Bioressource insects and biodiversity - opportunities and challenges

Birgit Rumpold, Michael Klocke and Oliver Schlüter
Leibniz-Institute for Agricultural Engineering Potsdam-Bornim e.V. (ATB), Germany

- 300 Employees
- Budget: 20 Mio €
- Incl. third party funding
- Approx. 160 external research partners

The four Research Programs of the ATB.
Leibniz Research Alliance „Sustainable Food Production and Healthy Nutrition“

- 14 Leibniz Institutes
- Interdisciplinary network
- focus on the two societal challenges sustainability and health
Content

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3. Insects as feed
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Class Insecta

- Lat.: „insectum“ = cut into sections
- 3 body parts: head, thorax, abdomen
- Phylum: Arthropoda/ Subphylum: Hexapoda
- 6 legs
- More than 1 million described species
- Chitinous exoskeleton
- Metamorphosis (holo- or hemimetabolism)
Role of insects

- Plant pollination
- Natural pest control
- Degradation of organic material (e.g. dead plants)
- Feed
- Food
Edible insects - facts

- Consumed by more than 2 billion people worldwide
- 1,900 edible species known

Ento: http://www.core77.com/blog/case_study/case_study_ento_the_art_of_eating_insects_21841.asp
2. Insects as food

Entomophagy worldwide

Number of edible insects per country in the world. The total number of insects species in the world amounts to 1909. The data (updated March 2012) has been compiled by Yde Jongema from literature (see http://www.ent.wur.nl/UK/Edible+insects/Worldwide+species+list/).

Realization: GRS group Wageningen University. Remark: countries not showing recorded edible insects species only indicates that it is not mentioned in literature.
2. Insects as food

Relevant food species (consumption [%])

- Coleoptera – beetles (31%)
- Lepidoptera – caterpillars (18%)
- Hymenoptera – bees and ants (14%)
- Orthoptera – crickets, locusts, grasshoppers (13%)
- Hemiptera – true bugs (10%)
- Isoptera – termites (3%)
- Odonata – dragonflies (3%)
- Diptera – true flies (2%)

(Source: van Huis et al., 2013)
Average nutrient composition of edible insects

(Data derived from literature, Rumpold & Schlüter 2013; n = Data amount; NFE – nitrogen-free extract (carbohydrates); based on dry matter)
Edible insects - facts

- Consumed by more than 2 billion people worldwide
- 1,900 edible species known
- Rich in protein, fat, micronutrients
- High feed conversion efficiency
- Multivoltinism
- Low space requirements
- Low GHG emissions
- Organic waste valorisation
Liabilities of edible insects

- Toxic potential (production of toxins as defense mechanisms, sequestering of toxins via feed uptake)
- Potential heavy metal and pesticide content (via feed uptake)
- Allergenic potential (contains e.g. tropomyosin)
- Anti-nutrients
- Zoonotic risks (insects function as vectors)
- Microbiological risk (pathogens, spores, spoilage bacteria such as enterobacteriaceae)

Safe and controlled rearing conditions including substrate and personnel are mandatory
Legislation and food insects

REGULATION (EC) No 258/97 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 27 January 1997
concerning novel foods and novel food ingredients

1. This Regulation concerns the placing on the market within the Community of novel foods or novel food ingredients.
2. This Regulation shall apply to the placing on the market within the Community of foods and food ingredients which have not hitherto been used for human consumption to a significant degree within the Community and which fall under the following categories:

- (c) foods and food ingredients with a new or intentionally modified primary molecular structure;
- (d) foods and food ingredients consisting of or isolated from micro-organisms, fungi or algae;
- (e) foods and food ingredients consisting of or isolated from plants and food ingredients isolated from animals, except for foods and food ingredients obtained by traditional propagating or breeding practices and having a history of safe use;
- (f) foods and food ingredients to which has been applied a production process not currently used, where that process gives rise to significant changes in the composition or structure of the foods or food ingredients which affect their nutritional value, metabolism or level of undesirable substances.

- no history of "significant" consumption in the European Union prior to 15 May 1997.

✓ Obtained by traditional breeding practices and having a history of safe use.
Insects as feed

- Insects represent a natural feed source e.g. for birds and fish, reptiles
- Potential replacement of soy bean and fish meal
- Due to feed ban not allowed in Europe
Average amino acid spectra of edible insects

(data derived from literature, Human amino acid requirement: WHO; Soy meal 48: www.feed-alp.admin.ch/fmkatalog; n = Data amount)
## Quality of insect proteins as feed

<table>
<thead>
<tr>
<th>(rats, t=28 days)</th>
<th>FI</th>
<th>WG</th>
<th>TD [%]</th>
<th>NPU</th>
<th>PER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apis mellifera (bee; dried)</td>
<td>284.35</td>
<td>45.9</td>
<td>79.8</td>
<td>42.5</td>
<td>1.50</td>
</tr>
<tr>
<td>Honey bee protein</td>
<td>406.45</td>
<td>104.03</td>
<td>94.3</td>
<td>62.0</td>
<td>2.47</td>
</tr>
<tr>
<td>Casein</td>
<td>352.80</td>
<td>96.67</td>
<td>96.8</td>
<td>70.0</td>
<td>2.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(rats, t=4 weeks)</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Defatted spent silkworm pupae (B. mori)</td>
<td>233</td>
<td>47</td>
<td>67</td>
<td>45</td>
<td>1.39</td>
</tr>
<tr>
<td>Casein</td>
<td>301</td>
<td>84</td>
<td>72</td>
<td>2.50</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(rats, t=7 days)</th>
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<tbody>
<tr>
<td><em>Rynchophorus phoenicus</em></td>
<td>75.40</td>
<td>8.59</td>
<td>91.79</td>
<td>1.31</td>
<td></td>
</tr>
<tr>
<td><em>Imbrasia belina</em> larvae</td>
<td>59.40</td>
<td>4.30</td>
<td>86.03</td>
<td>0.87</td>
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</tr>
<tr>
<td>Casein</td>
<td>80.60</td>
<td>8.60</td>
<td>92.57</td>
<td>1.22</td>
<td></td>
</tr>
</tbody>
</table>

- Removal of chitin improves protein quality

- **FI** – feed intake [g/t/rat], **WG** – weight gain [g/t/rat], **TD** – true digestibility, **NPU** – net protein utilisation, **PER** – protein efficiency ratio; Ozimek et al (1985); Rao (1994); Ekpo (2011)
Legislation and feed insects

- Lifting of feed ban (EU 999/2001) regarding feeding processed non-ruminant animal protein in aquaculture (June 1st, 2013)
- In aquaculture the lift of the feed ban only valid for proteins from "slaughtered" non-ruminants
- Feeding of insect proteins to poultry, pigs and cattle to date prohibited.
Other applications

“Yellow biotechnology” = Insect biotechnology:
Production of e.g. novel enzymes, microorganisms, antibiotics (antimicrobial peptides), chemicals

Degradation/valorisation of organic residues
E.g. food waste, manure, lignocellulose

Fertilizer
Frass and rearing residues
Opportunities

- Bioconversion and valorization of organic residues to food, feed, chemicals, enzymes, and bioactive substances
- Direct contribution to food and feed as well as protein and nutrient security
- Alternative to meat
- Replacement of soy bean and fish meal in feed
  → Contribution to forest and aquatic biodiversity
- Immense potential in insect biodiversity
  → Application of to date unexploited species
Challenges

- Ecological services provided by insects are vital for food and feed security
  → Insect preservation

- The majority of insects used as food is to date collected in the wild
  → controlled mass rearing to prevent overexploitation

- Potential hazard of foreign insect species on the indigenous ecosystem

- Consumer acceptance of insects as food

- Legal barriers on the use of insects as food and feed
Future research

- Identification and investigation of known and unknown insect species and their potential applications
- Investigation of microbial/ enzymic/genetic potential of insects
- Development of safe mass rearing and processing methods for insects as food and feed
Thank You!