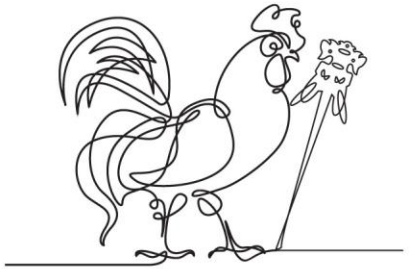

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Insects in poultry feeding: regulatory issues and production of insects as feed

WAGENINGEN UNIVERSITY & RESEARCH

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Content

- Global use of animal feed
- Protein transition
- Insects in the value chain
- Biowaste categories as medium to grow insects
- Insect species
- Insect (products)
- Products and animal feed market – Legislation
- Nutritional value and variation
- Bioactive properties of insect products
- Summary
- Future research

Global use of animal feed

- Estimated: 1236 million tons compound feed in 2021
- Prediction: 1500 million tons compound feed in 2050

Feed per region 2021 vs. 2020 (million metric tons)

Region	2020 (MMT*)	2021 (MMT)	Growth MMT	Growth (%)
Africa	43.201	44.221	1.020	2.4%
Asia-Pacific	433.610	458.121	24.511	5.7%
Europe	270.205	266.840	(3.365)	-1.2%
Latin America**	177.572	178.382	0.811	0.5%
Middle East	24.791	24.592	(0.199)	-0.8%
North America***	248.123	252.928	4.805	1.9%
Oceania	10.359	10.433	0.074	0.7%
Grand Total	**1,207.861**	**1,235.517**	**27.656**	**2.3%**

**Million metric tons*

***Latin America includes all Central-American countries, including Mexico.*

****North America includes Canada and the U.S.*

Global use of animal feed

- Top ten feed-producing countries 2021 vs. 2020

2021 Top Ten Feed-Producing Countries	2020 Total Feed Production (MMT)	2021 Total Feed Production (MMT)	Var. 2020 to 2021 (MMT)	Var. (%)
China	239.980	261.424	21.444	8.9%
USA	226.753	231.538	4.785	2.1%
Brazil	78.413	80.094	1.681	2.1%
India	39.256	44.059	4.803	12.2%
Mexico	37.925	38.857	0.932	2.5%
Spain	34.841	35.580	0.739	2.1%
Russia	32.531	33.000	0.469	1.4%
Turkey*	26.300	25.300	(1.000)	-3.8%
Japan	24.821	24.797	(0.024)	-0.1%
Germany	24.930	24.506	(0.424)	-1.7%
Grand Total	**765.75**	**799.16**	**33.405**	**4.4%**

**Turkey increased in rank, entering the list of top ten feed-producing countries. As a result, Argentina dropped out of the top ten.*

Global use of animal feed

- Feed production by sector 2021 vs. 2020

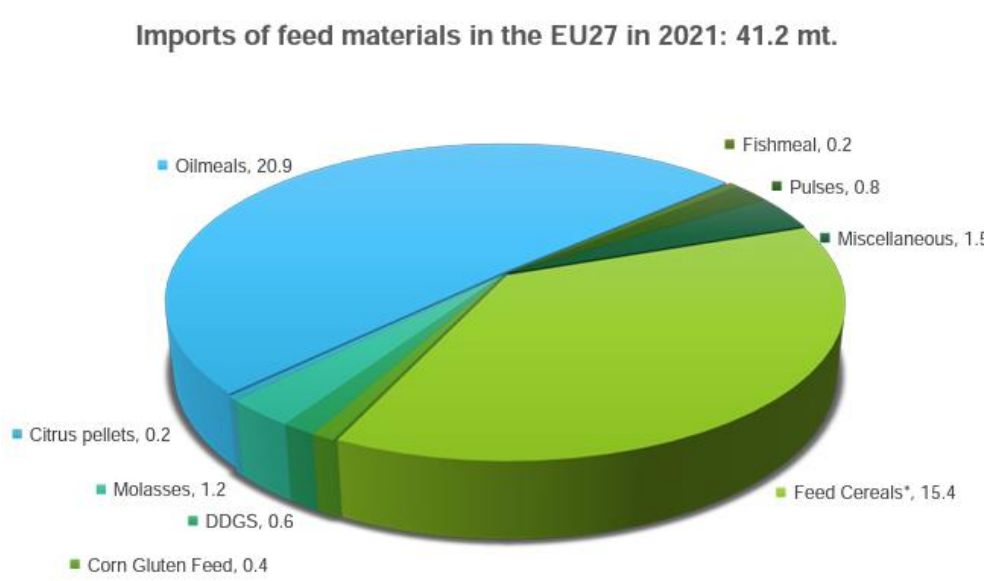
Sector	2020 (MMT)	2021 (MMT)	Growth (MMT)	Growth (%)
Broiler	343.098	350.921	7.823	2.3%
Pig	290.904	310.214	19.310	6.6%
Layer	161.073	158.789	(2.285)	-1.4%
Dairy	130.433	132.946	2.513	1.9%
Beef	117.758	115.486	(2.271)	-1.9%
Aquaculture	49.530	51.355	1.826	3.7%
Pet	31.587	34.165	2.578	8.2%

Protein transition

- Why is a protein transition necessary?
  - World's growing population and increasing prosperity
  - Need to move towards a more sustainable model of protein production and consumption
  - EU dependency on protein ingredients
- What are the alternatives?
  - Animal protein from circular systems
  - Plant-based proteins
  - Aquatic protein sources: seaweed, algae, duckweed
  - Insects

EU27 - Feed materials

- Dependency on soybean meal!



EU balance sheet for protein feed materials in 2020/21		EU total feed use (mio. t proteins)	EU total feed use of EU origin (mio. t proteins)	Self sufficiency
CROPS		15.62	14.21	91%
Thereof	wheat	4.20	3.91	93%
	barley	3.56	3.56	100%
	maize	5.08	4.00	79%
	oilseeds	0.45	0.45	100%
	pulses	0.85	0.76	89%
CO-PRODUCTS (*)		23.26	8.45	36%
Thereof (**)	Soybean meals	12.06	0.41	3%
	Rapeseed meal	3.96	2.66	67%
	Sunflower meal	2.40	1.26	53%
OTHER (*)		0.36	0.30	83%
Thereof	Fishmeal	0.31	0.25	81%
	Skimmed milk powder	0.05	0.05	100%
TOTAL		39.24	22.96	59%

(*) excluding on farm uses
(**) including soy protein concentrate

Source: EU feed protein balance sheet

Alternative European protein sources

Category	Protein source
Oil seeds	Proteins of defatted soybeans, rapeseed and sunflower seed
Grain legumes	Peas, Vicia faba, lupines and their concentrates, chick peas
Forage legumes	Lucerne (alfalfa)
Leaf proteins	Grass, sugar beet leaves
Aquatic proteins	Algae, both macro- (seaweed) and micro-algae, duck weed
Cereals and pseudo-cereals	Protein concentrates from oat and quinoa

Van Krimpen et al., 2013 Wageningen Livestock Research report 662

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Cereals and pseudo-cereals	Protein concentrates from oat and quinoa
Insects	Black soldier fly, mealworm, housefly

Van Krimpen et al., 2013 Wageningen Livestock Research report 662

Insects as raw material for feed

- Insects may contribute to a more sustainable animal protein production chain

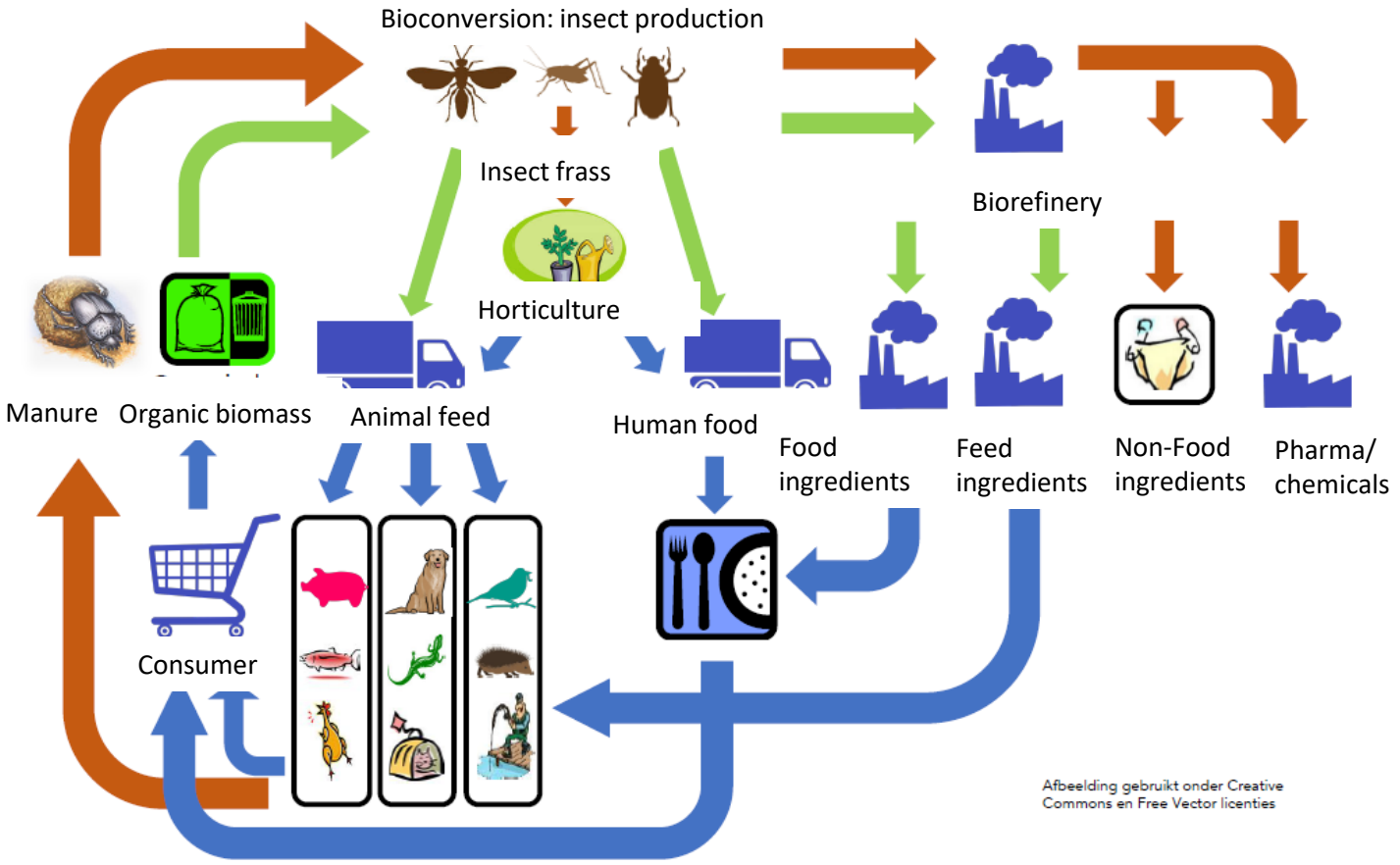
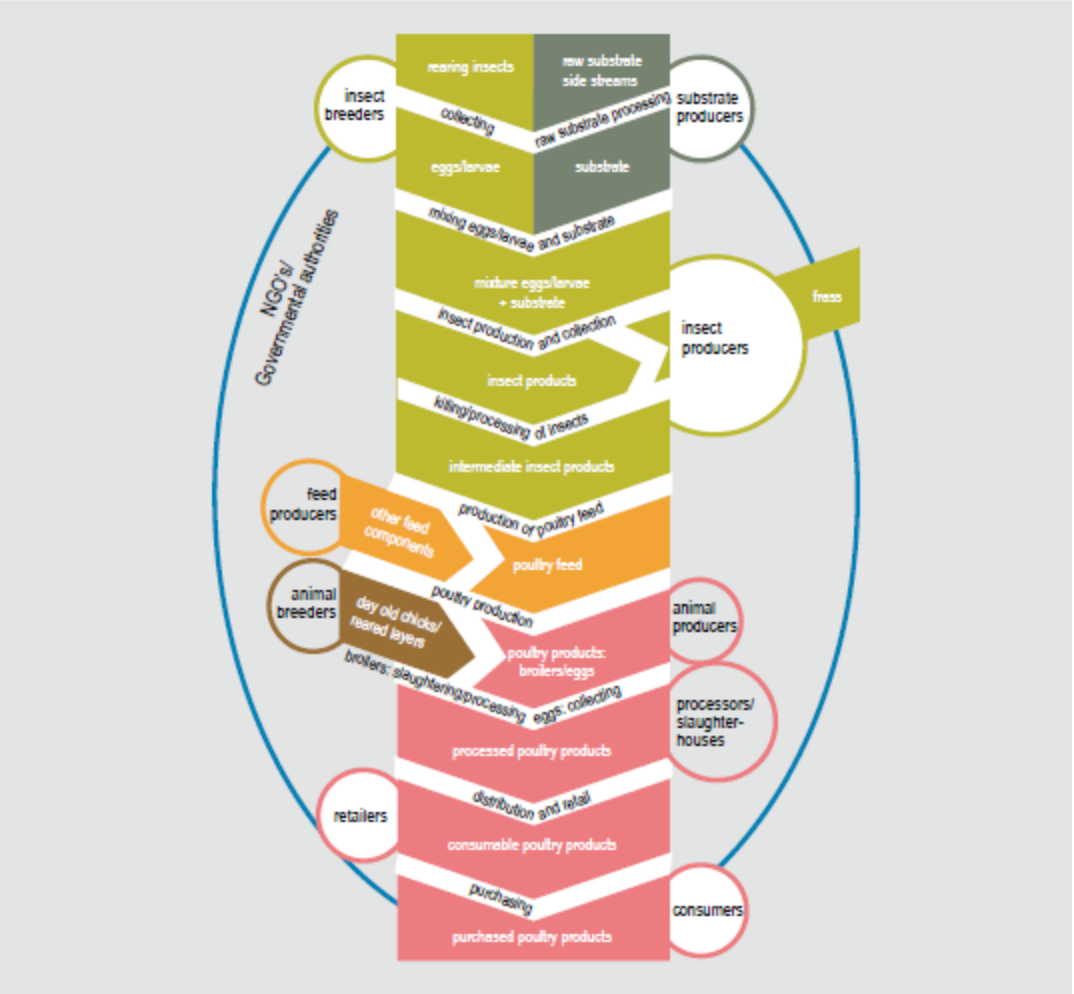


Figure formatted by: New Generation Nutrition

Schematic overview of a generic insect-fed poultry production value chain

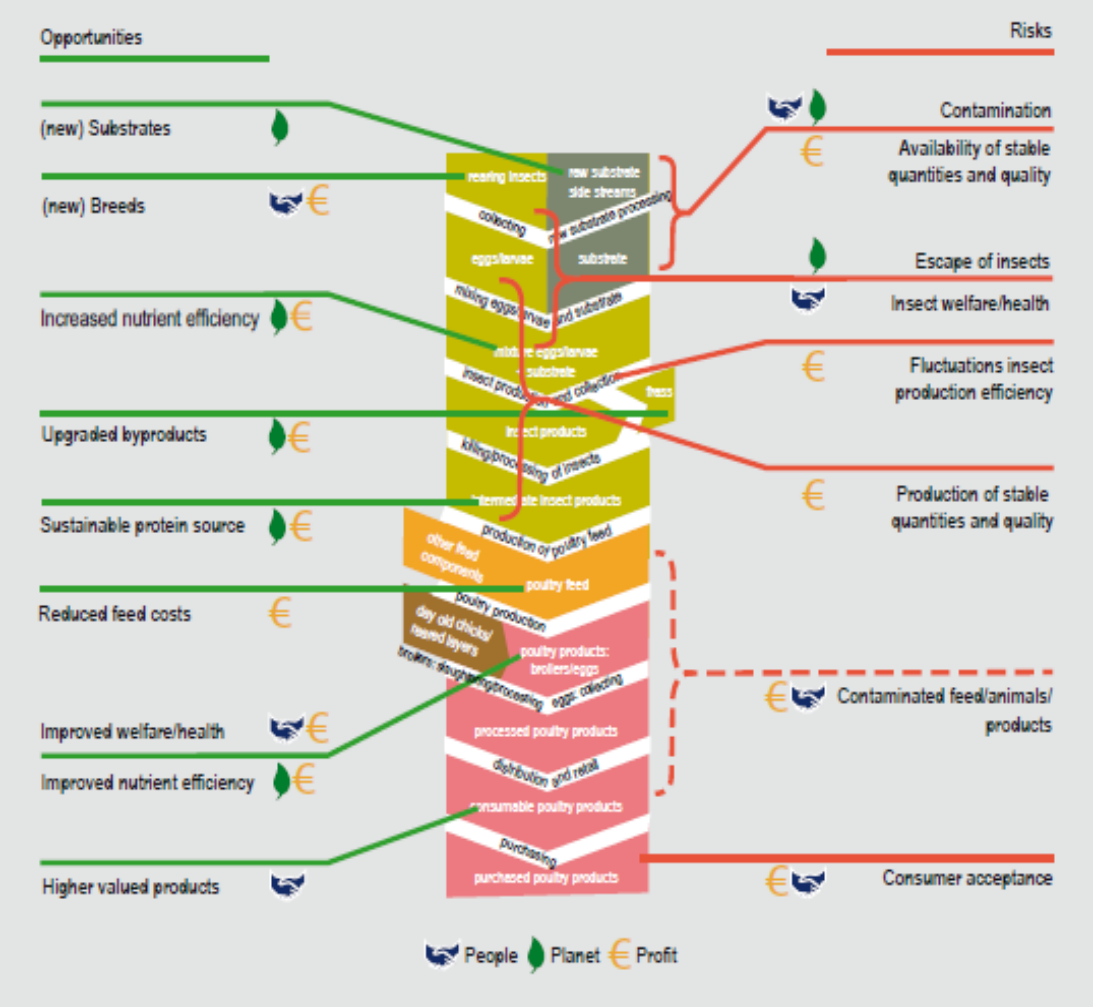


- Organic side streams (grey)
- Rearing insects, insect production and the provision of intermediate insect products (green)
- Manufacturing of poultry feed (orange)
- Use of animals (brown)
- Production of poultry products for final purchase and consumption (pink)

Saatkamp et al. 2022.

DOI 10.3920/JIFF2021.0216

Main opportunities and risks of an insect-fed poultry value chain



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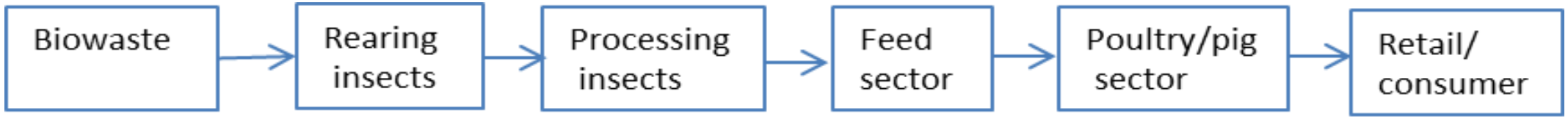
Insects in the production chain



Biowaste categories

- Vegetables
- Former foodstuff
- Horticulture
- Fermentation (co-products from breweries and ethanol production)
- Slaughter plant
  - Animal proteins
  - Blood
- Manure

Some insect species for large scale production

- Black Soldier Fly (*Hermetia illucens*)
- Mealworm (*Tenebrio molitor, Alphitobius diaperinus*)
- House Fly (*Musca domestica*)
- Some examples:
  - Enviroflight – Darling (BSF) USA
  - Innovafeed (BSF) France
  - Protix (BSF) Netherlands
  - Ynsect (yellow mealworm) France
  - Hermetia GmbH (BSF) Germany
  - HiProMine (BSF) Poland
  - BioFlyTech (BSF) Spain

Insect (products)

- Insect larvae (live)
- Insect larvae (intact, freeze-dried)
- Insect larvae processed
    - Insect meal (grinded larvae)
    - Insect oil
    - Insect protein
    - Chitin
    - Bioactive peptides (antimicrobial)
    - Fatty acids (lauric acid)

Products and animal feed market (IPIFF)

Insects as feed - **Regulation (EU) No 68/2013** on the Catalogue of feed materials and in accordance **with Regulation (EC) No 999/2001 and Regulation (EC) No 1069/2009**	Ruminant animals	Aquaculture	Poultry	Pigs	Pets	Fur and other animals (e.g. zoo)	Technical uses(e.g. cosmetic industry, bio-based fuels, production of other bio-based materials such as bioplastics)
Insect proteins (under entry 9.4.1. 'Processed animal protein')	✗	✓ **	✓ **	✓ **	✓	✓	✓
Insect fats (under entry 9.2.1 'animal fat')	✓	✓	✓	✓	✓	✓	✓
Whole insects (untreated) (under entry 9.16.2. 'terrestrial invertebrates, dead')	✗	✗	✗	✗	✓ ***	✓ ***	✓
Whole insects (treated- e.g. Freeze drying) (under entry 9.16.2.'terrestrial invertebrates, dead')	✗	✗	✗	✗	✓ ***	✓ ***	✓
Live insects (under entry 9.16.1 'terrestrial invertebrates, live')	✗	✓ *	✓ *	✓ *	✓ ***	✓ ***	✓
Hydrolysed insect proteins (under entry 9.6.1. 'Hydrolysed animal proteins')	✓	✓	✓	✓	✓	✓	✓

*if authorised by the national competent authority of the Member State where the product is being commercialised
** Limited to Black Soldier Fly (*Hermetia illucens*), Common Housefly (*Musca domestica*), Yellow Mealworm (*Tenebrio molitor*), Lesser Mealworm (*Alphitobius diaperinus*), House cricket (*Acheta domesticus*), Banded cricket (*Gryllodes sigillatus*), Field Cricket (*Gryllus assimilis*) and Silkworm (*Bombyx mori*).
*** if authorised by the national competent authority of the Member State where the product is being commercialised, under the specific conditions applicable to processed pet food (in case the product is intended for use as processed pet food)

Restriction to insect species (insect PAPs for aqua feed)- Regulation (EU) **No 142/2011; Annex X Chapter 2 Section 1, A.(2).** - Insect PAPs must be produced in **processing plants approved** in accordance with Article 24(1)(a) of Regulation (EC) No 1069/2009 and **dedicated exclusively** to the production of products derived from farmed insects '**Regulation (EC) No 999/2001; annex IV, chapter IV, Section F, 1 (a)**. - Insect PAPs must be produced according to **processing methods 1 to 5** or **processing method 7 (Regulation (EU) No 142/2011, Annex X, Chapter II, Section 1, B (2).**	
No restriction as to the insect species (provided that these are not pathogenic to humans and animals)	

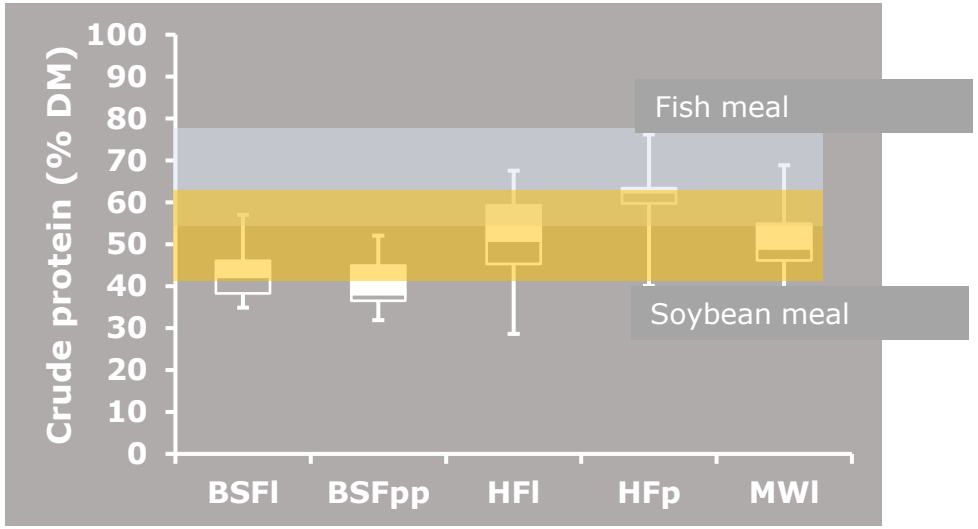
https://ipiff.org/wp-content/uploads/2019/12/IPIFF-Guide-on-Good-Hygiene-Practices.pdf

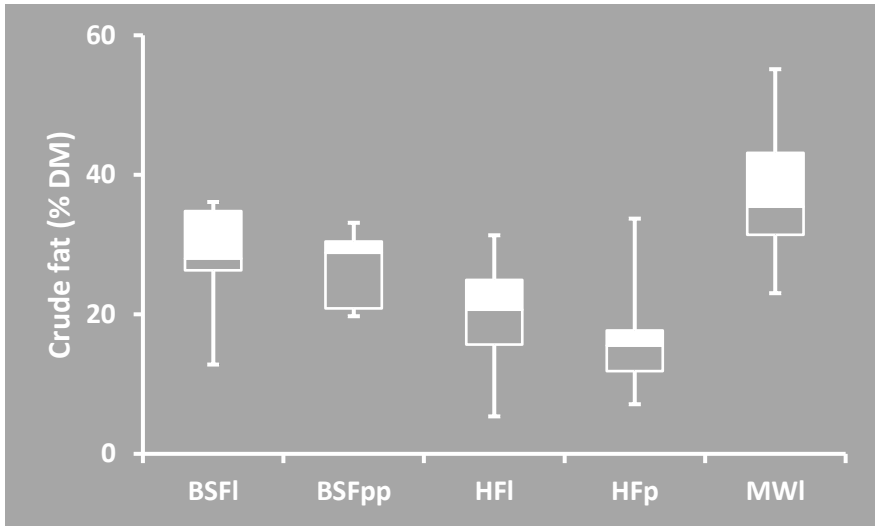
Products and target market (IPIFF)

- The Regulation No 2001/999 (Annex IV) amended by the Regulation 2017/893 (Annex X) authorizes the use of insect proteins originating from seven insect species – namely black soldier fly (*Hermetia illucens*), common housefly (*Musca domestica*), yellow mealworm (*Tenebrio molitor*), lesser mealworm (*Alphitobius diaperinus*), house cricket (*Acheta domesticus*), banded cricket (*Gryllodes sigillatus*) and field cricket (*Gryllus assimilis*) – in feed for aquaculture, poultry and swine animals.
- As of November 2021, as part of the EU legislation on animal by-products (i.e. Regulation (EU) 2021/1925), the EU legislator authorized the use of silkworm (*Bombyx mori*) processed animal proteins (PAPs) in aquaculture, poultry and pig feed, expanding the list from seven to eight authorized species.
- Three research priorities (IPIFF):
  - Exploring the use of 'new substrates' as feed for insects
  - The reuse of insect by-products – a focus on the promising contribution of insect frass to agriculture
  - Exploring the nutritional and health benefits of using insects for food and feed

IPIFF, August 2022. https://ipiff.org/insects-eu-legislation/

Insects: a protein-rich feed ingredient in pig and poultry diets





- BSFl black soldier fly larvae
- BSFpp black soldier fly prepupae
- HFl housefly larvae
- HFp housefly pupae
- MWl mealworm larvae

The nutritional value of insects can greatly vary depending on species, development stage, and processing method

doi:10.2527/af.2015-0019

Variation in results

Insect rearing
Diet, age, environment

Ingredient extraction, drying, grinding,
storage

Feed/food mixing, pelleting, extrusion

Animal
performance, health, product quality

Factors affecting the decision-making process of using insect-based products in animal feed formulations

L. Gasco[1*], S. Bellezza Oddon[1], G.W. Vandenberg[2], T. Veldkamp[3] and I. Biasato[1]

Insect species and composition, Variability and processing methods, Availability and consistency of supply, Nutrient digestibility, Anti-nutritional factors, Physical pellet properties, Palatability, Safety risks, Stability, Impact on product quality, Legislation

DOI 10.3920/JIFF2022.0164

Bioactive properties of insect products for monogastric animals

- Insects and insect products as a valuable feed ingredient (aquaculture, poultry, and pigs)
- Possible health-promoting effects
- Three categories of bioactive compounds in insects:
    1. Antimicrobial peptides: α-helical peptides, cysteine-rich peptides, proline-rich peptides, glycine-rich peptides
    2. Fatty acids: Lauric acid
    3. Polysaccharides: chitin and chitosan

Veldkamp et al. 2021. Bioactive properties of insect products for monogastric animals – a review. Journal of Insects as Food and Feed. https://doi.org/10.3920/JIFF2021.0031

In summary

- Insects are valuable alternative protein and fat sources
- Replacement of fishmeal or soybean meal up to inclusion levels 10-15% result in similar or better performance
- Decrease of cost price is required
- Constant nutritional value and supply
- Standardized procedures for insect production and processing
- Addressing the legislative barriers in Europe and alternative substrates for insects

Further research from animal feed perspective

- Nutritional requirements of insects
- Feeding value of biowaste sources for insects
- Safety of not yet legally allowed substrates to grow insects
- Processing of insects
- Nutritional value of insects for livestock
- Optimal inclusion level of insect products in feed
- Role of chitin/chitinase
- Functional properties of insect products for livestock (protein, oil, chitin, lauric acid, bioactive peptides)

Let’s join forces and cooperate

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