Insects as a Potential Food Allergens

Phil Johnson

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Overview

- Food Allergy
- Cross-reactivity
- Current evidence for cross-reactivity
- Opinions on handling food insects as allergens
- Gaps in our knowledge
- Cross-reactivity: a growing issue with novel foods ?

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FARRP

- **Food Allergy Research and Resource Program**
- Department of Food Science and Technology at UNL
- **Industrial consortium** (approx. 90 member companies)
- Provide **advice, guidance and analysis** to food industry
- **Basic and applied research** on food allergens

- Involvement in assessment of novel foods (both GMO and non-GMO) including preparation of GRAS submissions

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Insects do not pose a unique or in any way unsurmountable allergy risk

- The assessment of potential allergy risk is a requirement of novel food evaluations (e.g. GRAS)
- The primary purpose of these evaluations is to provide information to those likely affected and allow the mitigation of any identified risk

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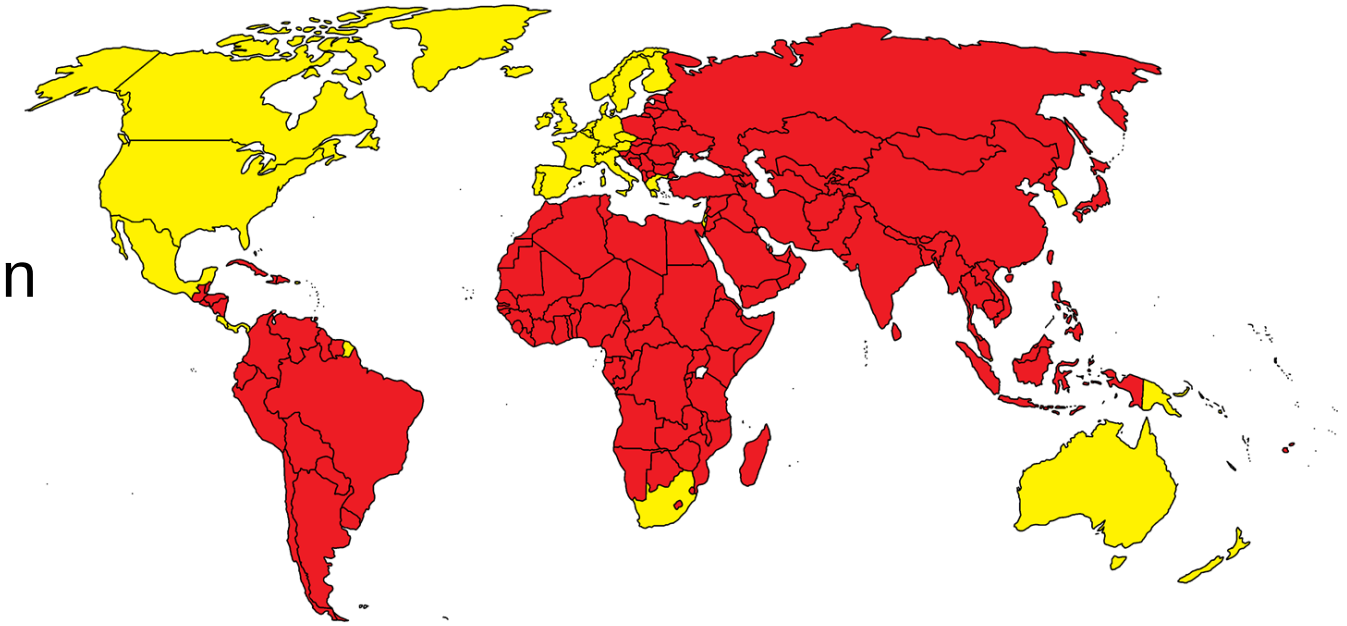
Food Allergy

- Reaction to **protein** in a food
- Symptoms range in severity
- Higher in West (3-4%) than East (often poor data) – correlated with wealth
- No standardized cure
- Avoidance only control
- Labeling in most Western economies, increasingly prevalent elsewhere



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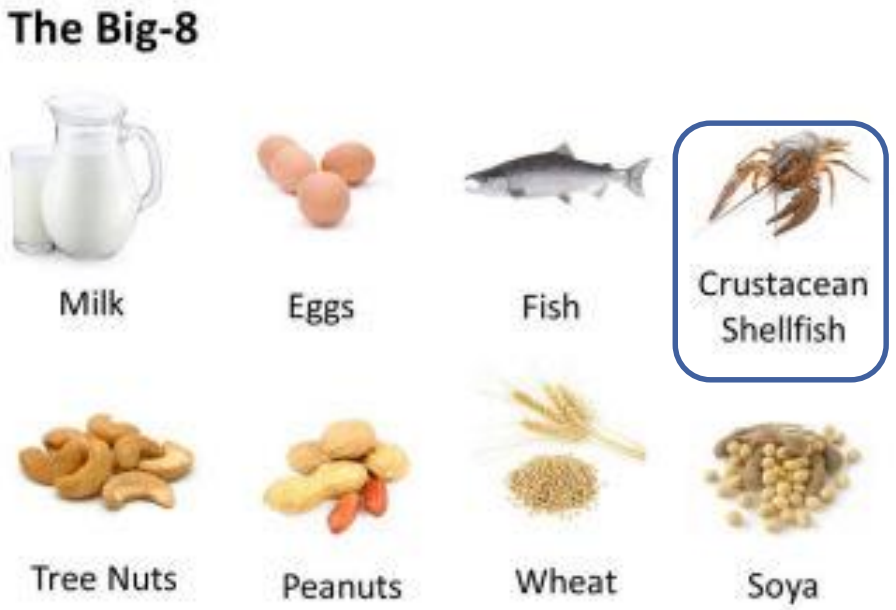
Cross-reactivity

In practical terms: **the ability of a food to cause a reaction in someone allergic to another food**

Cross-reactivity to the following foods are by far the most significant issue:



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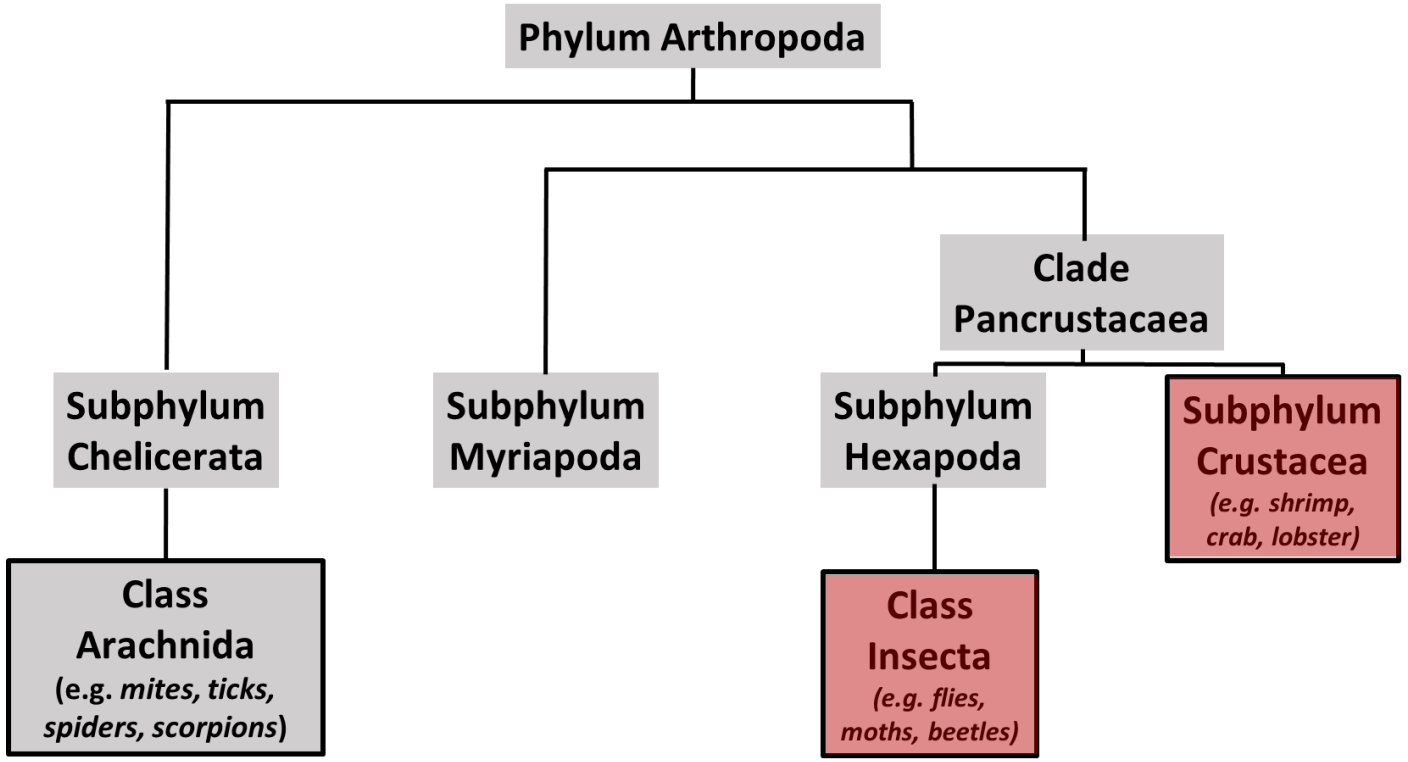
Arthropods we eat



The **more related** two organisms are:

- The more likely it is that the proteins they contain will be the same
- The more likely that a cross-reaction will occur

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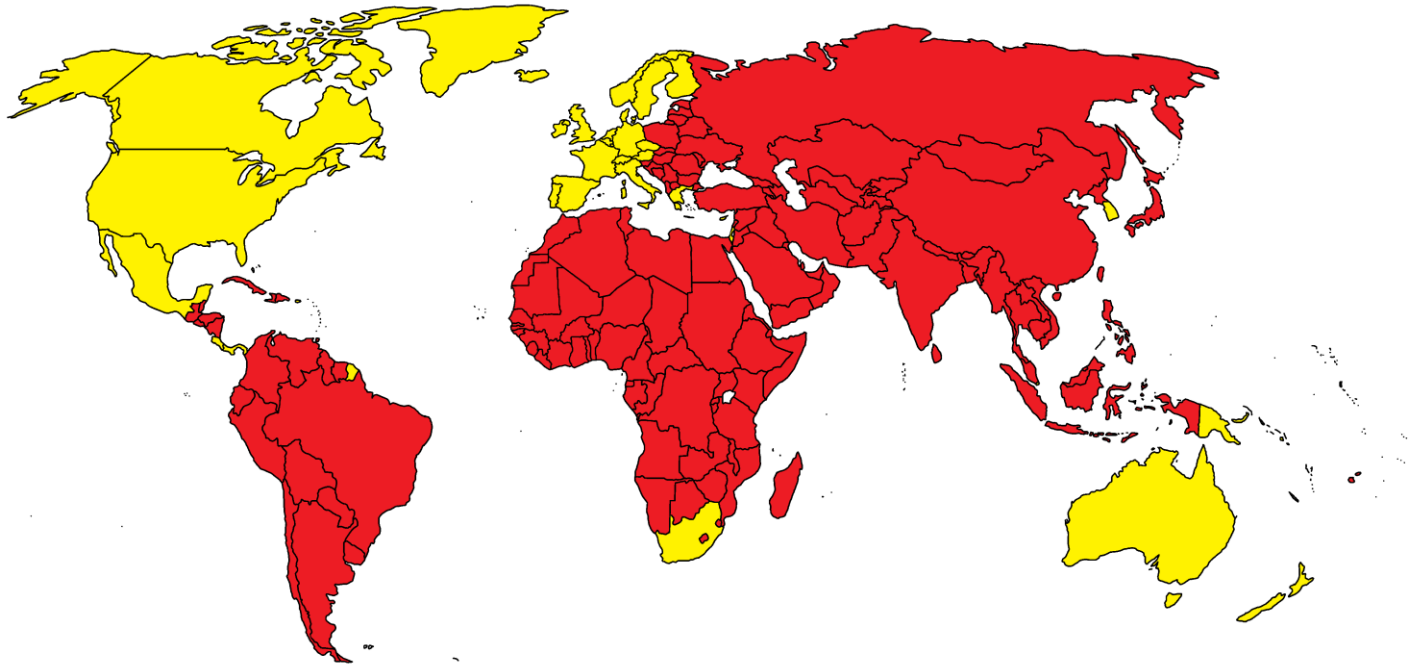
Introducing a new food to the Western population

In the West

- Traditionally eat crustacea
- Do not eat insects

- Has shellfish allergy
- Has a higher rate of food allergy



We are introducing a novel food similar to a known allergen to a potentially sensitive population

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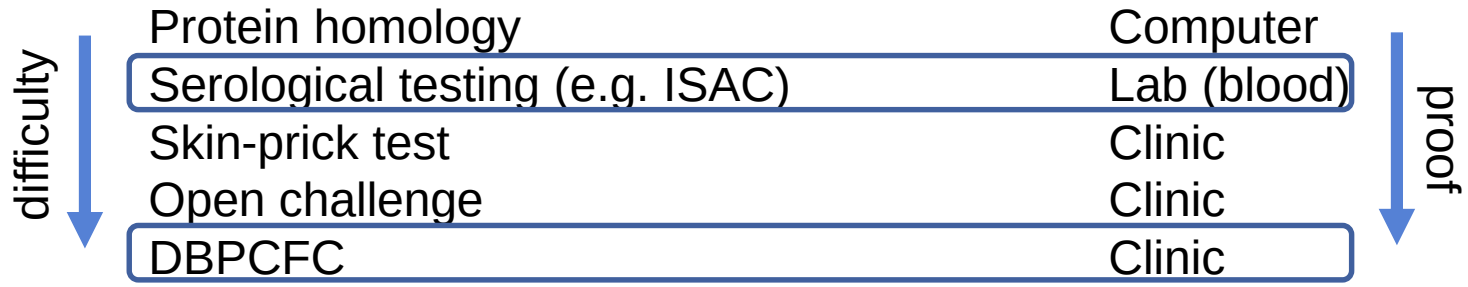
Is there evidence for cross-reactivity ?

For most techniques we use either blood from shellfish allergics or the patients themselves



- **Serological testing** provides evidence that antibody in the patients blood can bind one/more proteins in the food.
- **DBPCFC** considered the ‘gold standard’ of allergy diagnosis, and proof of allergenicity.
- Researchers favor less difficult techniques which give molecular information

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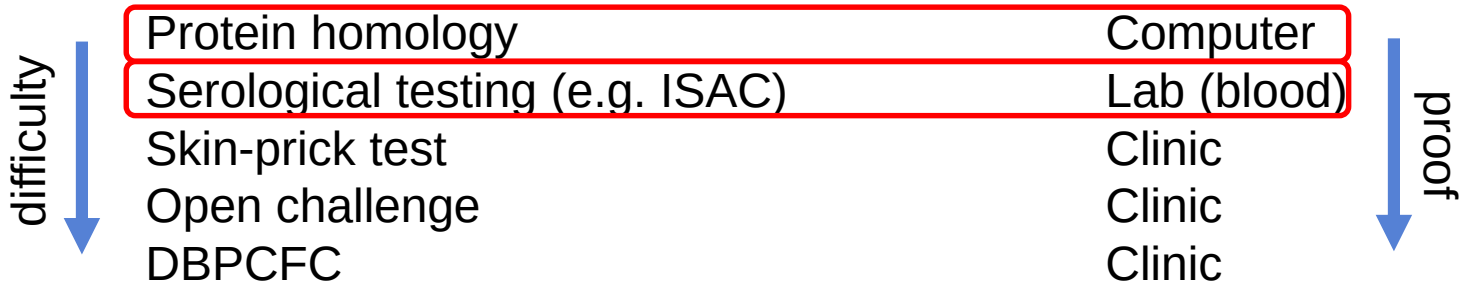
Serological and homology studies across insects



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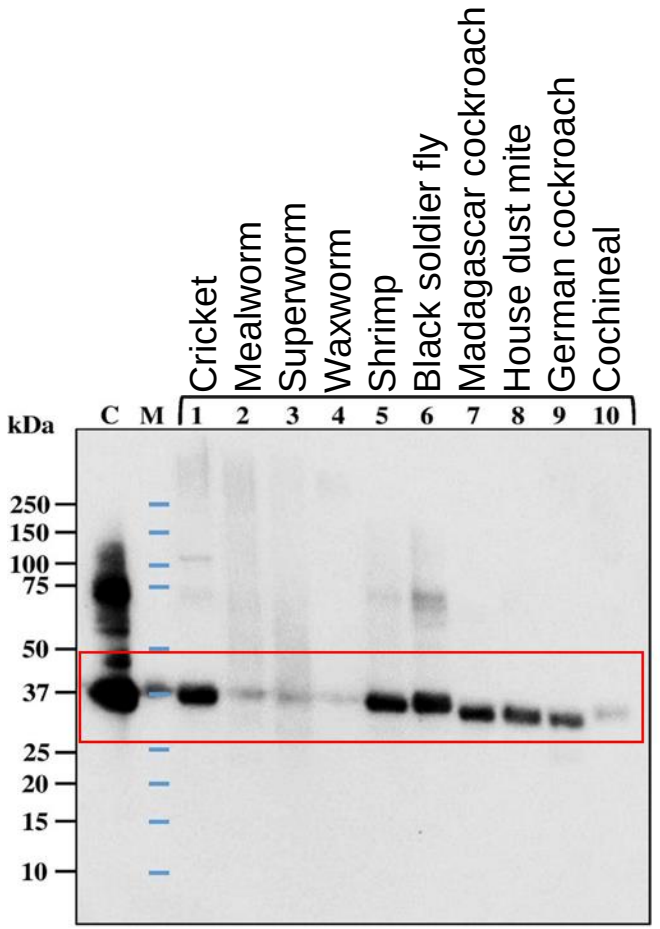
Cross-reactivity with shellfish allergens is a key concern with insect consumption

Western blotting is a type of serological testing

We can see individual proteins from a food which bind IgE from the blood of allergic patients

We looked at:

- Cricket
- Mealworm
- Superworm
- Waxworm
- Shrimp
- Black soldier fly
- Madagascar cockroach
- House dust mite
- German cockroach
- Cochineal*



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Cross-reactivity with shellfish allergens is a key concern with insect consumption

Most shellfish allergic sera:

- Reacted to insect proteins
- Reacted to **tropomyosin**: a ubiquitous muscle protein
- Showed less reactivity to **waxworm, superworm and mealworm** than to other insects

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Tropomyosin is an especially problematic allergen

- Tropomyosin from shrimp is **similar to that from a range of insects**
- Importantly, the parts of the protein to which **human IgE binds** are mostly identical or similar
- We **do not have full length tropomyosin sequences from cricket**, but cDNA cloning and mass spectrometry experiments confirm the cricket tropomyosin is unlikely to be significantly different

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Cricket tropomyosin is likely to be difficult to digest

- Tropomyosin from cricket is also resistant to digestion by **pepsin**, the major protease in the human stomach; and **trypsin** and **chymotrypsin**, major proteases in the duodenum

- Protease resistance is used as an indicator for potential allergenicity in the GM risk assessment process

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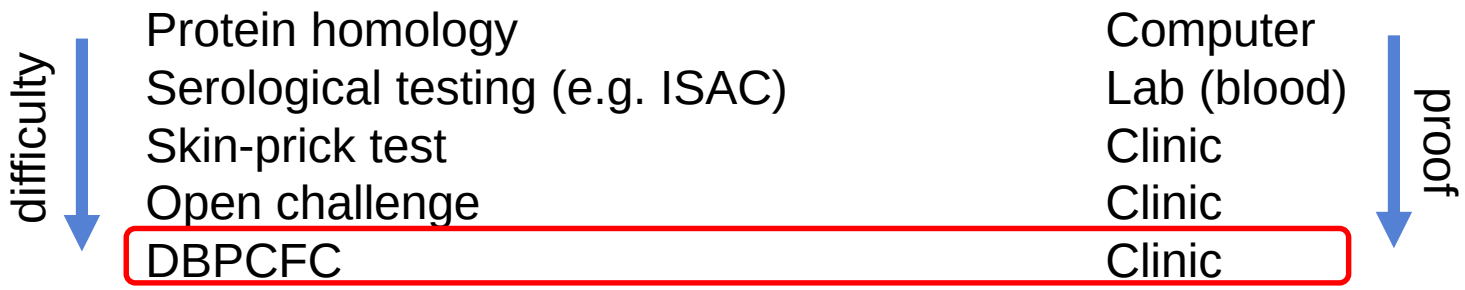
Clinical studies on mealworm



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DBPCFC of shellfish allergics with mealworm

Patient	0.01 g (2.16 mg)	0.1 g (21.6 mg)	1 g (216 mg)	3 g (648 mg)	10 g (2.16 g)	30 g (6.48 g)	60 g (13.0 g)	Mueller mealworm	Sampson mealworm	Diagnostic shrimp challenge
1	—	—	—	—	—	—	—	Negative	Negative	—
2	—	—	—	OA*	OA	—	OA	0	1	—
3	—	—	—	P, U†	—	—	P, U, NC, F	1	2	10 g†
4	—	—	—	—	OA*	OA	OA	0	1	—
5	—	—	—	—	—	—	OA, N, Sw, U†	1	3	—
6	—	—	—	—	—	—	N, AP*	2	**2**	**0.3 g*** **1 g†**
7	—	OA*	OA	—	OA, AP	OA, AP	ND	2	2	—
8	—	—	—	OA, U†	OA	OA	OA, U, AR, Cj	1	**2**	**0.1 g***
9	—	—	—	—	OA, Dy, NC†	OA, N, S	OA, N, P, Dy	3	4	—
10	—	—	—	—	—	—	—	Negative	Negative	—
11	—	—	—	—	U†	N, AP	ND	2	2	—
12	—	—	—	—	—	N, AP, Cj†	ND	2	2	—
13	—	—	—	—	—	—	U, N†	2	**2**	**1 g†**
14	—	—	OA*	—	—	OA	OA, Cj, P, N, V†	2	2	—
15	—	—	U†	U, C	U, C, Dy, W, F, N	ND	ND	3	4	—

Broekman *et al*, (2016). Majority of shrimp-allergic patients are allergic to mealworm. *J. Allergy Clin. Immunol.* 137(4): 1261

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DBPCFC of shellfish allergics with mealworm

- Confirmed mealworm allergy in **13 out of the 15** subjects
- **Symptoms were typical** of those we would expect from shrimp consumption
- Although a limited set of individuals was studied, it was concluded that shellfish allergics **react to roughly the same amount of mealworm as they do shrimp**
- It is likely that **insects do not pose more of a risk than does shrimp**

- **The levels of shrimp required to cause a reaction are typically far higher than other allergens**

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How should manufacturers of insect foods handle the allergy problem ? (my take)

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Labeling and consumer information

Insects are in **no way a unique** cross-reactive allergen issue
With more protein-rich novel foods entering market, **the issue is likely to grow**

Problem: the food poses a risk to people who are allergic to another food

- We cannot label the food as containing the other food
- We should also consider the wellbeing of consumers

Regulators have not provided advice to manufacturers regarding cross-reactivity
BUT the following solution has not been challenged (as yet):

Label the food as 'May not be suitable for shellfish allergics' or similar

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Existing labels

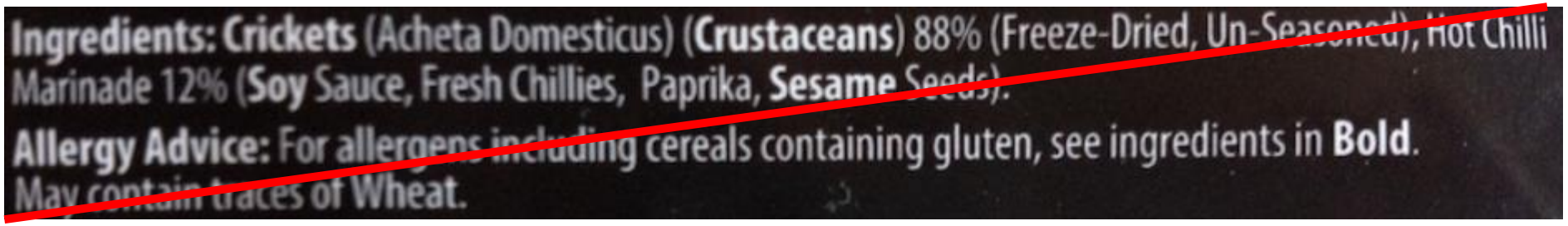
PEOPLE WHO HAVE AN ALLERGIC REACTION TO SHELLFISH CAN HAVE A SIMILAR REACTION WHEN EATING INSECTS.

Individuals with a crustacean shellfish allergy, may be allergic to crickets.

Contains Nuts. If you have a Shellfish Crustacean allergy, you may be allergic to this product.

Indications: contains tree nuts and crickets. If you have a Crustacean shellfish allergy, you may be allergic to this product.

seeds, Vanilla Extract, Sea Salt. **ALLERGEN INFORMATION:** If you have a Crustacean shellfish allergy, then you may be allergic to this product due to the crickets.



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Cross contact during production

- As a likely food allergen, I would advise that **insects are handled as such** in a production environment
- This would mean taking steps to preventing insect materials ending up in products which are not meant to contain insects
- Likely a growing issue if (as appears likely) insect products expand into larger facilities handling many different types of food

This means an **allergen control plan**
http://farrp.unl.edu/allergen-control-food-industry

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Occupational exposure

- Insects and related arthropods are known to both **sensitize and elicit reactions through airway and skin contact**
- **Respiratory and contact protection** should be provided to those working in environments where insects and handled and processed
- Care should be taken in **exposing shellfish and dustmite allergics** to an insect-containing food facility

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How should consumers handle the allergy problem? (my take)

- Shellfish allergic individuals should not consume insect-based products. There is a likelihood of reaction
- Shellfish allergics should **familiarize themselves with the labeling** of insect-containing foods
- Dust mite allergics should also be cautious

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Key Takeaways

- Food insects examined so far have proven to be **likely or certain food allergy risks** in the Western population particularly to shellfish allergics
- The **extent of this risk** compared to other known allergens is unknown
- Labeling most often consists of a '**may pose a risk to shellfish allergics**' or similar language. I would consider this best practice
- Insects should be controlled as allergens in a manufacturing environment and employee contact minimized.

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Insects do not pose a unique or in any way unsurmountable allergy risk

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Sample #

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