

# ALLERGENICITY RISK OF EDIBLE INSECTS, A SYSTEMATIC REVIEW OF HUMAN STUDIES

ORAL COMMUNICATION  
02 OCTOBER 2023

VANDA LOPES DE ANDRADE<sup>1,2</sup>, NAIR CUNHA<sup>1,2</sup>, PAULA RUIVO<sup>1,2</sup>, PAULA PINTO<sup>1,2,3</sup>

<sup>1</sup> ESCOLA SUPERIOR AGRARIA, INSTITUTO POLITÉCNICO DE SANTARÉM, 2001-904 SANTARÉM, PORTUGAL

<sup>2</sup> LIFE QUALITY RESEARCH CENTRE (CIEQV), IPSANTAREM/IPLEIRIA, 2040-413 RIO MAIOR, PORTUGAL

<sup>3</sup> RESEARCH CENTER FOR NATURAL RESOURCES, ENVIRONMENT AND SOCIETY (CERNAS), Coimbra, PORTUGAL

**PREDICT**



Centro de Estudos de Recursos Naturais, Ambiente e Sociedade - CERNAS, financiado pela Fundação para a Ciência e Tecnologia, Ministério da Educação e Ciência, referência UIDP/00681/2020 (<https://doi.org/10.54499/UIDP/00681/2020>). Centro de Investigação em Qualidade de Vida (CIEQV) - financiado pela Fundação para a Ciência e Tecnologia, Ministério da Educação e Ciência, referência UIDP/04748/2020.

This work is licensed under [CC BY-NC 4.0](https://creativecommons.org/licenses/by-nc/4.0/)

# ALLERGENICITY RISK OF EDIBLE INSECTS, A SYSTEMATIC REVIEW OF HUMAN STUDIES

- 01** Introduction
- 02** Methodology
- 03** Results
- 04** Impact and future perspectives



# INTRODUCTION

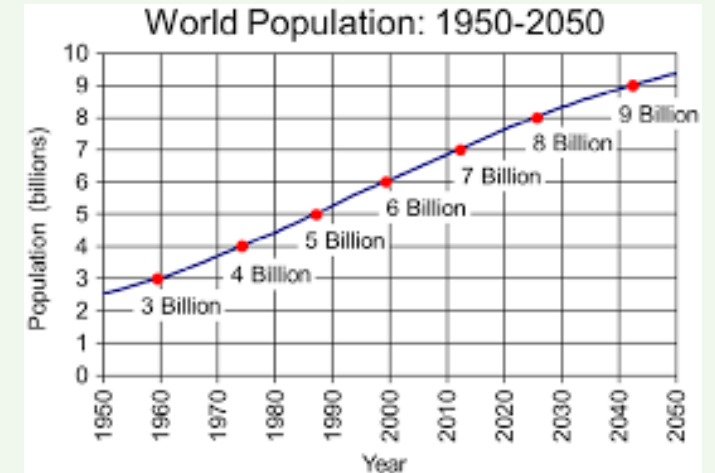
## New food sources demand

Lately we are facing challenges such as

- the increase in population;
- the sustainability of our planet;
- the pressure of high protein demand;



A trend towards the search for diversification of **protein sources** has emerged in recent years.



Us census Bureau, international database, August 2016 update.



# INTRODUCTION

## Edible insects

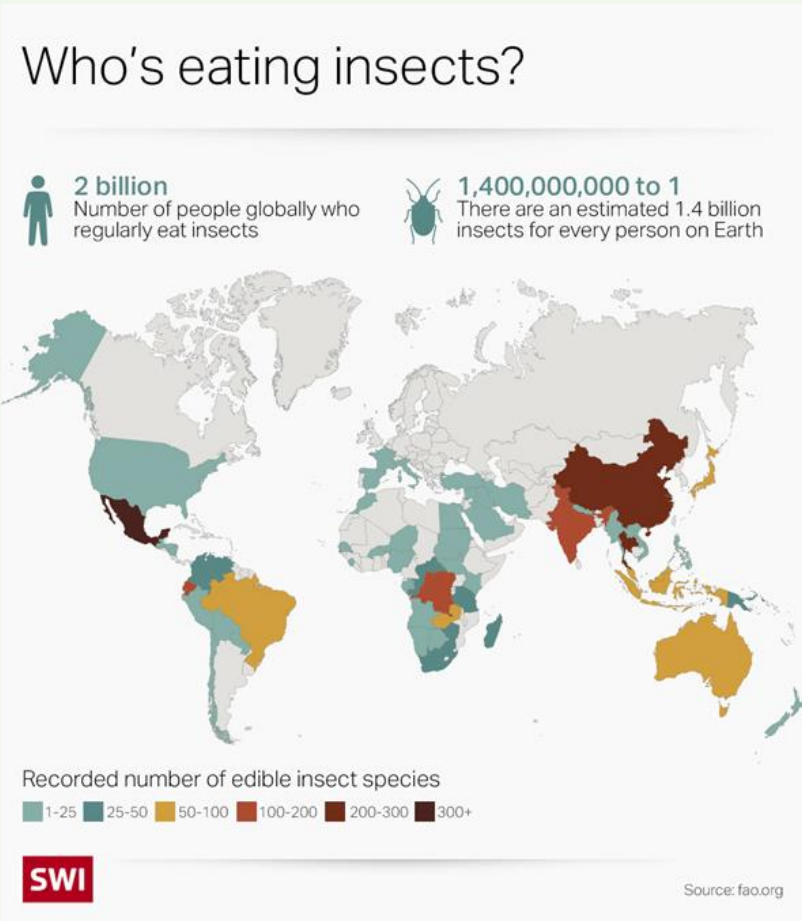


- In this view, edible insects are considered a **valuable source of highly nutritious food**;
- According to a FAO report, insects could help eradicate world hunger and decrease the dependence of the world's growing population on intensive livestock farming.



# INTRODUCTION

## Edible insects consumption in the world



- Eating insects is a common practice in several countries, such as Africa, Asia, Australia, Oceania, and Latin America;
- More recently, there is an **interest from Western countries** in insects like crickets and meal-worms for human consumption.



# INTRODUCTION

## Food allergies

- On the other hand, food allergy is a **major health concern** in Western society, with a prevalence of around 3 to 4% in the general population;
- Symptoms which may range from an oral allergy to extremely severe conditions, such as anaphylactic shock; food-allergic responses also contribute to chronic inflammatory disorders.



# INTRODUCTION

## Allergies do insects

- As concerns to edible insects, in some countries where insect consumption is common, the prevalence of allergic reactions to insects, and even death, is considered relevant;
- A great matter of concern, in addition to **direct sensitization**, is the immunoglobulin E **cross-reactivity** between insects, crustaceans, and house dust mite allergens, generally known as **pan-allergens**.



# INTRODUCTION

## Need of information

- In view of the possibility of insect farming and commercialization in Europe, the European Food Safety Authority (EFSA) has requested **scientific risk assessments** on the use of insects as food, with a particular focus on allergenicity;

- The **objective** of this work was to provide an **update** on the information regarding allergenicity assessment studies to evaluate the cross-reactivity between edible insects and other common allergies.





# METHODOLOGY

## Search

- This systematic review was conducted in accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (**PRISMA**) guidelines.
- Briefly:
  - Searches were performed during August 2022 in Pubmed, Web of Science, and Science Direct, specifying articles from the last 10 years;
  - The following key-words were used (i) “edible insects” AND “health”, All Fields; (ii) “Gryllus OR Gryllodes OR Acheta OR cricket OR beetle OR Tenebrio OR worm OR Alphitobius” AND “health”, Title/Abstract.



# METHODOLOGY

## Inclusion and exclusion criteria

- **Inclusion criteria:**

- ✓ studies with edible insects,
- ✓ in vivo studies with humans measuring health-related outcomes, and adults.



- **Exclusion criteria:**

- books; editorials; reviews;
- no edible insects;
- studies with edible insects not related to human health (ex. Insect farming or acceptance)



# METHODOLOGY

## Data treatment and bias risk assessment

- Data were **extracted** independently by two researchers to an Excel template previously defined which included: (i) study characteristics: type of study, number of test participants, number of control participants, type of control, insect product (test), administration of test and control, and duration of intervention; (ii) characteristics of participants; and (iii) outcomes: for each analyzed parameter, data collection method and conditions, and observed result;
- A standardized form was constructed based on the Cochrane Collaboration's tool for **assessing the risk of bias** for human studies.



# RESULTS

## Selected articles

- According to the inclusion criteria five studies addressed allergenicity:
  - One patient **study case**;
  - One **epidemiological study** that assessed exposure to insect allergens;
  - Three **cross-reactivity *in vitro*** studies involving patients' sera exposure to extracts containing insects' allergens.



# RESULTS

## Patient study case



- Severe food anaphylaxis induced by the **mealworm** (*Tenebrio molitor*) in a 31-year-old man allergic to house dust mite but not to crustaceans, who consumed one cooked larva.
- Prick-tests and a serum proteomic analysis allowed the identification of *Tenebrio molitor* proteins to which he was sensitized: **hexamerin**, **tropomyosin**,  **$\alpha$ -amylase** (previously identified as an allergen in mealworm with a structural homology with house dust mite), and **larval cuticle proteins A1A and A2B** (both known mealworm allergens).



# RESULTS

## Epidemiological study



- Evaluation of the clinical significance of allergens from the **mopane worm** (*Imbrasia belina*), in a rural community occupationally exposed by harvesting;
- Patients were exposed to an in-house preparation of the mopane worm inhalant allergen extract by a skin prick;



# RESULTS

## Epidemiological study

- **Allergen sensitization** was assessed by skin prick test patterns, measurements of lung function by spirometry, and fractional exhaled nitric oxide levels (markers of allergic airway inflammation).



# RESULTS

## Epidemiological study

- Respiratory health symptoms were detected among participants sensitized to the mopane worm;
- **50% of the participants were sensitized** to the mopane worm;
- Additionally, mopane worm harvesting seems not to be the only determinant for mopane worm sensitization as 50% of the sensitized subjects were not harvesters.





# RESULTS

## *In vitro* cross-reactivity studies – study 1

- Assessment of *Gryllus bimaculatus* (cricket)-induced allergy in shrimp-allergic subjects, using as a control group the sera of subjects without a shrimp allergy;
- Allergen-specific IgE levels for shrimp and *Gryllus* in the sera of the subjects after the exposure of the samples to the insects' protein extracts was evaluated;



# RESULTS

## *In vitro* cross-reactivity studies – study 1

- High molecular weight **tropomyosin** was concluded to be the major allergen in shrimp and *Gryllus* and a cross-reactive allergen between both species;
- Shrimp-allergic subjects seemed to be at a higher risk of developing an allergy to cricket



# RESULTS

## *In vitro* cross-reactivity studies – study 2

- Addressing if subjects allergic to crustaceans and house dust mite, **cross-reactivity with yellow mealworm** allergens could occur.
- Patients' sera were exposed to different yellow mealworm protein fractions and the results were compared with the ones from the subjects who were allergic to grass pollen, peanuts, fish, or eggs and/or milk but not to crustaceans or house dust mite (control group).



# RESULTS

## *In vitro* cross-reactivity studies – study 2

- Two known pan-allergens, **tropomyosin** and **arginine kinase**, were identified as major cross-reactive allergens in the yellow mealworm.



- In addition, being dominant house dust mite allergens Der p1 and Der p, 2 patients with both a house dust mite and crustacean allergy may experience an allergic reaction when consuming products containing yellow mealworm protein;



# RESULTS

## *In vitro* cross-reactivity studies – study 3

- Addressing the effect of **thermal processing** on the allergenicity potential of several edible insect species: buffalo worm (*Alphitobius diaperinus*), the mealworm larvae (*Tenebrio molitor*), the cricket (*Gryllodes sigillatus*), the grasshopper (*Locusta migratoria*), and the silkworm larvae (*Bombyx mori*).
- The sera of patients allergic to house dust mite, shrimp, or mealworms and the sera of subjects not allergic to either shrimp or house dust mite (control subjects) were challenged for immunorecognition with thermal processed or raw protein extracts of the five insect species



# RESULTS

## *In vitro* cross-reactivity studies – study 3

- 1% of house dust mite-allergic patients and **87% of shrimp-allergic patients recognized at least one insect protein extract.**
- **Tropomyosin** was an important cross-allergen for house dust mite- and shrimp-allergic patients; **larval cuticle proteins** seemed to play a major role in the cross-reactivity of patients primarily sensitized to mealworms.
- Some proteins were thermostable; thermal processing **partially reduces cross-allergenicity.**

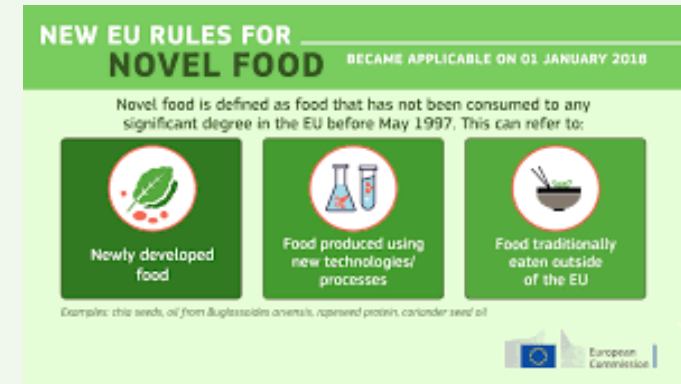


# RESULTS

- Overall:
  - Adverse reactions described after ingestion of edible insects can be caused by cross-reactivity with crustaceans (as well as house dust mite inhalant allergens);
  - Apparently, this is mostly due to the presence of the two most common allergens among invertebrates: tropomyosin and arginine kinase (among others);
  - House dust mite, shrimp-, and mealworm-allergic patients are advised to be cautious when consuming insects.



# IMPACT AND FUTURE PERSPECTIVES



- Food allergens are mostly proteins; therefore, greater efforts in the analysis and identification of the potential allergenicity of these novel proteins should be a fundamental activity to ensure a high level of food safety for European consumers.
- Including allergenicity assessments as part of the risk assessment of novel food is crucial; they should be carried to the existing allergic population identified by the immunoglobulin E (IgE) cross-reactivity.







**Thank  
You**