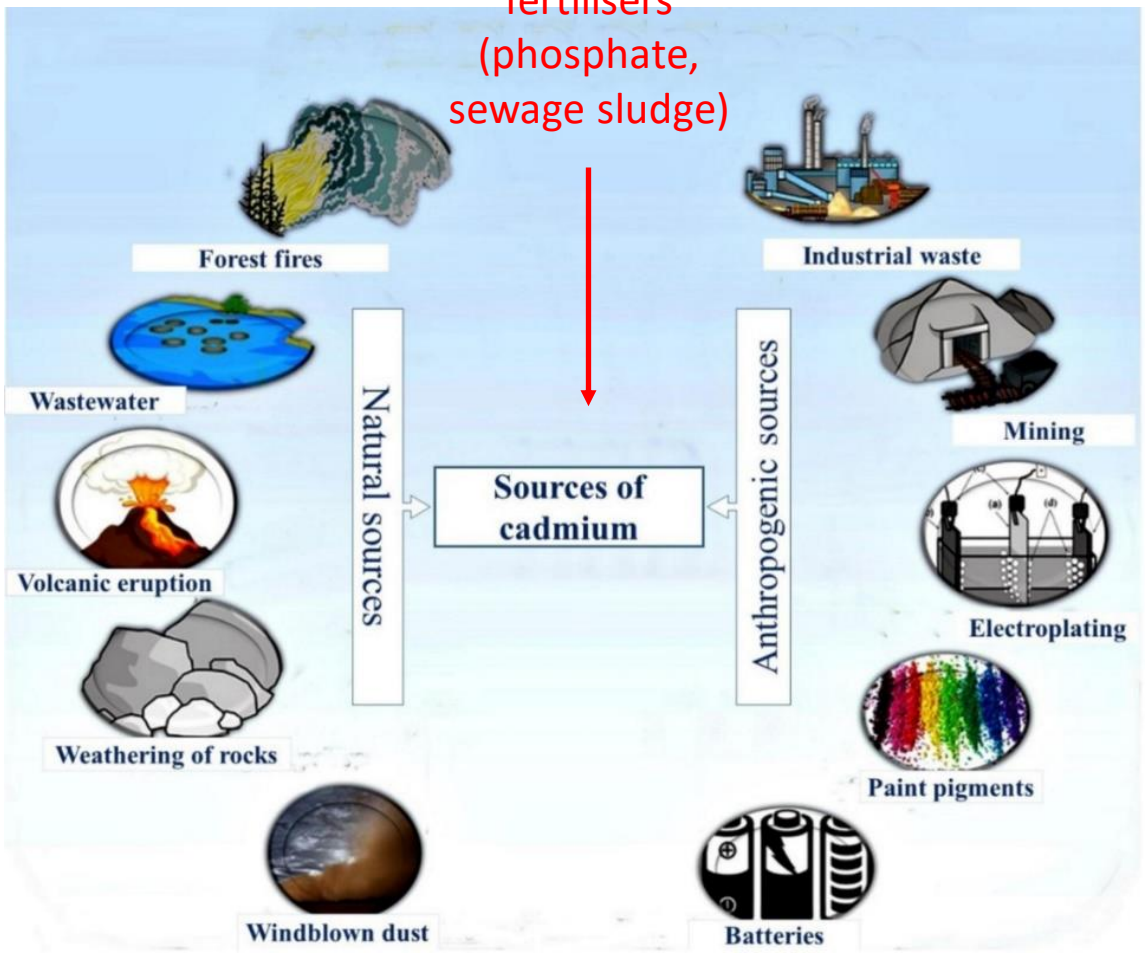
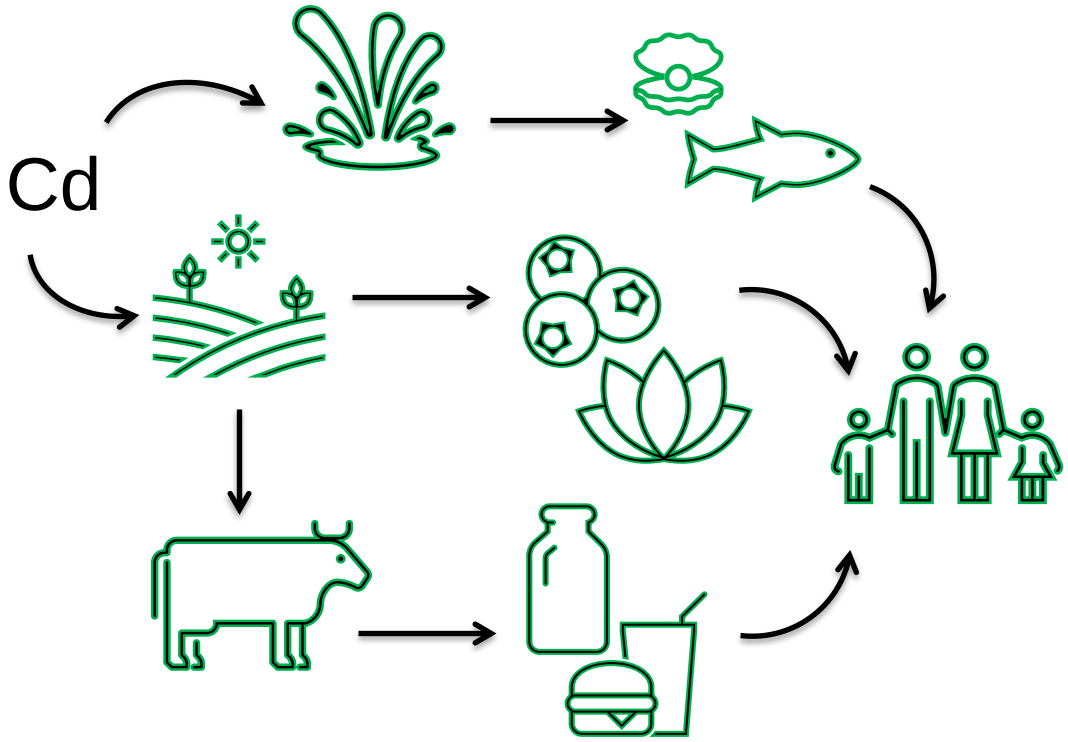


Image: **Zulfiqar *et al.* (2022)** https://doi.org/10.3389/fpls.2022.773815

Foodborne exposure: Cadmium



European assessments:

- High cadmium: Algal formulations, cocoa-based products, crustaceans, edible offal, fungi, oilseeds, seaweeds, water molluscs
- Main dietary contributors: Cereals and cereal-based products, vegetables, nuts/pulses, starchy roots (potatoes), meat and meat products
- Tolerable Weekly Intake (TWI) for cadmium of 2.5 µg/kg bw can be exceeded

EFSA (2009) Cadmium in food - Scientific opinion of the Panel on Contaminants in the Food Chain https://doi.org/10.2903/j.efsa.2009.980

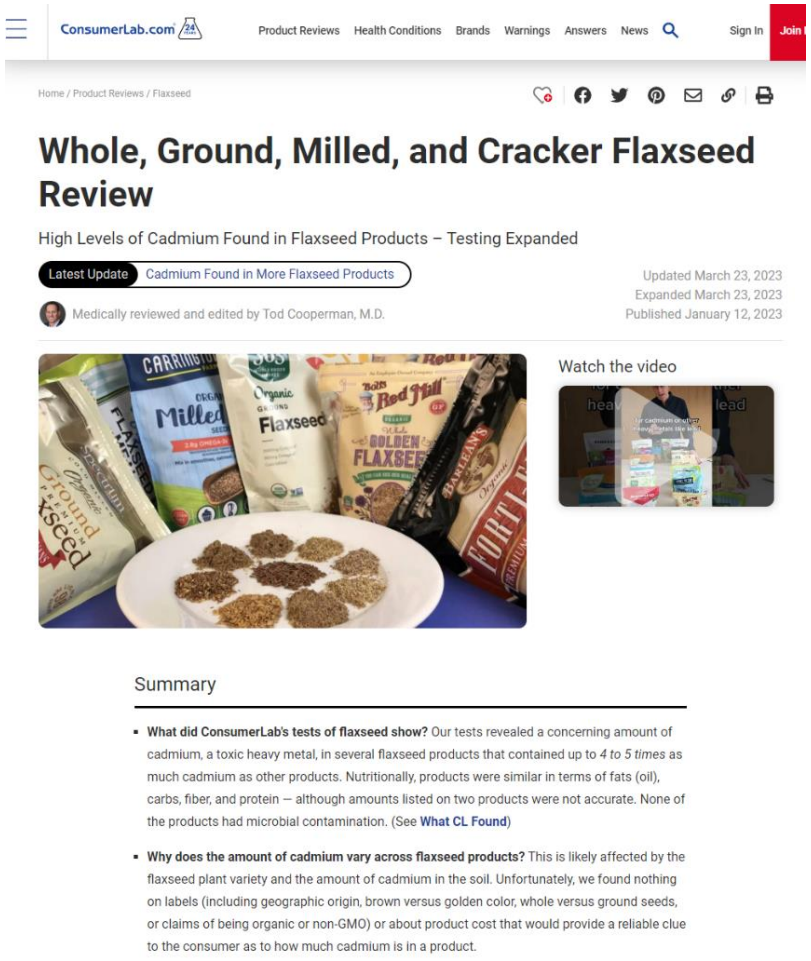
EFSA (2012) Cadmium dietary exposure in the European population https://doi.org/10.2903/j.efsa.2012.2551

Assessment from 44 national studies worldwide:

- Main dietary contributors: Cereals and cereal-based products, vegetables, and fish and seafood
- Provisional Tolerable Monthly Intake (PTMI) for cadmium of 25 µg/kg bw can be exceeded

JECFA (2021 meeting) Safety evaluation of certain contaminants in food: prepared by the ninety-first meeting of the Joint FAO/WHO Expert Committee on Food Additives https://www.who.int/publications/i/item/9789240060760

First signal: Independent testing



https://www.consumerlab.com/reviews/flaxseed-whole-ground-and-milled/flaxseed-food/

Full details not available without subscription.

Available information:

- Tested 16 products from retail (7 whole, 8 ground/meal/milled, 1 cracker product)
- One-third were "high in cadmium"
- Cd concentration in some products higher than others ("up to six times")

(also looked at arsenic, lead, "microbes", nutrition labelling)

Further investigations

Cd concentration (mg/kg)	Supporting information
0.50 ww	Limit for Cd in "Linseed and sunflower seed" **Commission Regulation (EC) No 1881/2006** of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs (introduced August 2021)
1.1 (ww?)	**RASFF alert (2021)** Linseed ("Cereals and bakery products), Belgium (company's own check)
Range 0.27 - 1.3 dw Mean 0.62 dw	Seeds, Finland: 24 samples from experimental farm, 61 samples from commercial fields. Moisture content of the seed 5-13% Method: Atomic absorption spectroscopy (uncertainty ±18%) **Kymäläinen & Sjöberg (2006)** https://doi.org/10.2137/145960606777245533
Range <LD to 0.79 (all but one sample <0.50) (ww/dw not stated)	Flour, Brazil: 6 samples from retail Method: (1) Ultrasound-assisted supramolecular solvent-based dispersive liquid–liquid microextraction (SM-DLLME) + thermospray flame furnace atomic absorption spectrometry (TS-FF-AAS); (2) microwave-assisted digestion + TS-FF-AAS **Lemes & Tarley (2021)** https://doi.org/10.1016/j.foodchem.2021.129695

Further investigations

Commodity	Cadmium concentration (mg/kg, mostly 'as is') Mean	Max
Caraway seed	0.04	0.16
Cardamom seed	0.06	0.06
Cotton seed	0.12	0.12
Cumin seed	0.05	0.16
Dill seed	0.06	0.06
Linseed	0.26	1.30
Poppy seed	0.52	7.21
Rape seed	0.04	0.59
Soya bean (immature seeds)	0.01	0.02
Sunflower seed	0.46	302.00

Data from **GEMS/Food database** (https://extranet.who.int/gemsfood/Search.aspx), kindly provided by Peter Cressey (ESR)

Risk

Risk assessment (Finland) **Kymäläinen & Sjöberg (2006)** https://doi.org/10.2137/145960606777245533

- Cd concentration in seeds available in Finland, 24 g or 30 g daily intake (optimal for utilisation of functional components), consumption of the seeds by people weighing 50, 70 or 90 kg (in addition to the regular diet)
- Evaluated whether the added flaxseeds causes the estimated daily Cd intake to approach or exceed the Provisional Tolerable Daily Intake (PTDI) of 1 µg/kg bw (WHO/FAO, 1993)
- Risk is highest for people with an already high Cd dietary exposure, and lower body weight, consuming linseed with higher concentrations of Cd.

Summary:

- Work to quantify and to reduce dietary cadmium exposure continues
- Flaxseed for human consumption could contain elevated Cd levels (now ML in EU)
- Consumption of flaxseed as seeds or ingredients in other foods increasing (?)
- Messaging from independent consumer advocacy groups is powerful
- Low Cd accumulating cultivars offer a good risk management option

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Allergens: Some observations

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Awareness of four areas

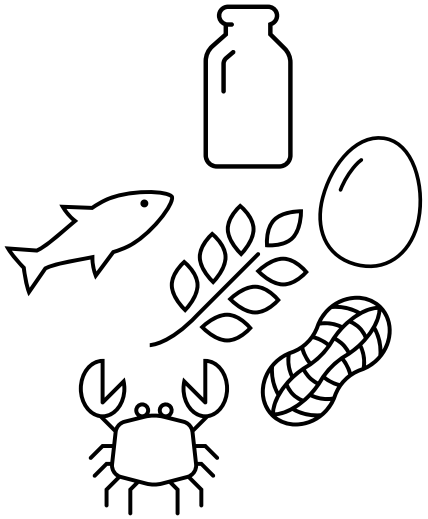
1. Allergens in alternative food packaging
2. Allergens in trending foods
3. Allergens in alternative proteins
4. Increasingly recognised allergenic conditions

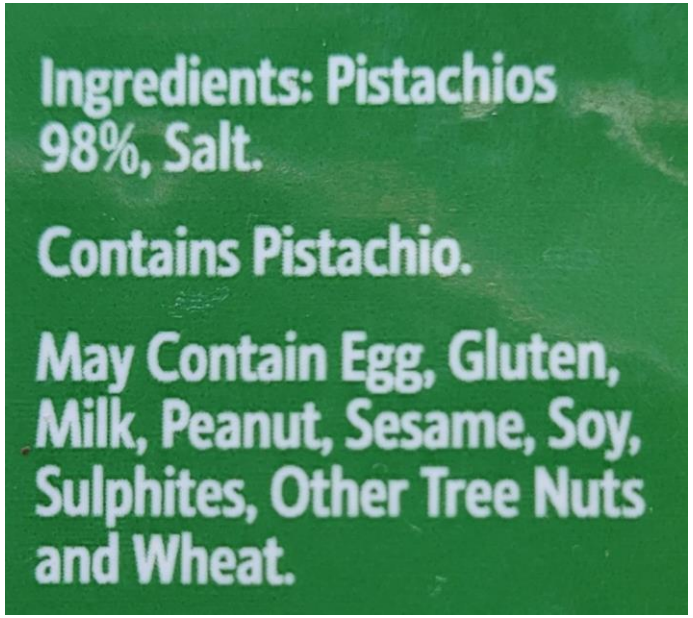
Food allergy	Food intolerance
Immune system reaction (production of antibodies)	Adverse reaction (e.g. rash, asthma, irritated bowel, headache)
Symptoms within minutes or few hours	Symptoms within minutes or hours
Mild to life-threatening	Usually not life threatening

Labelling requirements

Annex II of Regulation (EU) No 1169/2011

1. Cereals containing gluten: wheat, rye, barley, oats, spelt, kamut
2. Crustaceans
3. Eggs
4. Fish
5. Peanuts
6. Soybeans
7. Milk
8. Nuts: almond, hazelnut, walnut, cashew, pecan, Brazil, pistachio, macadamia
9. Celery
10. Mustard
11. Sesame seeds
12. Sulphur dioxide and sulphites: certain concentrations
13. Lupin
14. Molluscs



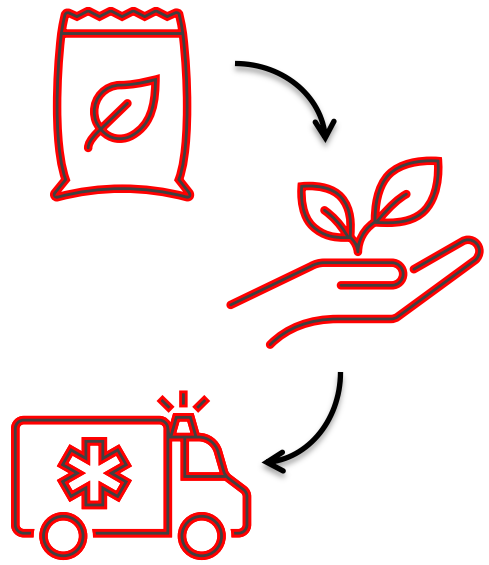


1. Allergens in alternative food packaging

- Drivers for new food packaging: Consumer demands, sustainability
- Desire for packaging to be sustainably manufactured, functional (including keeping food safe) and biodegradable
- Food production by-products are a potential packaging materials

Allergen risk?

- Are allergenic proteins present in the final packaging material?
- If yes, could these transfer onto food or hands?
- If yes, could this lead to an allergenic response in sensitive people?



2. Allergens in trending foods

Chia seeds

- 2015 report: 54-year-old man hospitalised (also had hayfever, asthma, pollen and cat sensitivities
- 2023 case-series report: Seven patients allergic to chia, 2 anaphylactic

García Jiménez et al. (2015) https://www.jiaci.org/summary/vol25-issue1-num1186

Regula et al. (2023) https://doi.org/10.1016/j.jaci.2022.12.542

Hemp seeds

- 2015 case-series report: Five patients allergic to hemp seeds, all anaphylactic

Bertolin et al. (2015) https://doi.org/10.1016/j.jaci.2015.12.969

- **Cross-reactivity**
  e.g. chia/sesame, hemp/hazelnut
- **Pre-sensitisation**
  Hemp (also via smoking) increasing sensitivity to other food allergens

3. Allergens in alternative proteins

Potential sensitivities (cross-reactivity)

- Silk moth larvae (crustaceans, mites, molluscs)
- Pea protein (soy, peanuts)

De novo sensitisation

- Mealworms

Kopko et al. (2022) https://doi.org/10.1016/j.tifs.2022.09.008

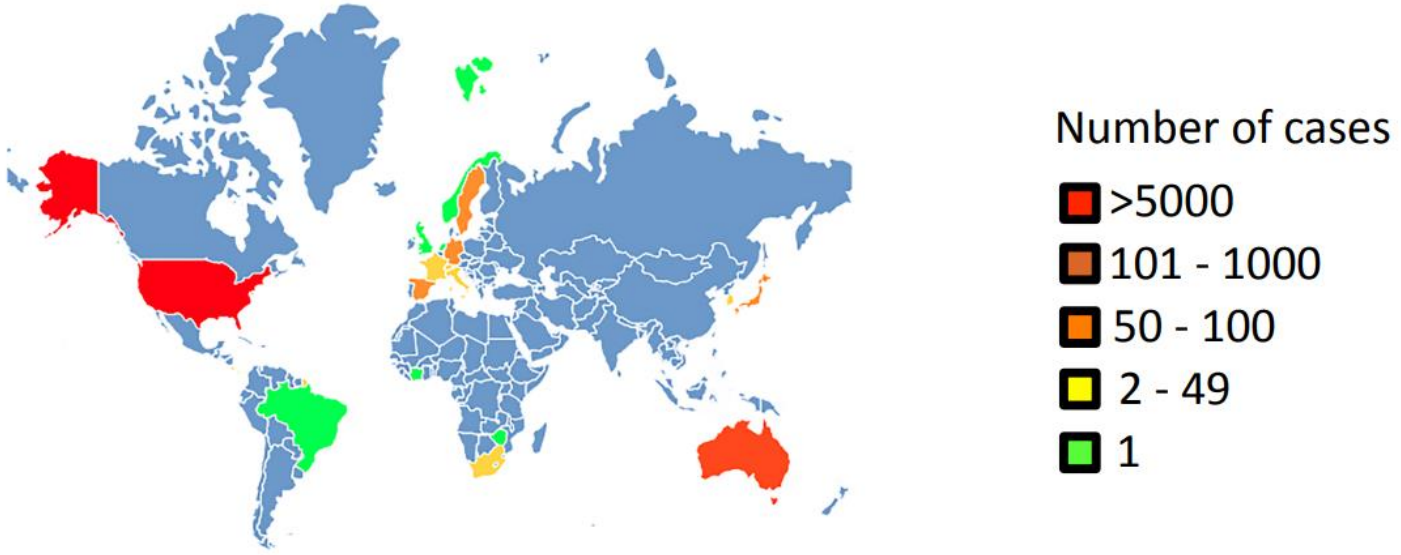
European Food Information Council " 5 trending alternative protein sources to meat in Europe"

4. Increasingly recognised allergenic conditions

Alpha-gal syndrome

- Alpha-gal sugar found in red meat animals and tick saliva
- Tick bites stimulate human sensitivity (mechanism being investigated)
- Subsequent meat consumption can trigger reaction, including anaphylaxis (>2h after eating)
- Syndrome can be temporary

NB: Vectorborne, not foodborne

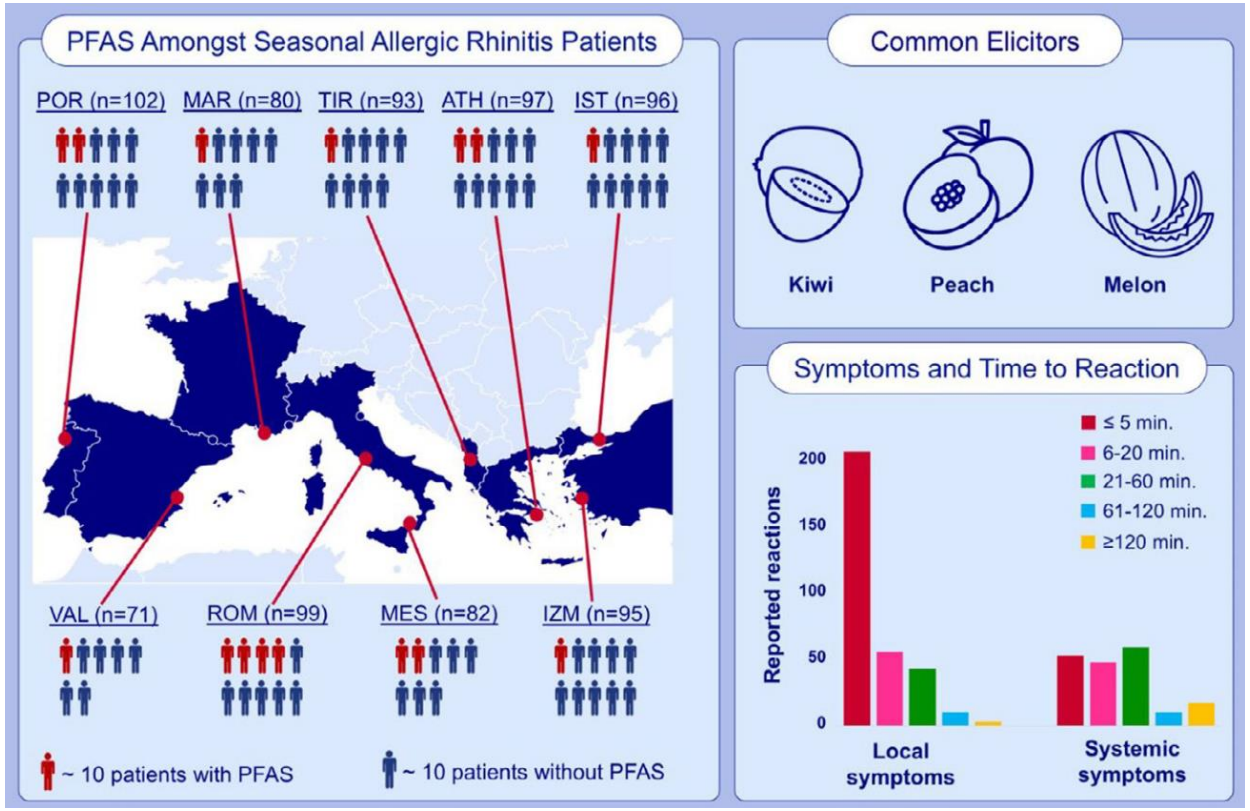


de la Fuente Jiménez et al. (2015)
https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-019-3413-z

4. Increasingly recognised allergenic conditions

Pollen food allergy syndrome (PFAS)

- At risk: People who suffer from seasonal allergic rhinitis (hayfever)
- Hypersensitivity to foods containing proteins similar in structure to pollen
- Oral Allergy Syndrome (OAS; swelling, itching, burning in mouth/throat), also skin reactions, systemic symptoms (respiratory, digestive, life-threatening anaphylaxis)



Lipp et al. (2021) https://doi.org/10.1111/all.14742