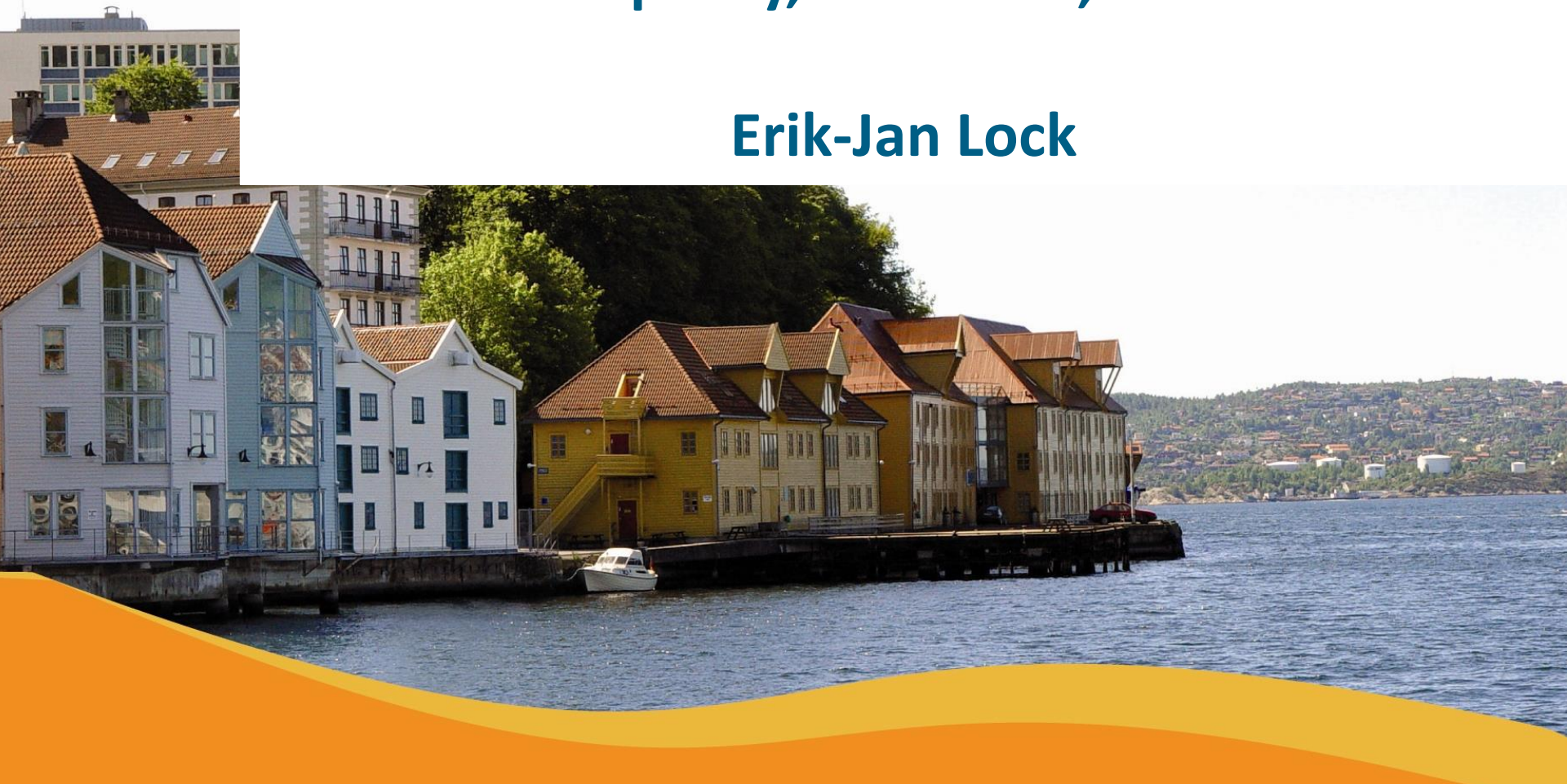
NIFES
NASJONALT INSTITUTT
FOR ERNÆRINGS- OG
SJØMATFORSKNING

Research projects on insects at NIFES

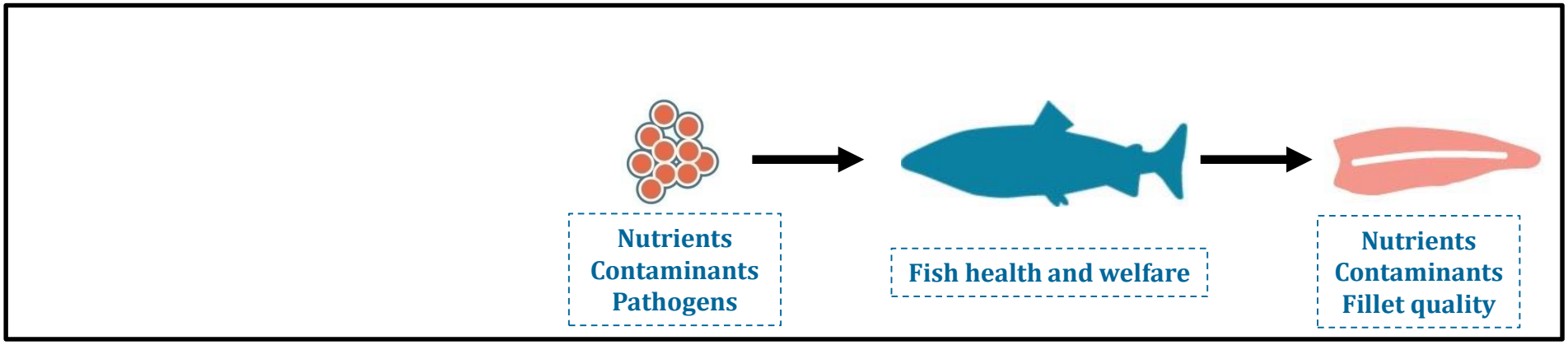
AquaFly, ENTOFÔR, NICE

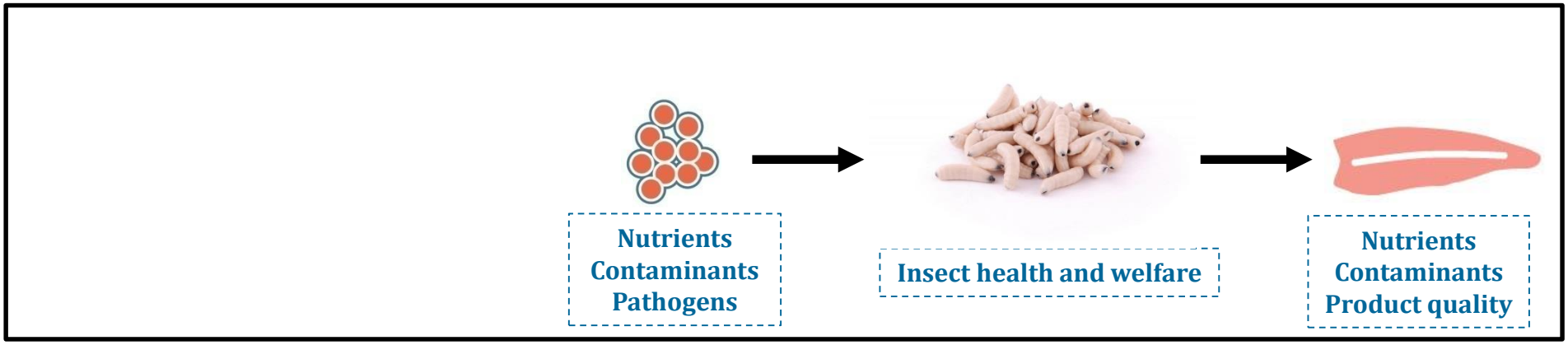
Erik-Jan Lock



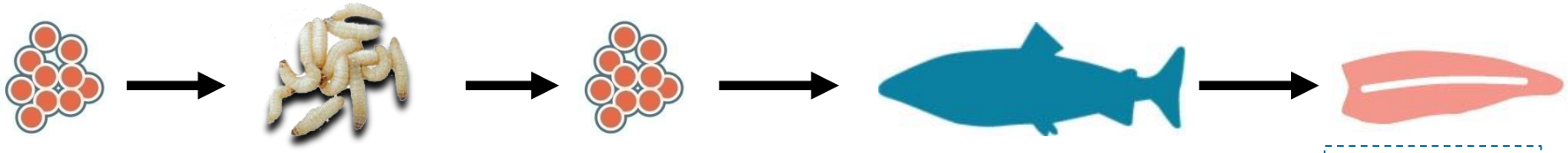
AQUAFLY

Forskningsrådet
The Research Council of Norway


Nutrients
Contaminants
Pathogens
Fish health and welfare
Nutrients
Contaminants
Fillet quality


Nutrients
Contaminants
Pathogens
Insect health and welfare
Nutrients
Contaminants
Product quality

Sustainability evaluation (social, environmental and economic) and ethical considerations



Nutrients, contaminants, pathogens

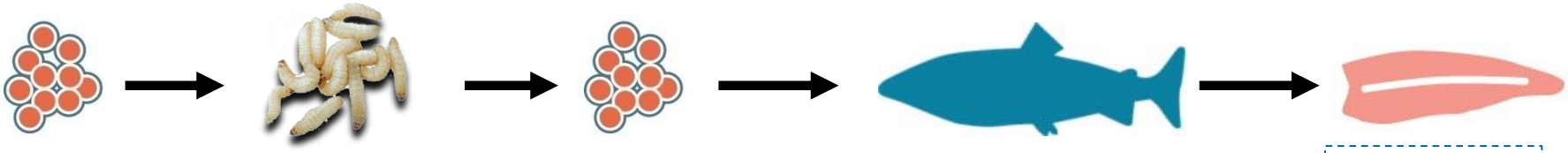
Fish health and welfare

Nutrients
Contaminants
Fillet quality

Universitas Bergensis

UAB Universitat Autònoma de Barcelona

Sustainability evaluation (social, environmental and economic) and ethical considerations



Nutrients, contaminants, pathogens

Fish health and welfare

Nutrients
Contaminants
Fillet quality

NUI Galway

PROTIX

EWOS

NIFES

NIFES

uni Research

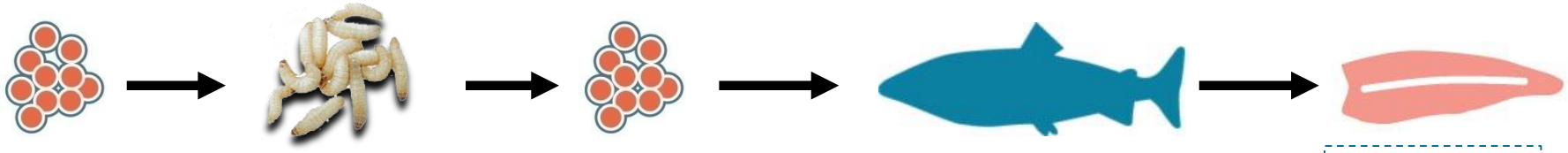
UNIVERSITY OF STIRLING

GIFAS

NIBIO
NORSK INSTITUTT FOR BIØØKONOMI

NMBU Norwegian University of Life Sciences

Sustainability evaluation (social, environmental and economic) and ethical considerations

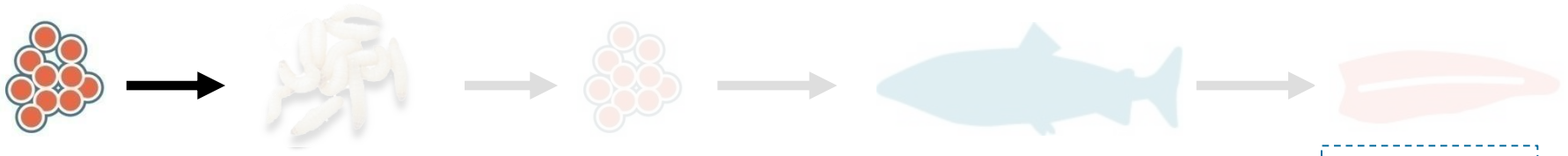


Nutrients, contaminants, pathogens

Fish health and welfare

Nutrients
Contaminants
Fillet quality

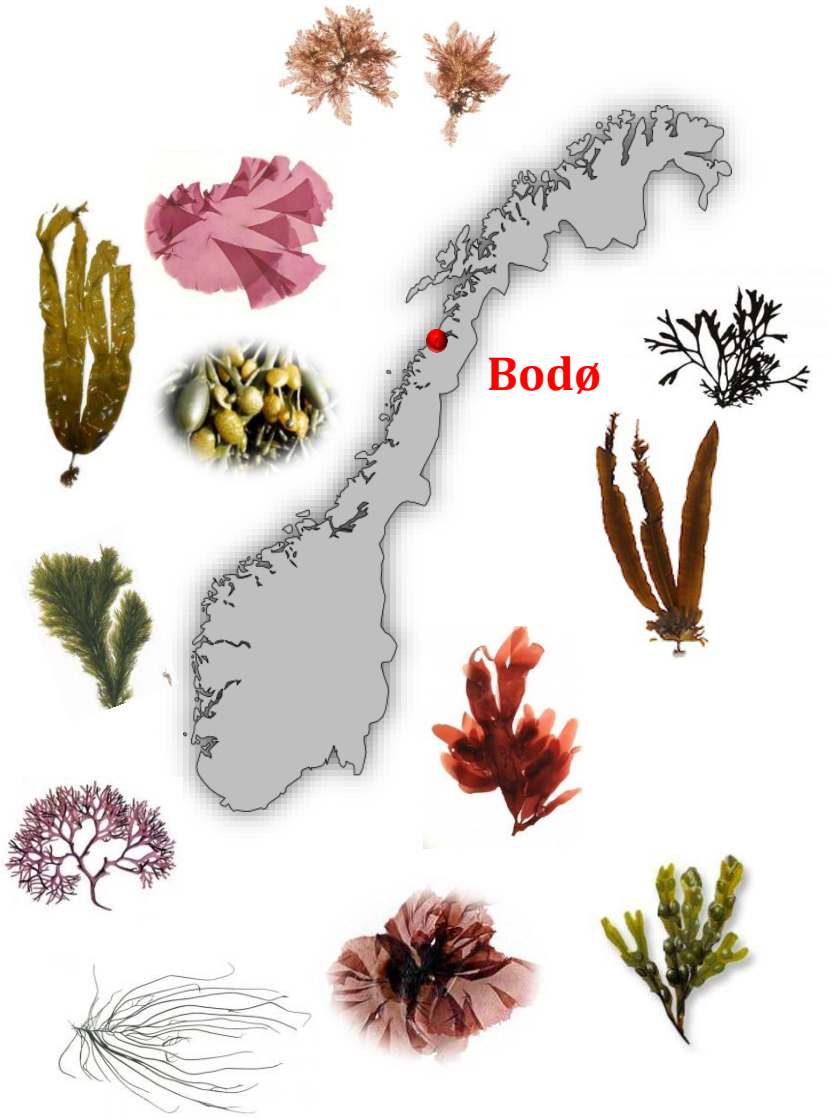
Sustainability evaluation (social, environmental and economic) and ethical considerations



Nutrients, contaminants, pathogens

Fish health and welfare

Nutrients
Contaminants
Fillet quality



Red algae

- Bangiales
  - *-Porphyra umbilicalis*
  - *-Porphyra dioica*
  - *-Porphyra purpurea*
- Gigartinales
  - *-Chondrus crispus*
  - *-Mastocarpus stellatus*
  - *-Furcellaria lumbricalis*
- Palmariales
  - *-Palmaria palmata*

Green algae

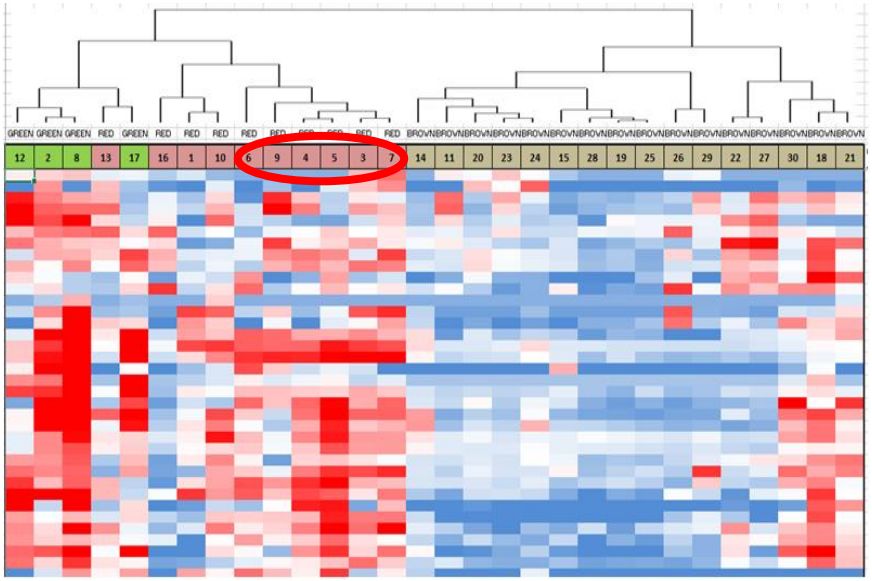
- Ulvales
  - *-Ulva lactuca*
  - *-Ulva intestinalis*
- Cladophorales
  - *-Cladophora rupestis*

Brown algae

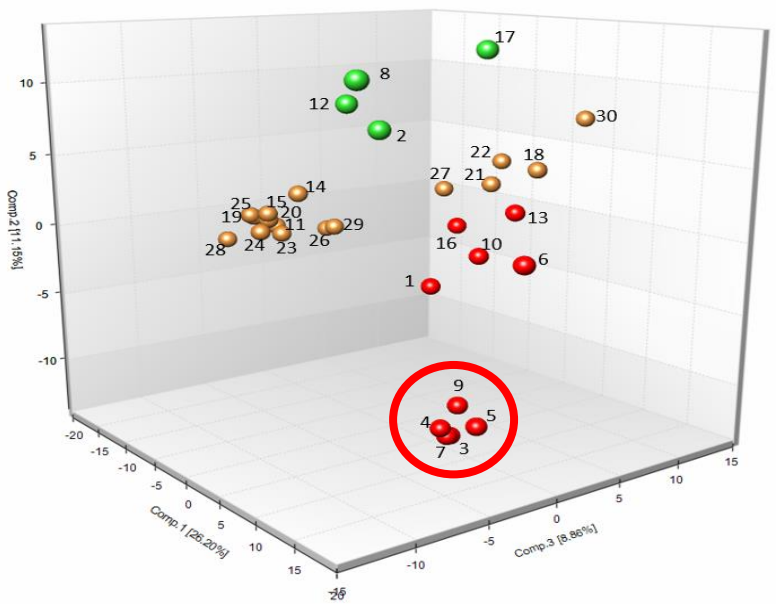
- Fucales
  - *-Fucus serratus*
  - *-Fucus vesiculosus*
  - *-Fucus spiralis*
  - *-Ascophyllum nodosum*
  - *-Pelvetia canaliculata*
  - *-Halidrys siliquosa*
  - *-Himanthalia elongata*
- Laminariales
  - *-Saccharina latissimi*
  - *-Alaria esculenta*
  - *-Laminaria digitate*
- Ectocarpales
  - *-Chordaria flagelliformis*

Porphyra cf. purpurea
Porphyra dioica
Porphyra cf. Umbilicalis
Palmaria palmata

Hierarchical cluster analysis



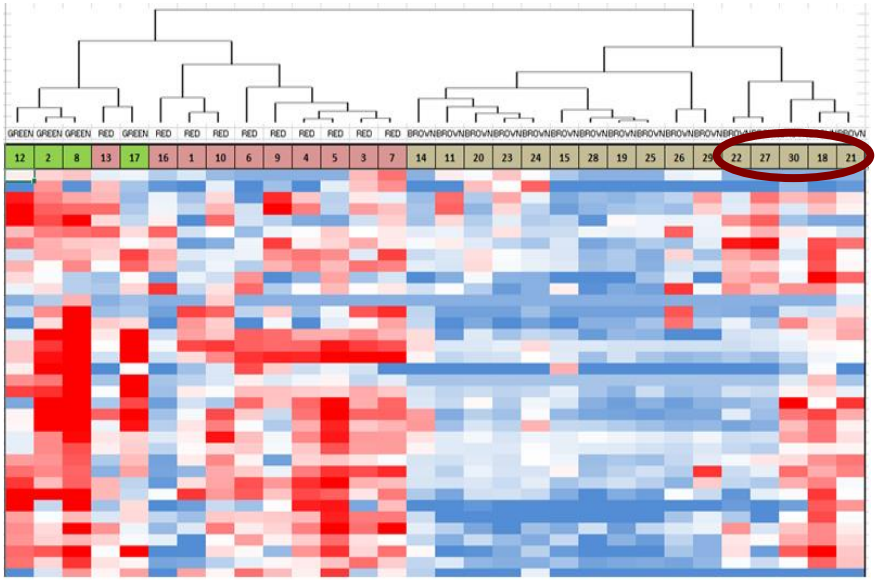
Unsupervised principal component analysis



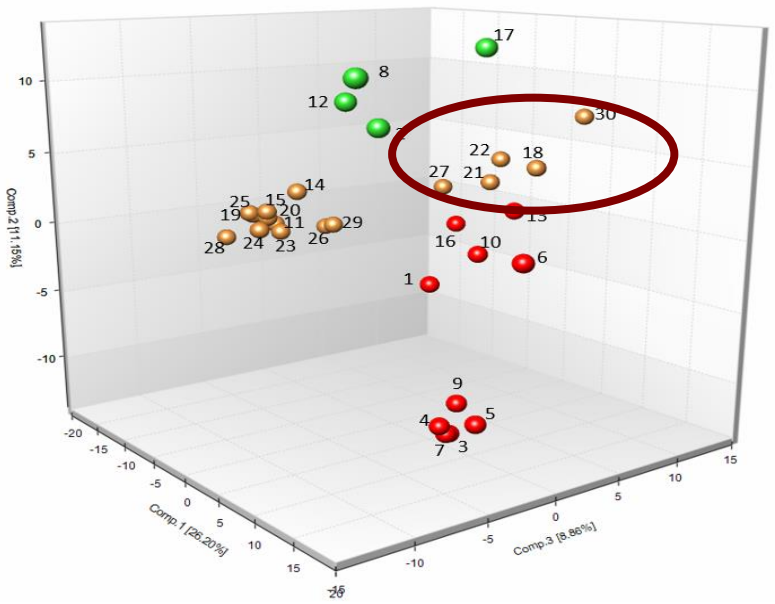
Bangiales and Palmariales species exhibited similar metabolite profiles in comparison to profiles from other red algae

Chordaria flagelliformis
Alaria esculenta
Saccharina latissima
Laminaria digitata

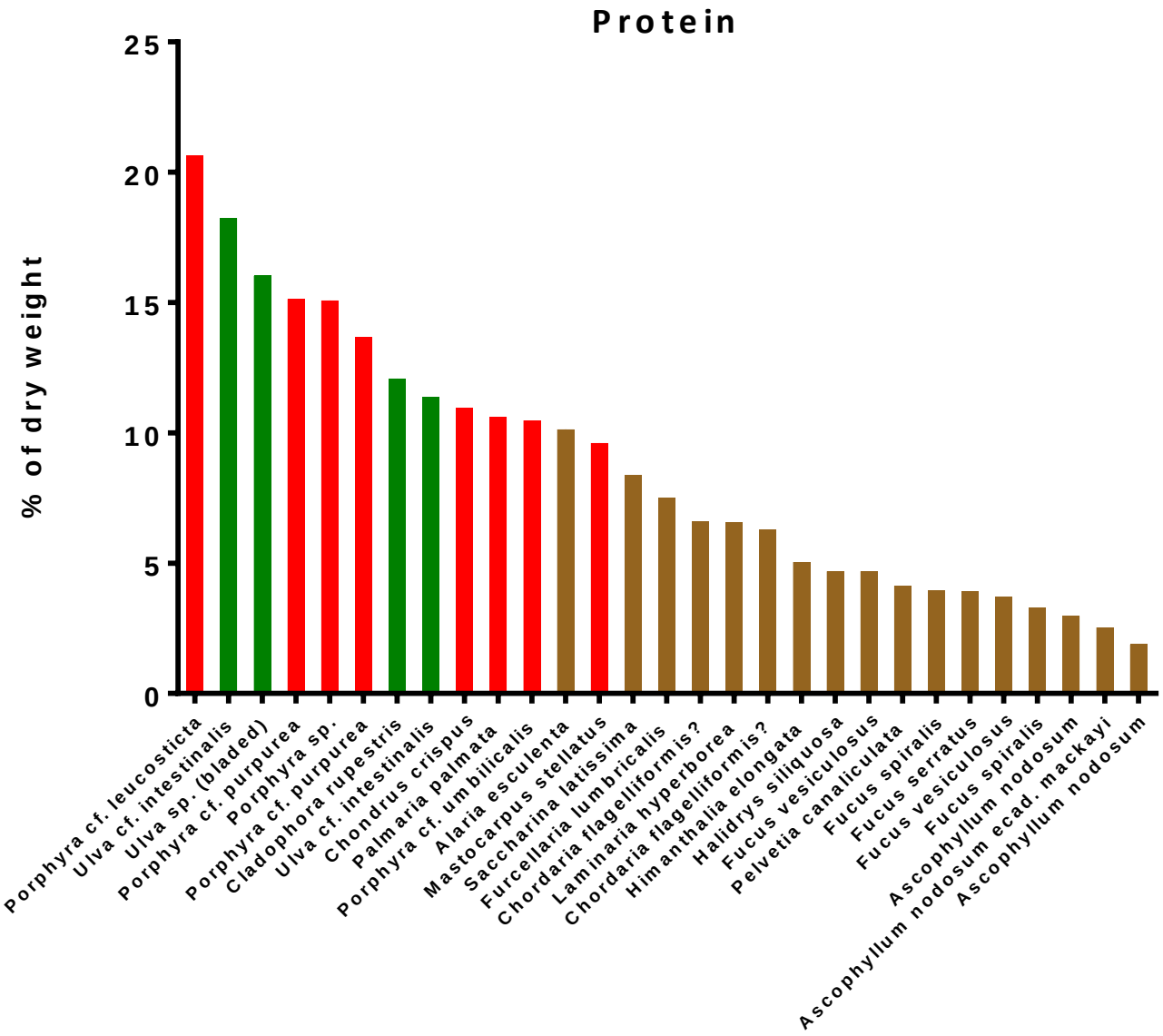
Hierarchical cluster analysis

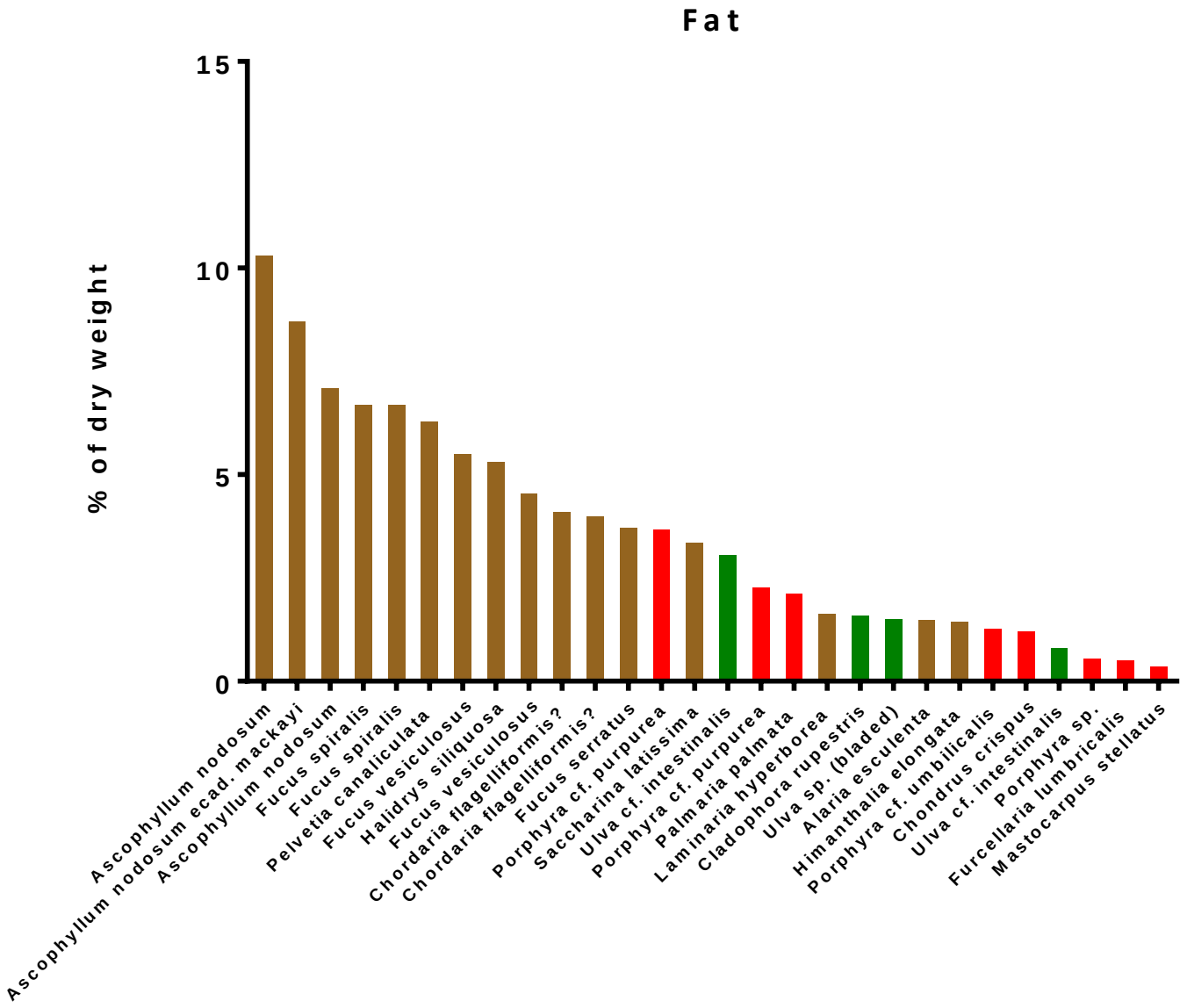


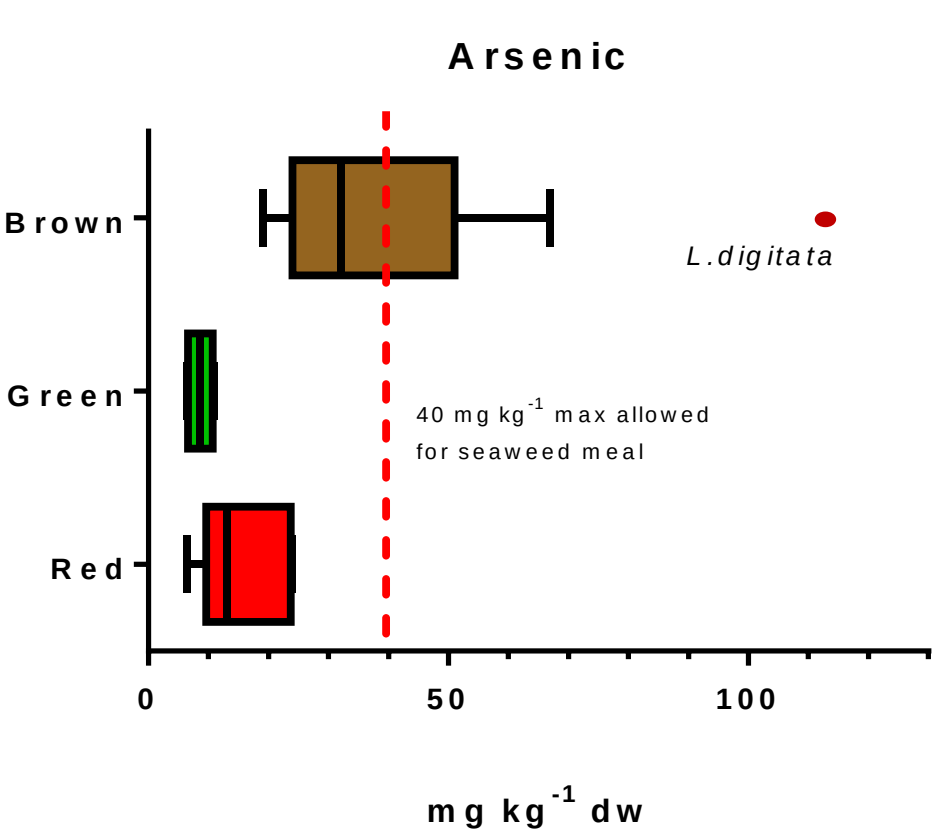
Unsupervised principal component analysis

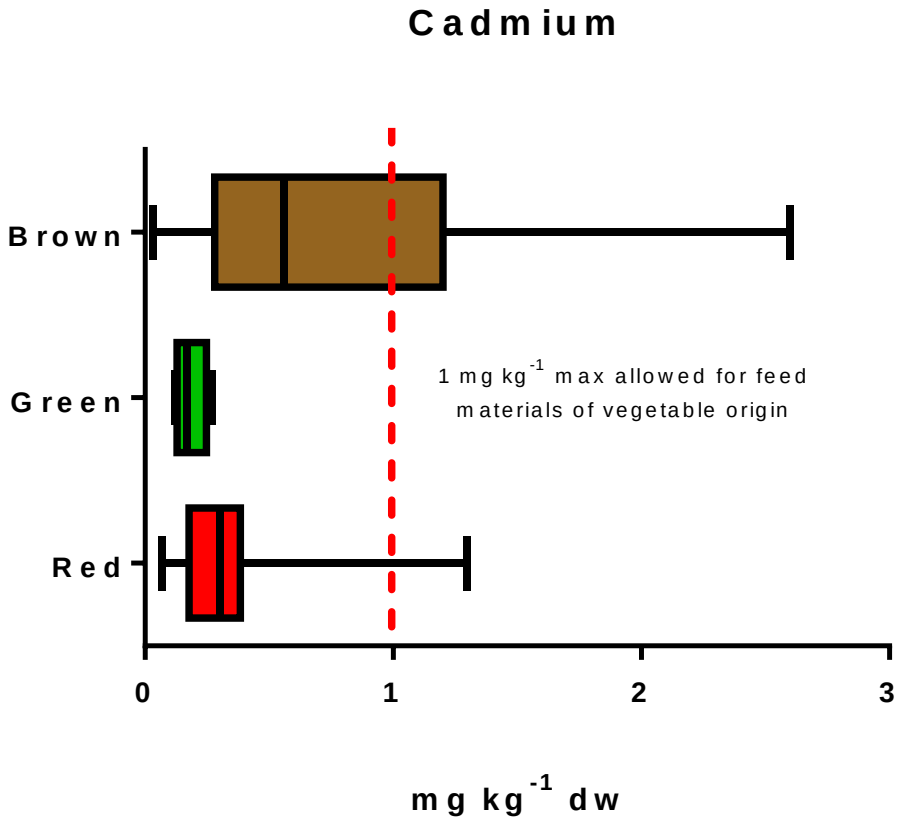


Metabolites of the algal species belongig to the laminariales and ectocarpales order were grouped separately

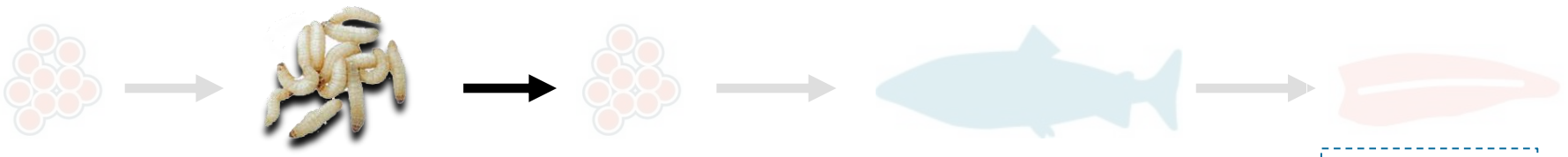

Protein
% of dry weight
25
20
15
10
5
0
Porphyra cf. leucosticta
Ulva cf. intestinalis
Ulva sp. (bladed)
Porphyra cf. purpurea
Porphyra sp.
Porphyra cf. purpurea
Cladophora rupestris
Ulva cf. intestinalis
Chondrus crispus
Palmaria palmata
Porphyra cf. umbilicalis
Alaria esculenta
Mastocarpus stellatus
Saccharina latissima
Furcellaria lumbricalis
Chordaria flagelliformis?
Laminaria hyperborea
Chordaria flagelliformis?
Himanthalia elongata
Halidrys siliquosa
Fucus vesiculosus
Pelvetia canaliculata
Fucus spiralis
Fucus serratus
Fucus vesiculosus
Fucus spiralis
Ascophyllum nodosum
Ascophyllum nodosum ecad. mackayi
Ascophyllum nodosum


Fat
% of dry weight
15
10
5
0
Ascophyllum nodosum
Ascophyllum nodosum ecad. mackayi
Ascophyllum nodosum
Fucus spiralis
Fucus spiralis
Pelvetia canaliculata
Fucus vesiculosus
Halidrys siliquosa
Fucus vesiculosus
Chordaria flagelliformis?
Chordaria flagelliformis?
Fucus serratus
Porphyra cf. purpurea
Saccharina latissima
Ulva cf. intestinalis
Porphyra cf. purpurea
Palmaria palmata
Laminaria hyperborea
Cladophora rupestris
Ulva sp. (bladed)
Alaria esculenta
Himanthalia elongata
Porphyra cf. umbilicalis
Chondrus crispus
Ulva cf. intestinalis
Porphyra sp.
Furcellaria lumbricalis
Mastocarpus stellatus


Arsenic
Brown
Green
Red
L.digitata
40 mg kg-1 max allowed
for seaweed meal
0
50
100
mg kg-1 dw


Cadmium
Brown
Green
Red
1 mg kg-1 max allowed for feed
materials of vegetable origin
0
1
2
3
mg kg-1 dw

Sustainability evaluation (social, environmental and ethical considerations



Nutrients, contaminants, pathogens

Fish health and welfare

Nutrients
Contaminants
Fillet quality

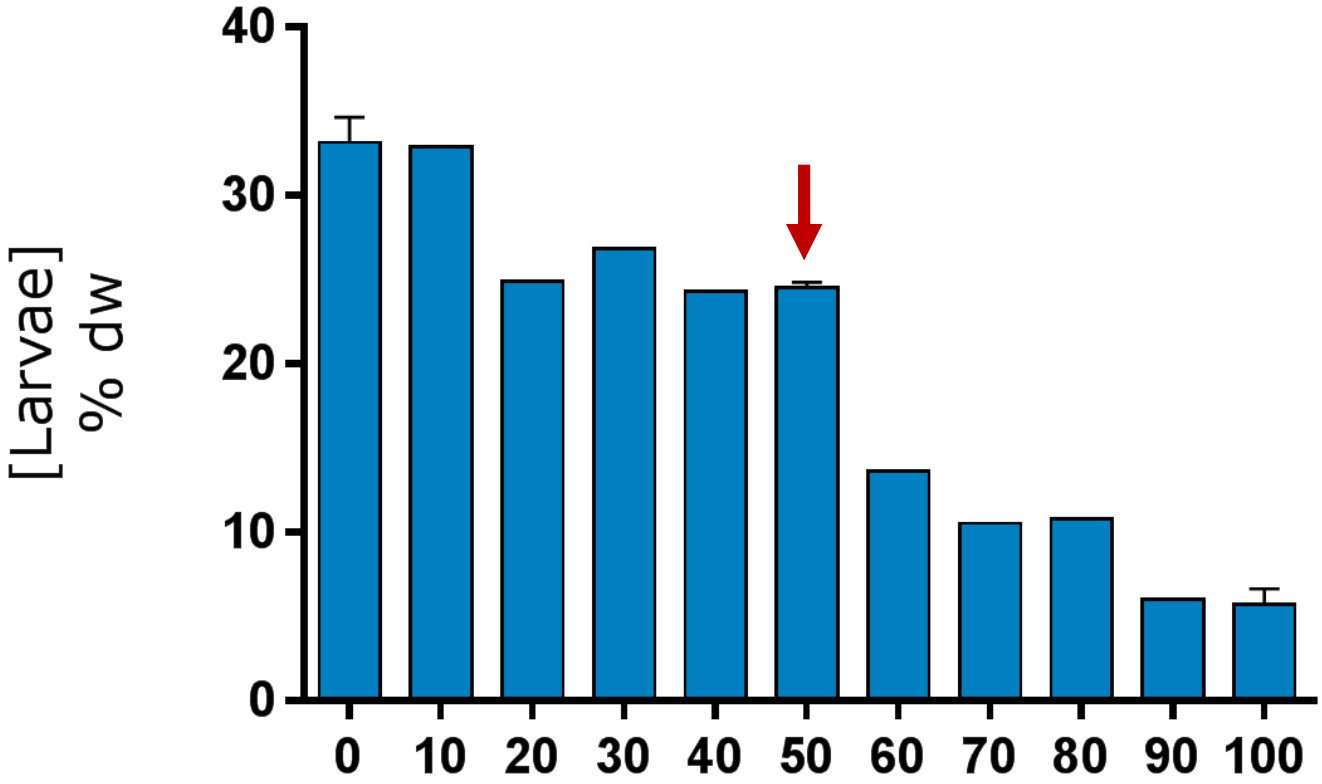
Feasible

Seaweed (%)	0	10	20	30	40	50	60	70	80	90	100
Control (%)	100	90	80	70	60	50	40	30	20	10	0

BSF composition

NIFES

- Protein content **35-40** % DM in all groups
- Amino acid profile does not change in the larvae fed seaweed enriched media
- Lipid content changes:



Eicosapentaenoic acid

NIFES

EPA

~1 % EPA

Iodine

NIFES

I

SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 5 October 2015

PUBLISHED: 8 October 2015

doi:10.2903/j.efsa.2015.4257

Risk profile related to production and consumption of insects as food and feed

EFSA Scientific Committee

Abstract

The present opinion has the format of a risk profile and presents potential biological and chemical hazards as well as allergenicity and environmental hazards associated with farmed insects used as food and feed taking into account of the entire chain, from farming to the final product. The opinion also addresses the occurrence of these hazards in non-processed insects, grown on different substrate categories, in comparison to the occurrence of these hazards in other non-processed sources of protein of animal origin. When currently allowed feed materials are used as substrate to feed insects, the possible occurrence of microbiological hazards is expected to be comparable to their occurrence in other non-processed sources of protein of animal origin. The possible occurrence of prions in non-processed insects will depend on whether the substrate includes protein of human or ruminant origin. Data on transfer of chemical contaminants from different substrates to the insects are very limited. Substrates like kitchen waste, human and animal manure are also considered and hazards from insects fed on these substrates need to be specifically assessed. It is concluded that for both biological

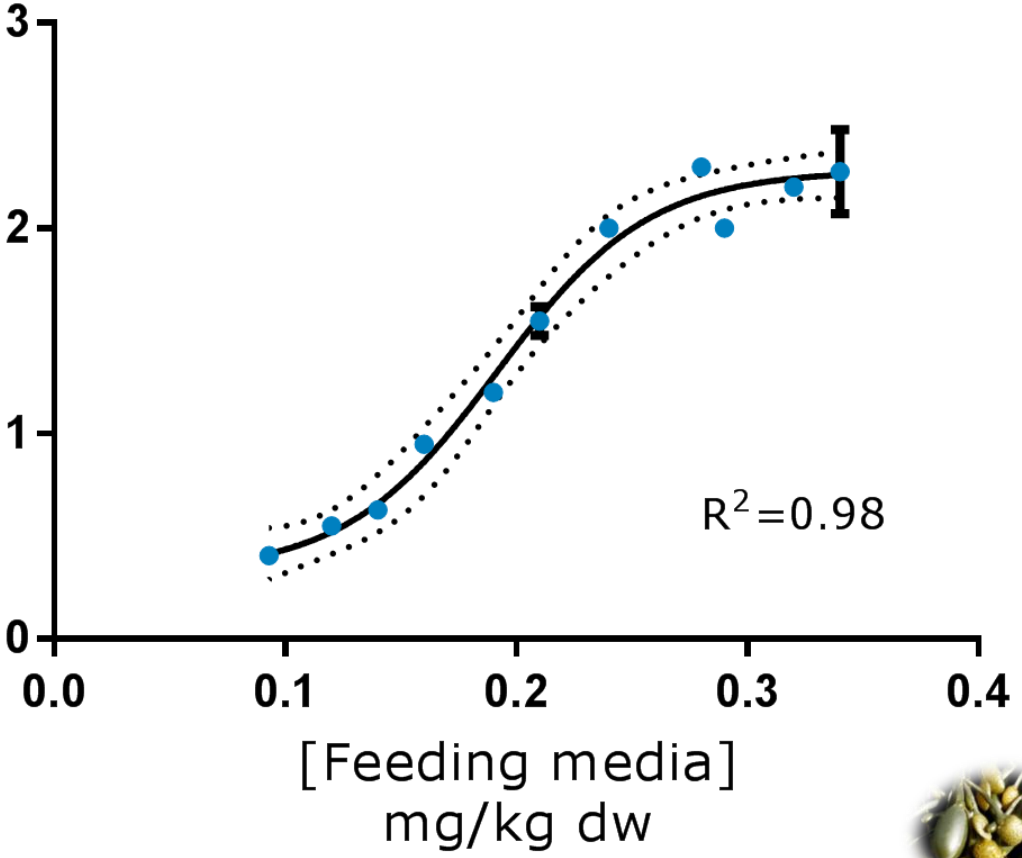
Undesirable elements

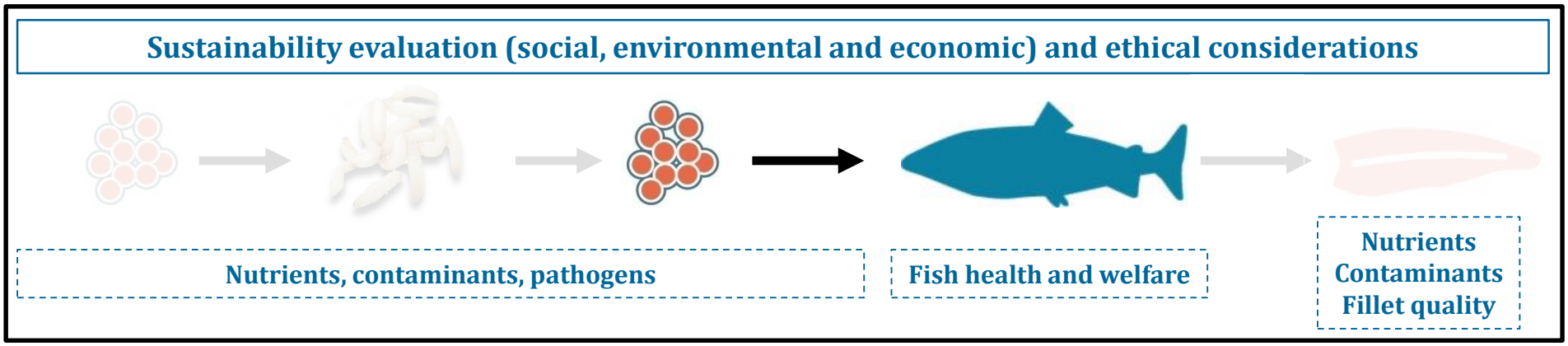
NIFES

As

Undesirable elements

Cd





Two feeding trials:

- Freshwater salmon (2016)
  - EWOS
  - 8 weeks
  - Start 50 gr – End 130 gr
- Seawater salmon (2017)
  - GIFAS
  - 6 months
  - Start 1 kg – 4 kg

Freshwater feeding trial EWOS

NIFES

Protein	Fish meal SPC	**Diet 1**	**Diet 2**	**Diet 3**
	Insect meal	**Diet 4**	**Diet 5**	**Diet 6**
		Fish oil	Insect lipid Protix	Insect lipid AquaFly
		Lipid		

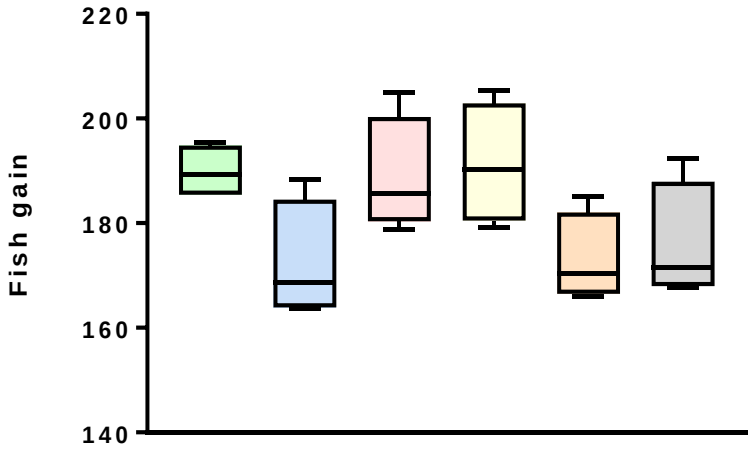
Formulation and proximate composition of the experimental diets

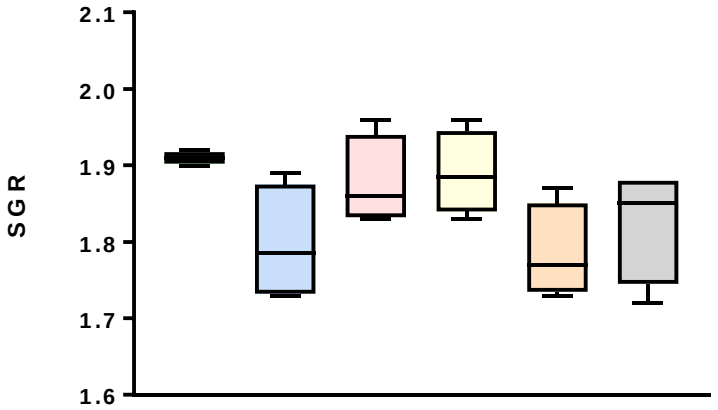
NIFES

	CTL	FM/IL	FM/ILAF	IM/FO	IM/IL	IM/ILAF
FM LT94	35	35	35	6	6	6
IM	0	0	0	60	60	60
VPC	29.6	29.5	29.5	5	5	5
Binder	14.3	14.3	14.3	14.4	14.4	14.4
FO	4.6	4.6	4.6	6.9	6.9	6.9
Veg Oil	12	0	0	4.8	0	0
Insect Oil	0	12	0	0	4.8	0
Aquafly Oil	0	0	12	0	0	4.8
Vit&Min premix	0.3	0.3	0.3	0.3	0.3	0.3
Misc	4.2	4.2	4.2	2.6	2.6	2.6
Sum	100	100	100	100	100	100
	0%	12%	12%	60%	65%	65%

FA (mg g^{-1})	CTL	FM/IL	FM/ILAF	IM/FO	IM/IL	IM/ILAF
12:0	**<0.01**	**41**	**33.7**	**35.3**	**47.9**	**48**
14:0	**3.9**	**12.7**	**12.2**	**12**	**14.4**	**15.2**
16:0	**12.4**	**22.4**	**20.7**	**24.7**	**26.6**	**27.8**
Saturated FA	**20.3**	**81.4**	**71.2**	**78.6**	**95.5**	**97.8**
Sum MUFA	**88.9**	**41.2**	**39.2**	**73.0**	**45.2**	**47.8**
Sum n-3	24.7	17.3	16.4	21.8	15.0	15.8
Sum n-6	22.6	20.9	16.3	27.8	25.9	25.5
Sum PUFA	47.3	38.2	32.7	49.6	41.0	41.4

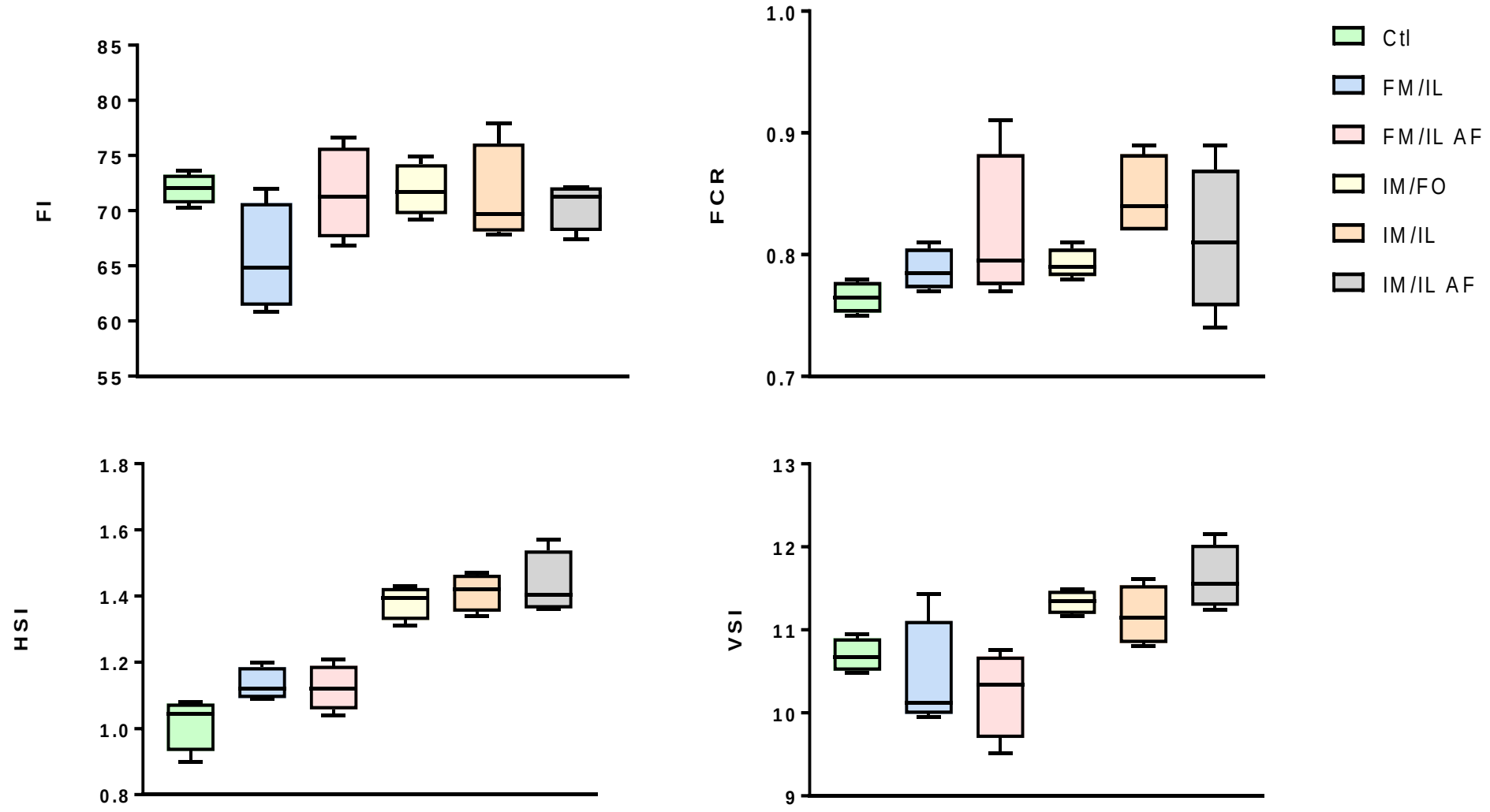
Growth performances

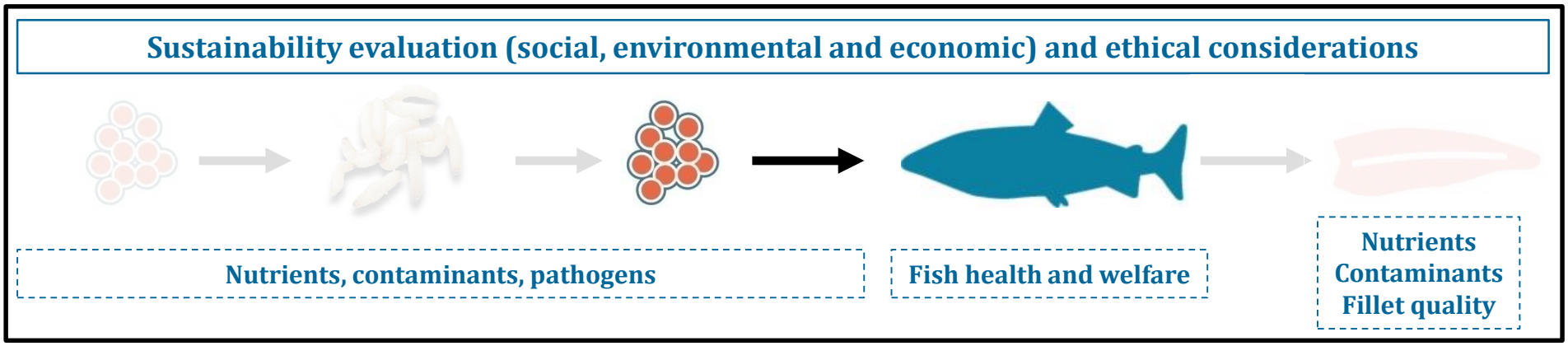




The lipid sources had a significant effect on fish gain and specific growth rate, no effect of protein source

Growth performances





- Seawater salmon (2017)
  - GIFAS
  - 6 months
  - Start 1 kg – 4 kg

Insect lipid

Insect meal

Insects in the Circular Economy

NIFES

AQUAFLY

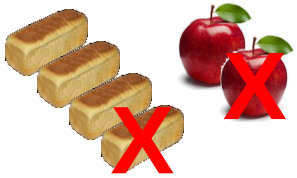
Underused (marine) resources

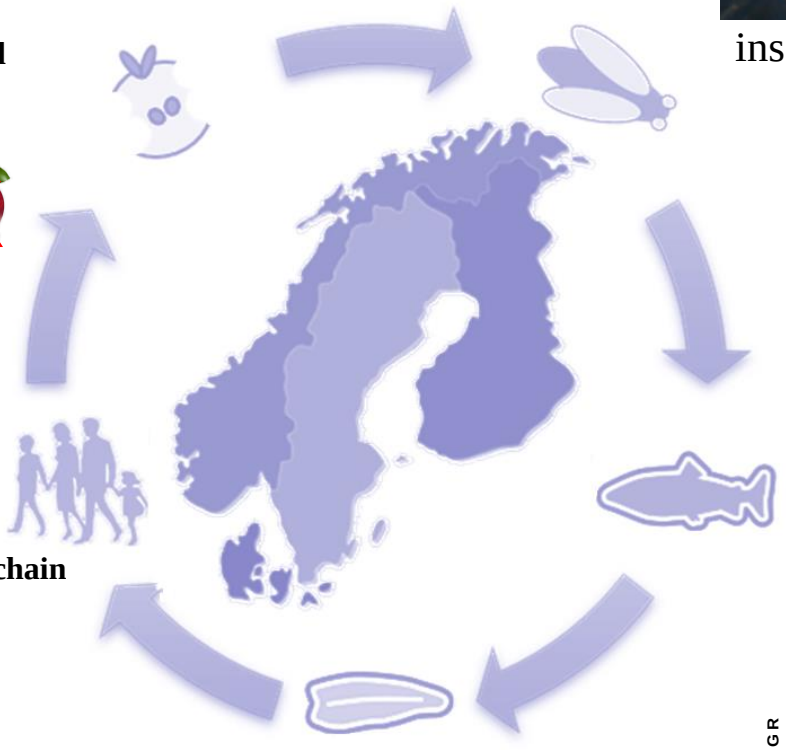
Insects convert <u>carbohydrate-rich</u> organic material into <u>animal protein and lipid</u>

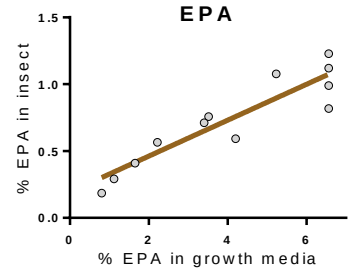
insectmeal

insectlipid

One third of the world's food is wasted
<u>1.3 billion tons</u>

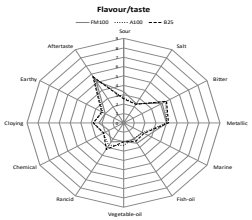




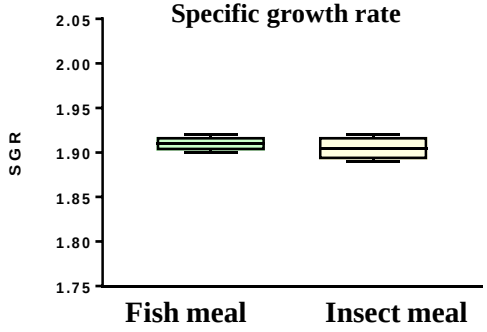


Retain valuable nutrients in the food chain and increase protein supply in a sustainable manner

Fillet quality
Food safety
Sensory testing



Specific growth rate



ENTOFÔR

from waste to resource

Forskningsrådet

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Universiteit Leiden

WAGENINGEN UR
For quality of life

cra-w

NorInsect AS

Myldregard AS

EURL
European Union Reference Laboratory

InvertaPro

NG
Norsk Gjenvinning

Orkla
Foods Norge

Botngaard Bioprotix AS

Main aim

To deliver knowledge and tools that policy makers, companies and other stakeholders need to direct and develop a waste-fed insect industry for feed production in Norway

WP 1: Identify attractive Norwegian organic waste streams that may be converted by insects to produce raw materials for animal feed
(WP1 leader: Ivar Pettersen, NIBIO)

Task 1.1: Identify factors determining suitability of organic waste as insect feed



Task 1.2. Segmented study of waste streams for insect production

WP 2: Evaluate and establish insect species cultures and methods that are relevant to convert the suggested waste streams into protein feed sources
(WP2 leader: Ingeborg Klingen, NIBIO)

Task 2.1: Determine insect species and establish methods for insect cultures on suggested organic waste streams



Task 2.2: Test relevant waste streams as insect feed
- Insect feeding studies

Work package 3: Development of insect functional ingredients
(WP3 leader: Vincenzo Fogliano, WUR)

Task 3.1: Development and characterization of protein based insect ingredients
- Cost-effective isolation and fractionation of insect protein
- Digestibility test in fish

Task 3.2: Development and characterization of lipid based insect ingredient
- Optimization of lipid extraction methods
- Test in aquafeed

WP 4. Develop methods for detection and tracing of non-legal waste use in the insect production chain
(WP leader: Marc Berntssen NIFES)

Task 4.1.: Peptidomic profiling of different insect species reared on specific waste products

Task 4.2.: Quantification of specific waste products or insect species in a feed ingredient mixture

WP 5: Validate and perform a wide scope screening for pesticides and mycotoxins for insect reared on different waste products
(WP leader: Marc Berntssen, NIFES)

Task 5.1. Development and validation of a wide scope screening method for detection of pesticides and mycotoxins in insect feed and insect products

Task 5.2. Screening of pesticides and mycotoxins in several waste substrates and insect materials

WP6 Communication with stakeholders and dissemination of results
(WP leader: Erik-Jan Lock, NIFES)

Task 6.1 Participation and communication with stakeholders and end-users

Task 6.2 Project website with project activities and results

NICE NETWORK ON INSECTS IN THE CIRCULAR ECONOMY

Task 6.3: Project management

NICE aims to form a knowledge base that can support sustainable development of the insect industry in Norway and the Nordic region.

1. Organizing seminars in Norway, Sweden, Finland and Denmark
2. Website: insect-network.org (.com)

www.insect-network.org


NICE
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Projects
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Events
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Network on Insects in the Circular Economy
From waste to high value products
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What is NICE?
Where?
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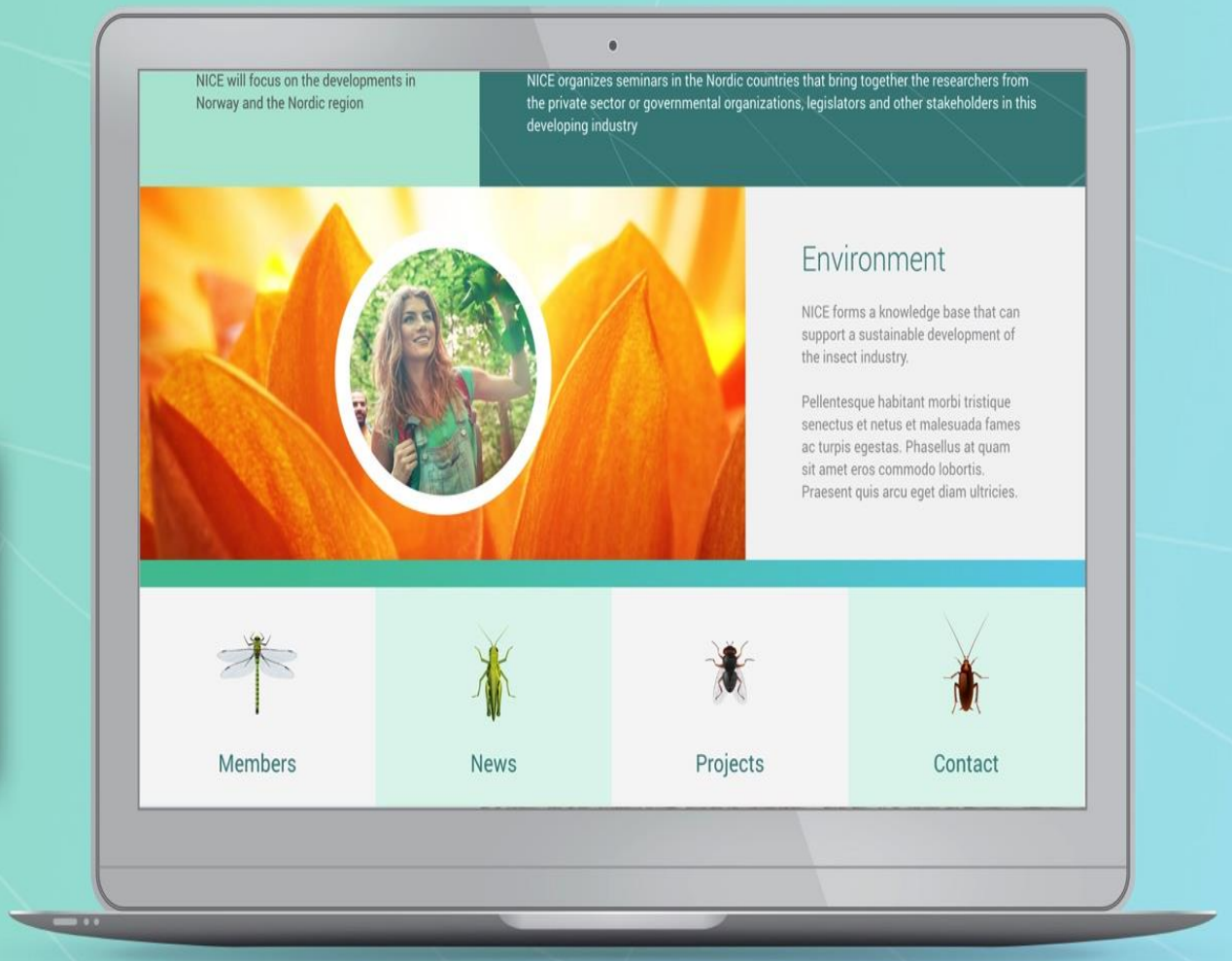
NICE will focus on the developments in Norway and the Nordic region
NICE organizes seminars in the Nordic countries that bring together the researchers from the private sector or governmental organizations, legislators and other stakeholders in this developing industry
Environment
NICE forms a knowledge base that can support a sustainable development of the insect industry.
Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Phasellus at quam sit amet eros commodo lobortis. Praesent quis arcu eget diam ultricies.
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Vi skal producere insekter til middagsbordet
Category: Innovasjonsfonden Danmark Tags: Food, Denmark, Industry, Investment
Danmark skal være foregangsland for bæredygtig industriel produktion af insekter til foder og fødevarer. Nyt projekt i Innovationsfonden vil anvende organiske rester og spildprodukter til at opdrætte insekter i industriel skala.
Fondens investering
• Investeringsprogram: Grand Solutions
• Investering: 19 mio kr.
• Samlet budget: 28 mio. kr.
• Varighed: 3 år
Potentiale
Med en stadig øget befolkning såvel i Danmark som i resten af verden stiger behovet for at producere føde. Her kan produktion af insekter til fødevarer være en effektiv kilde til mad. Eksempelvis kan man ud fra 10 kilo foder producere 4,5 kilo melorme, men blot 2,5 kilo gris og så lidt som 1,1 kilo kvæg.

Thank you for your attention!