Nederlandse Voedsel- en Warenautoriteit (NVWA)
Ministry of Economic Affairs

Risks associated with the consumption of mass-reared insects?

Insects to feed the World

FAO estimates that:

- The world needs to increase its food production by 70% in 2050 to serve a global population of 9 billion.
- Animal feed production is competing for resources (land, water and fertilizer) with human food and fuel production, urbanization and nature.
- 70% of world's agricultural land is already directly or indirectly dedicated to meat production.

Can we still produce sufficient animal protein?

FAO/Wageningen UR 14-17 May 2014 (Ede, NL)

NIEUW IN NEDERLAND

Delhaize, Carrefour, Jumbo …

INSECTEN SNACKS

ART.NR.	MERK	OMSCHRIJVING	INFO	EAN-CODE	COLLO	BTW	INKOOP	VERKOOP	THT	ADVIES
113150	CONBUGGIE	Buggieballs 10x20gr	met meelwormen	5425004035929	6	6	4,37	5,95	12 DGN	3 minuten frituren
113151	CONBUGGIE	buggieburgers 4x40gr	met buffalowormen	5425004035950	6	6	4,69	6,39	19 DGN	beide zijden om en om een minuut bakken
113152	CONBUGGIE	buggie crisps zout 35gr	met wasmotlarven	5425004035943	6	6	5,00	6,79	19 DGN	kunnen koud gegeten worden
113153	CONBUGGIE	buggie crisps paprika 35gr	met wasmotlarven	5425004035974	6	6	5,00	6,79	19 DGN	kunnen koud gegeten worden

Entomofagie, of het eten van insecten, is de toekomst. Rijk aan eiwitten en mineralen, zijn insecteneen duurzaam alternatief voor vleesconsumptie.

Insecten hebben een lage milieubelasting en hebben een zachte smaak die aanleunt bij nootjes. Kortom, duurzaam en lekker.

Mealworm

Grasshopper

30 sep 2014 11:15

Anderhalf miljoen Belgen allergisch aan wormen

Vanaf volgende week liggen échte eetbare wormen in de winkelrekken van Carrefour. Onder de naam 'Buggie Crisps' zijn licht gefrituurde wasmotlarven in hun geheel te koop, met een zout- of paprikasmaakje (6,79 euro voor 35 gram). Daarnaast zijn er ook bitterballen (5,79 euro) en burgers (6,39 euro), telkens met herkenbare meel- en buffalowormen.
Het Nieuwsblad bundelde de informatie.

Wax moth

Buffalo worm

De keuze om gehele insecten te verwerken in deze producten is bewust gemaakt. Er is hiervoor gekozen, omdat dit tot een eerlijker product leidt.
Indien insecten worden gedroogd en vermalen, verdwijnt het gros van de smaak alsook de zichtbaarheid van de component insect.
Bij verwerking van gehele insecten, is het voor de consument duidelijk wat hij of zij zal eten en wordt er niets verborgen.
De insecten worden gecontroleerd gekweekt en voldoen aan de strenge kwaliteitsnormen van Deli Ostrich, die ook voor de verwerking van insecten BRC A+ gecertifieerd is.

The Insect Cookbook






The Insect Cookbook – Food for a Sustainable Planet - by Arnold van Huis, Henk van Gurp en Marcel Dicke (published by Columbia University Press, New York, USA). Foto's: Floris Scheplitz.

Our future?

Inside a Japanese ornamental bug store

Arnold van Huis et al. FAO Forestry Paper 171, 2013

Industrial-scale processing for insects

Protix Biosystems BV
Re-feeding the planet

KOPPERT
BIOLOGICAL SYSTEMS

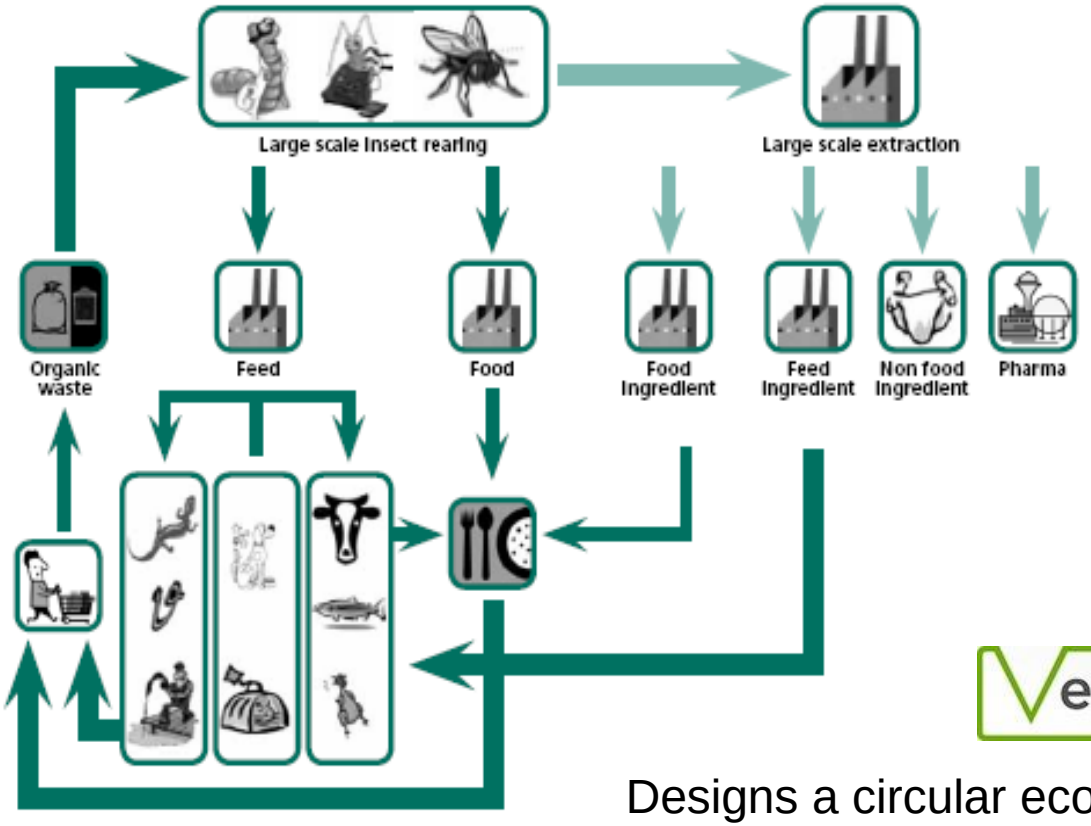
insecten kwekerij
van de Ven

kreca

INSECT CENTRE

jagran

Ynsect



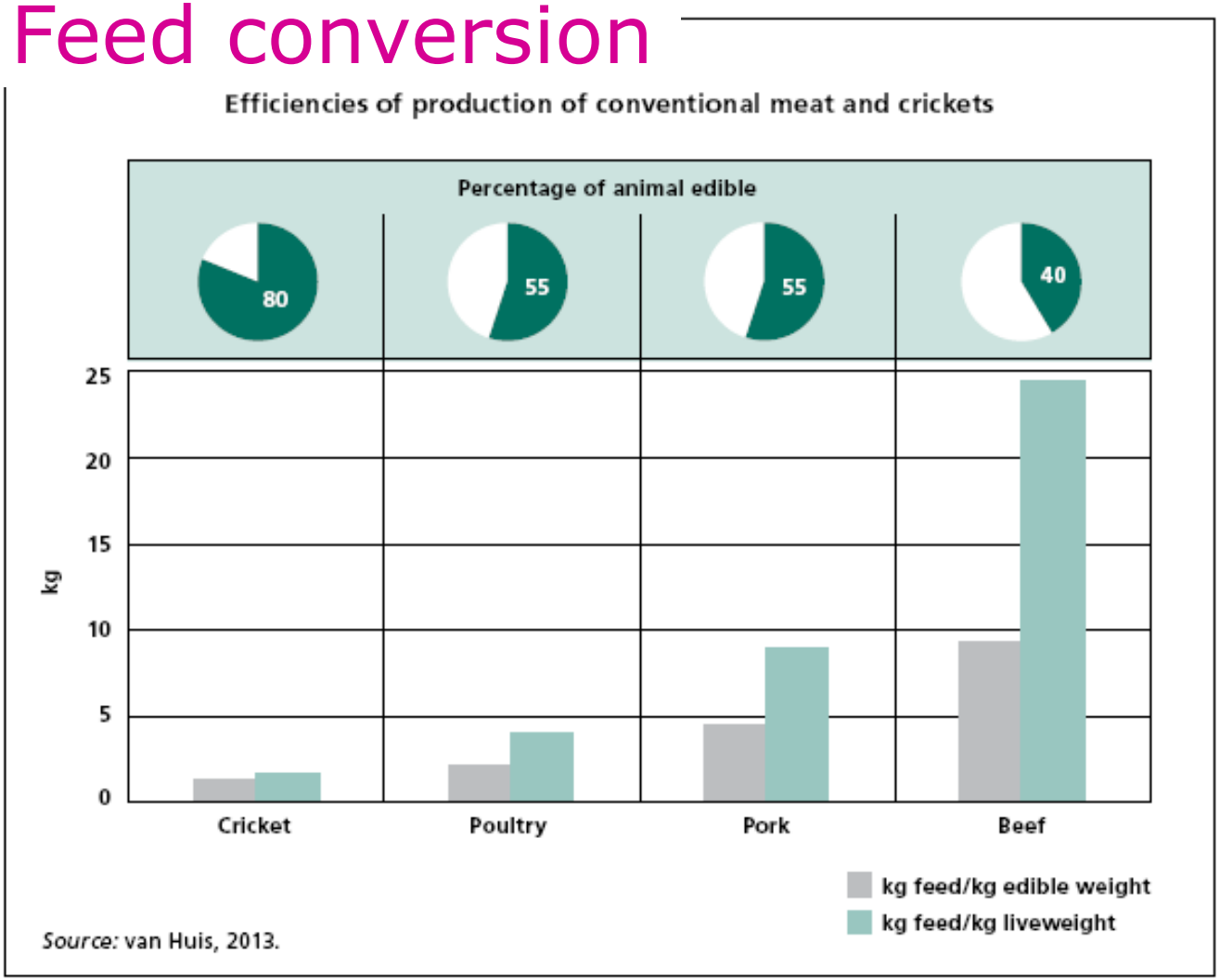
Source: M. Peters, personal communication, 2012.

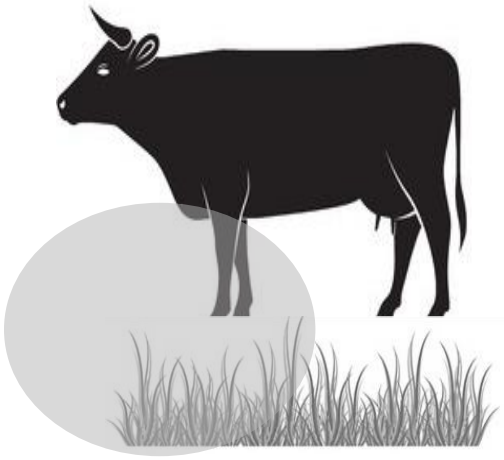
Venik

Designs a circular economy

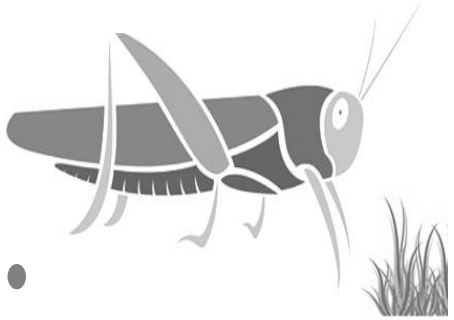
Adopted from: Arnold van Huis et al. FAO Forestry Paper 171, 2013

Feed conversion





2850 g CO_2/kg growth
8 kg feed/kg meat



18 g CO_2/kg growth
2 kg feed/kg meat

Adopted from: Arnold van Huis et al. FAO Forestry Paper 171, 2013

Housefly (*Musca domestica)*

Jagran BV has developed a concept to grow at industrial-scale larvae fed with organic waste such as GFT waste, sludge, restaurant waste and even manure.

- Due to specific amino acids, lipids, enzymes and other components in the long term even more sophisticated applications are foreseen for human nutrition and pharma.
- End of 2013 demo factory line of AEB and Jagran BV.

Black Soldier Fly (*Hermetia illucens*)

Bioconversion of 1000 kg of fresh manure from dairy cows yields about 13 litres of biodiesel, and about 17 kg of high-quality protein powder for animal feed to replace soya and fish meal.

Sorce: Li, Q., et. al. Bioconversion of dairy manure by black soldier fly (Diptera: Stratiomyidae) for biodiesel and sugar production. Waste Management (2011).

Novel protein sources

- Collecting from the wild;
- Semi-domestication;
- Buying from the market/the internet;
- Mass-rearing.

Background

In 2012 NVWA received mandates from the ministers of Agriculture (EZ) and Health (VWS) to assess the microbiological, chemical and parasitological risks arising from consuming mass-reared insects as food and feed.

In 2014 EFSA received a request from the European Commission (EFSA mandate number M-2014-0150).

September 2014 Scientific Committee of FASFC and Superior Health Council released an opinion on ‘Voedselveiligheid van insecten bestemd voor humane consumptie’ (dossier SciCom 2014/04 - SHC No. 9160).

(Un)-intentional consumption

Dutchman consumes annually up to 500 grams of insect protein (*Marcel Dicke, Dec 2010*).

Americans consume 900 grams of insects/ year subconsciously (*Factsheet, Ohio University*).

Chocolate
•60 insect fragments 100 gram
Fruit juices
•5 or more (fruit)fly eggs per 250 ml
Peanut butter
•30 insect fragments per 100 gram
Macaroni
•225 insect fragments per 225 gram

Source: FDA's Food Defect Action Level list (Pimentel et al. BioScience 27(3):178-185, 1977); VWA rapport 'Productvreemde delen', 2009.

State of the Art

To the best of our knowledge, no toxicological studies involving whole edible insects or insect derived protein(s) have been carried out in human subjects or in experimental animals.

Risk assessment NVWA-BuRO

Discussions with experts of edible insects (WUR) and members of the Dutch Insect Breeders Association (VENIK) on the topic of rearing insects.

Systematic literature review.

Human consumption:

- mealworm beetle (*Tenebrio molitor*)
- lesser mealworm beetle (*Alphitobius diaperinus*)
- European migratory locust (*Locusta migratoria*)

Feed consumption:

- Housefly (*Musca domestica*)
- Black soldier fly (*Hermetia illucens*)

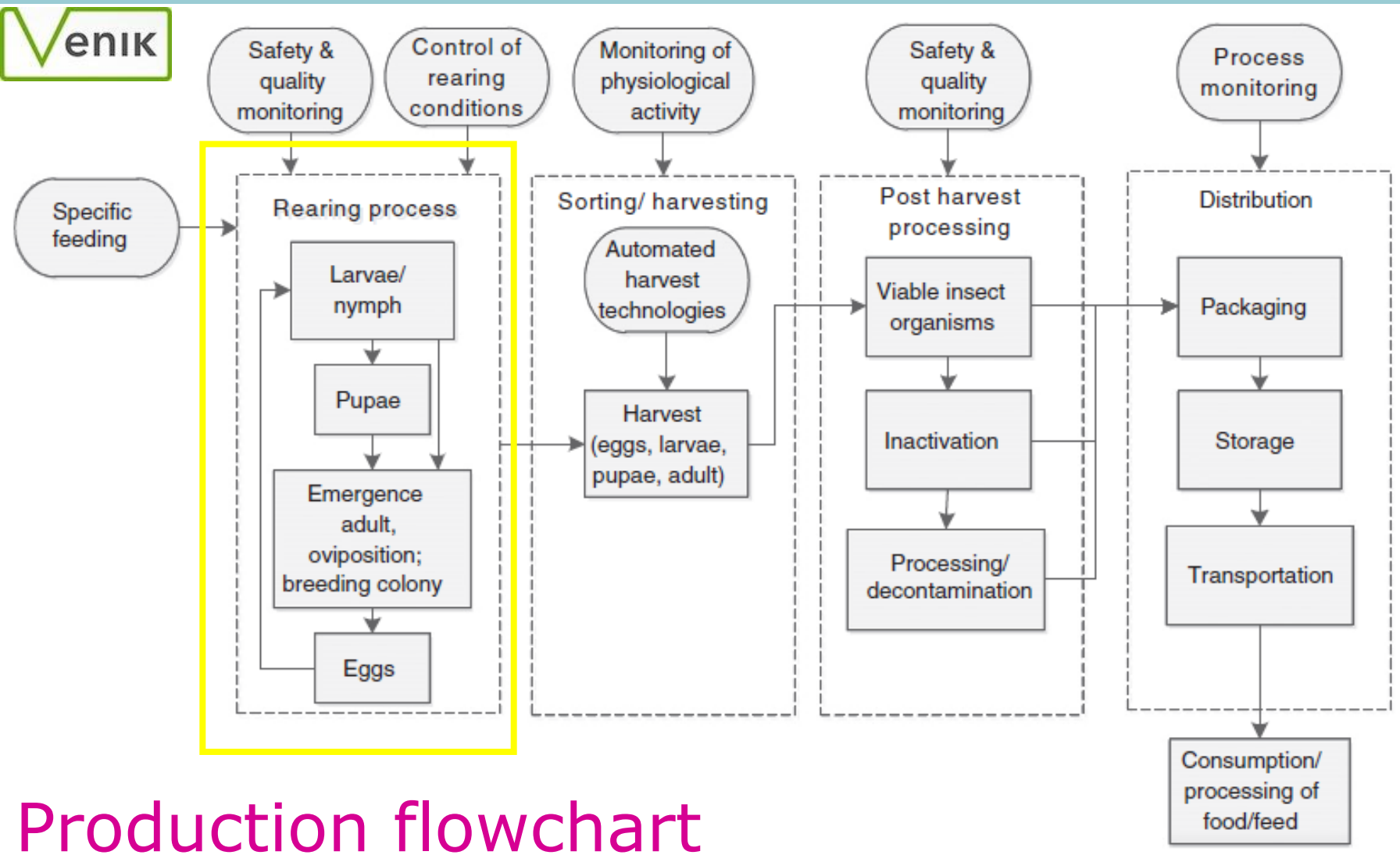
Extensive (peer) review.

Mandate

The Dutch assessment covers the main steps from production chain up to consumption including processing.

Food	**Feed**
Insect species	Insect species
Nutrient medium[1]	Organic waste[2]
Laying eggs	Laying eggs
Growing larvae	Growing larvae
Harvest by sieving	Harvest by sieving
Gut emptying	Gut emptying
Cleaning	Cleaning
Freezing	Freezing

[1]Bran mixed with flour or ground chicken feed, supplemented with carrots, potatoes and water;
[2]Regulation (EC) 1069/2009, animal by-products (former foodstuffs or VVM)



Production flowchart

http://venik.nl/site/wp-content/uploads/2013/06/Factsheet-Insectenkweek-en-kwaliteit.pdf

Microbiological hazards

- Pathogenic microorganisms may be present in the production environment or in the insects' feed – and thus could also be present in untreated larvae or insects.

- The packaging information indicates a shelf life of 52 weeks. However, there are no known studies of whether the product is safe throughout this 52-week period.

Microbiological hazards

- Small-scale studies have shown that the aerobic total viable count and the maximum permissible concentration of *Enterobacteriaceae* in fresh insects exceed the process hygiene criteria for the raw materials used in meat preparations (65% > 10^3 CFU/g).

Table 5. *Enterobacteriaceae*: number of samples and percentage of samples (%) at each concentration level (CFU/g)

Product	Number	$<10^3$	10^3-10^4	10^4-10^5	$>10^5$
Locust	17	59%	18%	24%	-
Lesser mealworm	17	24%	6%	41%	29%
Mealworm	18	11%	17%	28%	44%
Mealworm snack	3	100%	-	-	-
Total	55	35%	13%	29%	23%

NVWA, 2010

Microbiological hazards

- A ten-minute heat treatment reduced the aerobic total viable count (< 10^6 CFU/g) and concentration of *Enterobacteriaceae* (< 10^3 CFU/g) to values in compliance with the proposed process hygiene criteria.

Table 7. Average microbiota of whole, fresh and heat-treated mealworms (Klunder et al. 2012)

Colony forming units (CFU/g)	Fresh	Cooked (10 min.)	Roasted (10 min.)
Total number of aerobic bacteria	5.0×10^7	<50	<50
Enterobacteriaceae	6.3×10^6	<10	160
Bacterial spores	130	<10	40

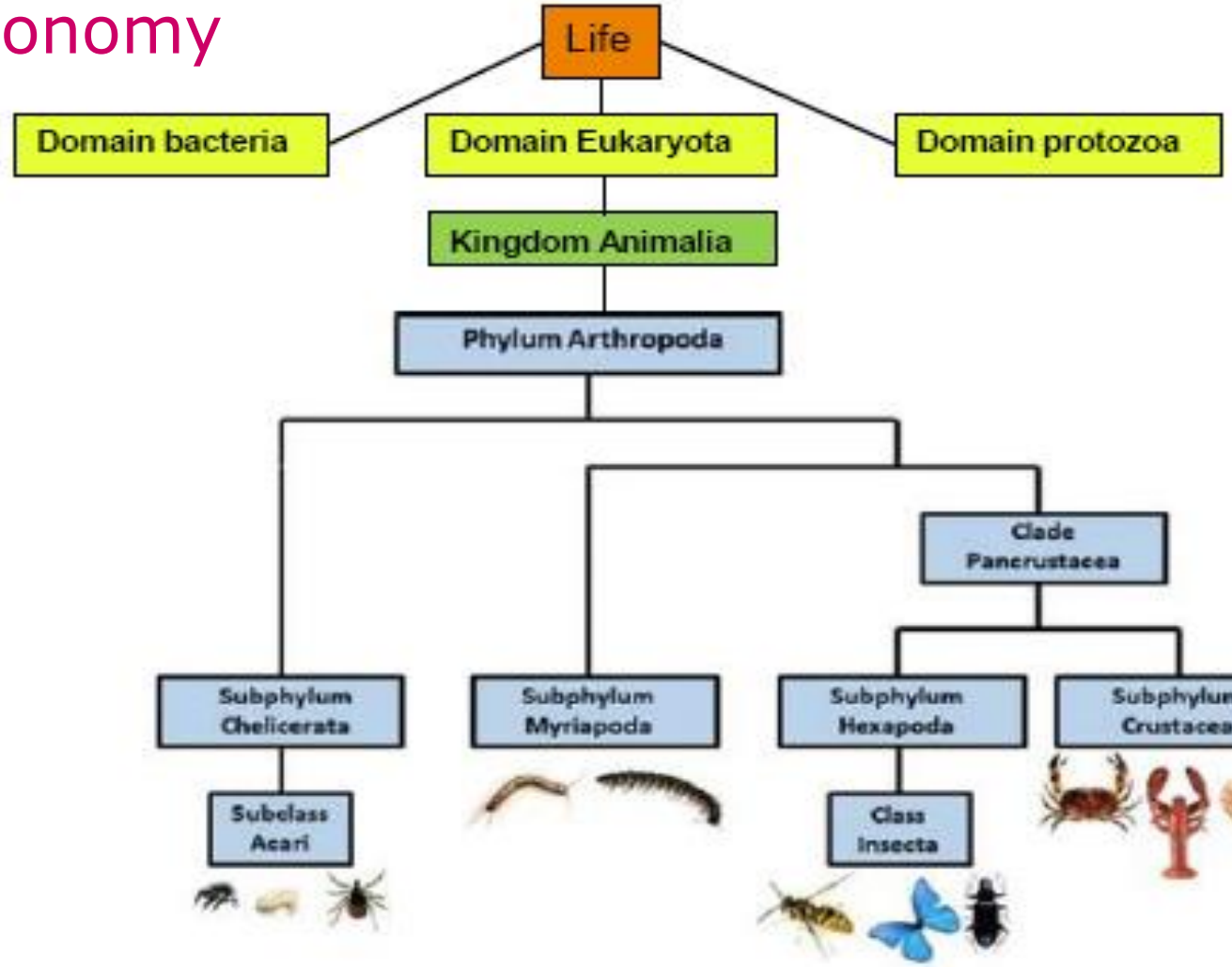
Klunder et al. Food Control 26:628-31 (2012)

Chemical hazards

- It is unclear exactly how much chitin (N-acetyl-D-glucosamine) insects reared contain, and whether there are any health risks associated with an intake of more than 2.7 grams of chitin per day. Depending on the percentage of chitin involved (estimated at 6%), the intake of a daily portion of 45 grams of freeze dried insects is not a cause for concern in terms of public health.

- Given the current production methods, these insects are unlikely to be exposed to toxic substances through their diet or through the surroundings in which they are reared.

Taxonomy



Verhoeckx & van Broekhoven Food and Chemical Toxicology (2014)

Crossreactivity

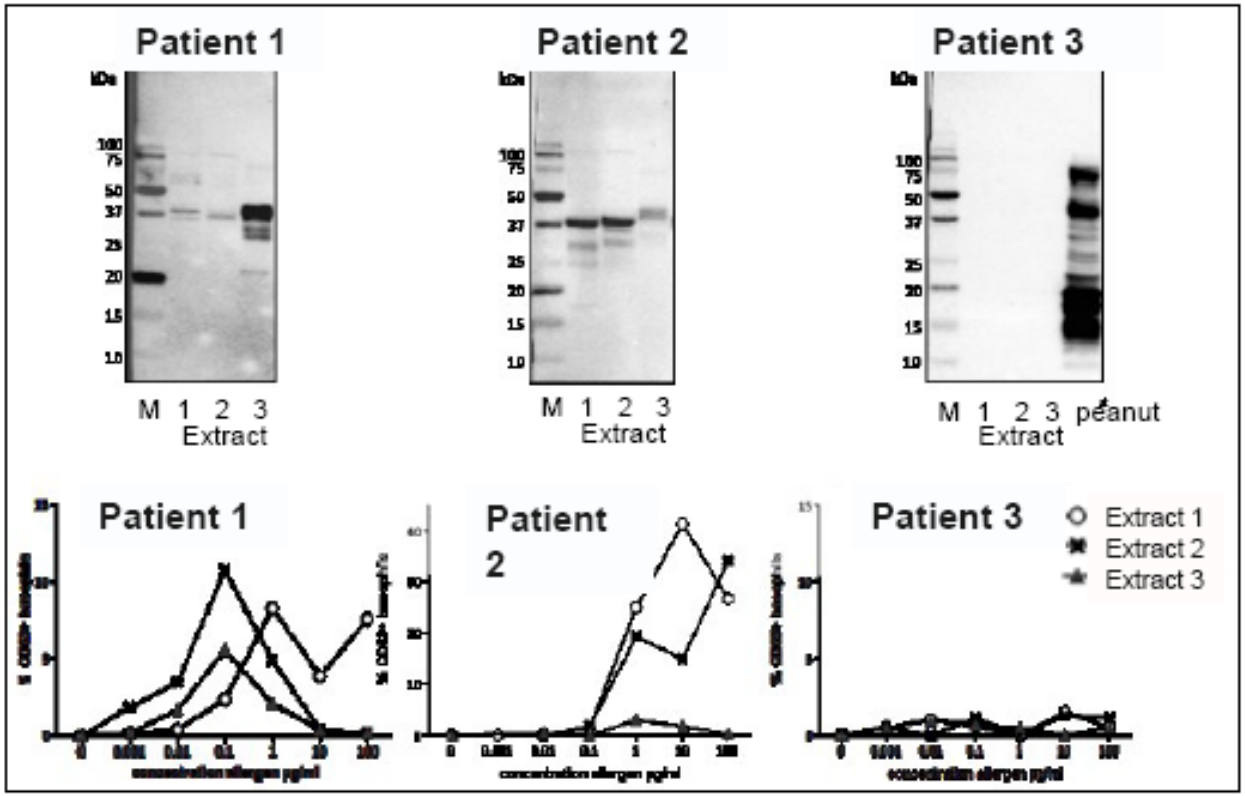
Universitair Medisch Centrum Utrecht

TNO innovation for life

sIgE from shrimp allergic patients react with mealworm proteins

Cross reactivity
Sera known allergy with mealworm

Functional cross reactivity
Sera known allergy with mealworm



Verhoeckx & van Broekhoven Food and Chemical Toxicology (2014)

Immunoreactivity

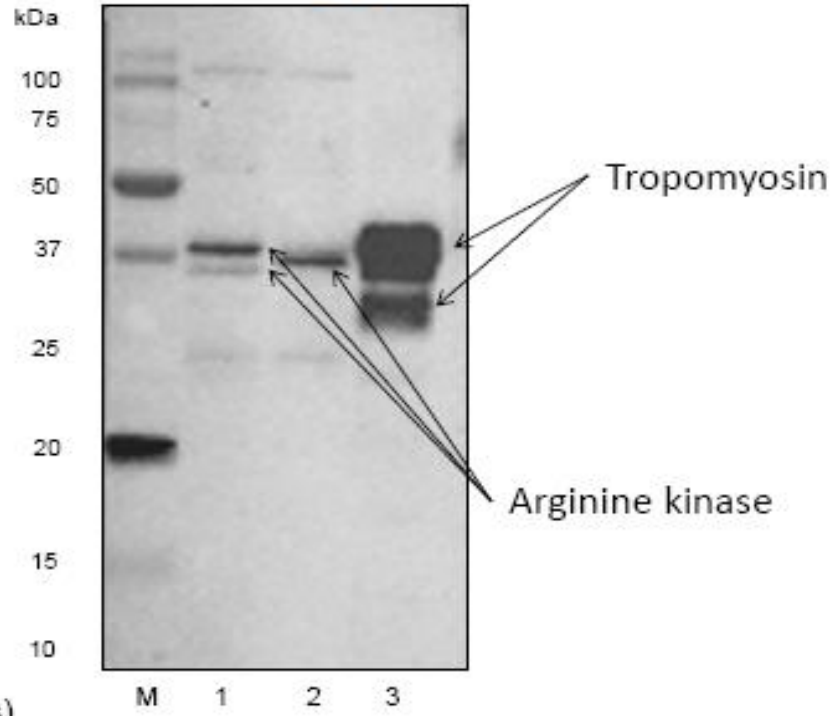
Universitair Medisch Centrum Utrecht

TNO innovation for life

Reactive proteins were identified as tropomyosin and arginine kinase

Identification proteins

Cross reactivity
Sera known allergy with mealworm



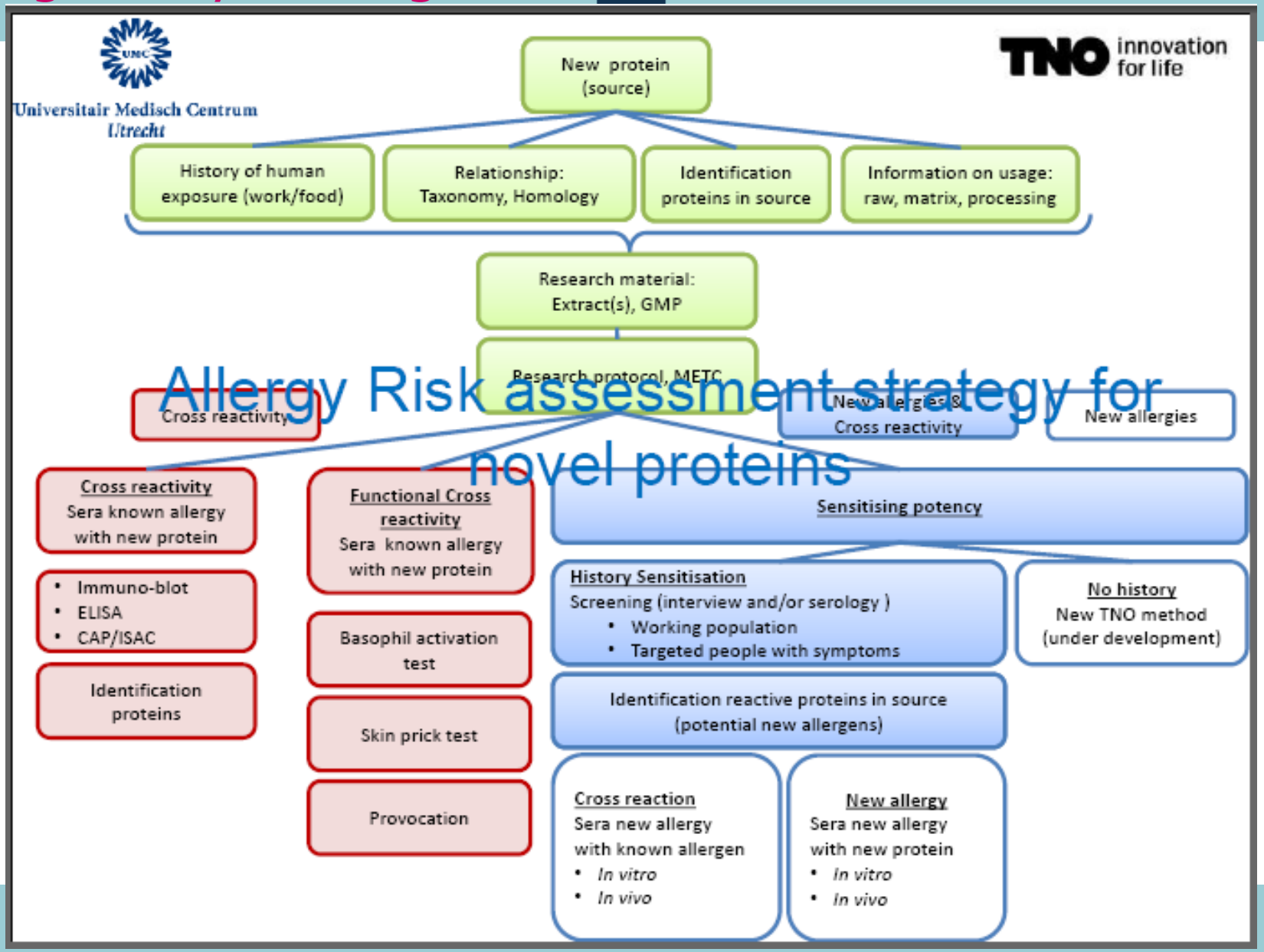
1 Soluble proteins (tris)
2 Dialysed (extract 1)
3 Difficult to solubilize proteins (urea)

Verhoeckx & van Broekhoven Food and Chemical Toxicology (2014)

Allergic hazards

- Mealworm proteins bind to IgE from shrimp allergic patients.
- Binding of mealworm proteins with IgE causes an immunological response in basophils.
- Reactivity with IgE from grass pollen, peanut, egg, milk or fish allergic patients was not observed.
- Possibility cannot be excluded that, after eating mealworms, sensitive individuals may experience sensitisation and allergic reactions.

Allergenicity testing



Research in progress

- Food challenge testing for mealworm in shrimp allergic patients (n=16) (in progress);
- Assessment of the sensitizing potency of mealworm among insect breeders (n=21) (in progress).
- Are there insects without tropomyosin and arginine kinase?

Knowns/unknowns:

- The possibility cannot be excluded that, after eating mealworms, sensitive individuals may experience sensitisation with allergic reactions (severity) comparable to shrimp proteins.
- There are no clinical records showing that shrimp allergic patients may experience sensitisation to house dust mites.

Conclusions

- Chemical, microbiological and parasitological risks of consuming insects can be sufficiently well controlled through the use of adequate production methods.
- Sensitive individuals may experience sensitisation and allergic reactions.
- The staff of insect rearing facilities may develop hypersensitivity or allergic reactions as a result of exposure to insects (or to insect body parts).
- If the expected intake of dried or freeze dried, whole insects exceeds 45 grams per day, the risk of chitin intake should be reassessed.

BON APPÉTIT

JP/NRC 01-11-2014