



General information	
PPP-number	AF-15220
Title	Controlling the safety of insects for feed & food
Theme	Voedselveiligheid (BO-46 AF-GV – Gezonde en veilige producten)
Implementing institute	Wageningen Food Safety Research (WFSR)
Project leader research (name + e-mail address)	HJ van der Fels-Klerx, ine.vanderfels@wur.nl
Coordinator (on behalf of private partners)	Marlou Bosch, Protifarm RD BV
Project-website address	http://www.wur.nl/en/project/Insure-the-safety-of-insects.htm http://www.wur.nl/nl/project/Borgen-van-de-veiligheid-van-insecten-1.htm
Start date	01-01-2016
Final date	31-12-2019 (met NAPRO tot 01-04-2020)

Approval by the coordinator of the consortium	
The final report must be discussed with the coordinator of the consortium. The "TKI's" appreciate additional comments concerning the final report.	
Assessment of the report by the coordinator on behalf of the consortium:	<input checked="" type="checkbox"/> Approved <input type="checkbox"/> Not approved
Additional comments concerning the final report:	None

Consortium	
Mention any changes in the composition of the project partners:	None

Summary of the project	
Problem definition	Nowadays, in Europe, insects are increasingly gaining interest as an alternative source of proteins (and also fat) in animal feed and human food production. As for every other feed/food ingredient and product, its safety for the consumer should be guaranteed. To date, little information is available on the safety of the use of insects for feed and food. This project fills (part of) this gap in knowledge. Results will be very useful for industry, including insect producers and processing companies for feed and food, such to be able to control the safety of their product. It will in this way stimulate economic activities of such companies in the Netherlands, and enhance their market share of insect products. The project will contribute to the safe use of this alternative source of protein for animal and human consumption. For consumers, this will lead to the availability of feed and food products, made from an alternative source of proteins. It will in this way contribute to sustainability of feed and food production and consumption in Europe.
Project goals	To obtain more insights into the safety of the use of insects in feed and food production. The project will focus on the possible microbiological and chemical contamination of insects and their products, from different sources of substrate. The results of the

	project will lead to more insights in the safe use of insects for feed and food as well as potential safety problems. Industry needs these results for even better ensuring the safety of their products and ingredients.
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Results	
Planned results in the original project plan	The planned results would ultimately lead to more insights in the safe use of insects for feed and food as well as potential safety problems. This would help insect and feed/food producers to control the safety of their product, and in such a way contribute to the high feed/food safety standard in the Netherlands, and stimulate economic activities of companies in the Netherlands, and enhance their market share of insect products. More specifically, project results would include in-depth insights into the safety, from chemical and microbiological points of view, as well as their sources of contamination, of insects used for feed and food. At the end of each year, the specific research focus for the following year would be decided upon by the consortium
Achieved results	<p>During the project, several experiments have been developed. Per year, one large experiment on insect safety has been performed. At the start of each year, the specific topic of that year was discussed and decided upon by the consortium partners.</p> <p>In 2016, we performed a large experiment aimed to investigate the potential accumulation of mycotoxins provided to larvae of the yellow mealworm (YMW, <i>Tenebrio molitor</i>) and the black soldier fly larvae (BSFL, <i>Hermetia illucens</i>), using feed contaminated with mycotoxins. The treatments included the mycotoxins Aflatoxin B1, Ochratoxin, Deoxynivalenole, Zearalenone, as well as the mixture of these four mycotoxins, each at three different contamination levels. The experiment with YMW was performed at Protifarm, and the experiment with BSFL at Bestico. Results showed no effects on survival and growth of either species, and little accumulation of all the four different mycotoxins in the insect larvae of either species.</p> <p>In 2017, an experiment has been done with rearing of BSFL on different types of supermarket returns ('former foodstuffs'). In total four different substrates were used including whole meals with and without meat, and with either plastic or carton as packaging material. The experiment was performed on large- and small-scale. The large scale experiment was held at Protix, and the small scale experiment was done at Entomology group of the Wageningen University. Samples of the substrates and the larvae were analysed for various chemical contaminants. Results suggested that certain environmental contaminants such as heavy metals, mineral oils, dioxins, and PCBs tended to accumulate in the larvae to varying degrees, but all concentrations of these chemical contaminants were below their respective legal limits (if any). A separate literature review was performed on the possible contamination of insects reared for feed and food with microbiological and chemical hazards and allergens.</p> <p>In 2018, we prepared and started a large experiment into the potential accumulation of various insecticides from the substrates into BSFL. Pesticides to be considered in this experiment were selected based on pre-defined criteria, as well as the concentration of each particular pesticide. Two experiments were performed sequentially: first with concentrations equal to the legal limit, then using higher or lower concentrations based on the results of the first experiment. The experiment was held at Bestico. Results showed varying effects of the pesticides on growth and survival of the BSF larvae. Most pesticide treatments reduced larval growth or had no effect. Three treatments reduced survival and/or growth, while two treatments appeared to</p>

	<p>increase larval growth. No accumulation of pesticides in the larvae was observed.</p> <p>Finally, in 2019, a follow-up to 2018's research on pesticides was started. The objective of the study was to investigate the comparability of the effects of pesticides between BSFL and lesser mealworm (LMW, <i>Alphitobius diaperinus</i>) – the two most commonly reared insect species for food and feed. This was done by replicating the first experiment of the 2018 study for this other species, using the same substances at the same concentrations as done previously. In the second experiment, substances that had an effect on survival or growth in the first experiment were mixed in order to assess the potential effects of combinations of insecticides. This experiment was held at Protifarm. First results showed that effects on survival and growth were less pronounced than was observed in the BSFL. In addition, concentrations of insecticides in the larvae were very low, signifying that these substances do not accumulate.</p>
Explanation of changes relative to the project plan	There were no changes relative to the project plan.

What was the added value created by the project for:	
Participating "Knowledge Institutes" (scientific, new technologies, collaboration)	WFSR has greatly increased its knowledge on insects as food and feed and is now a leading institute on the chemical safety of these products. Two scientific publications have thus far been published, and three more are scheduled to be submitted before 01-04-2020. Due to the knowledge gained in this project, participation in other related projects was secured. Among these, the H2020 project SUSINCHAIN, in which WFSR is deputy coordinator and WP leader.
Participating private partners (practical application of the results, within which period of time?)	The project has provided the involved companies with more knowledge on the safety of insects as food and feed, and the substrates which they use to rear their insects on. Results on survival and growth will help in selecting and avoiding appropriate feed materials for their rearing facilities, and results on accumulation of contaminants (or lack thereof) will assist them in controlling the safety of their products. Knowledge on the safety of novel feed materials may help in lowering currently existing legal barriers.
Society (social, environment, economy)	Novel insights on the safety of insects for food and feed have been developed. These insights have assisted and will continue to assist in paving the way for using insects at larger scale, which will play a role in meeting sustainability goals and providing a new component in the protein transition.
Possibly other stakeholders (spin-offs)	WFSR is involved as one of the partners in a working group which was set up by the Ministry of LNV.

Follow-up	
Did the PPP result in one or more patents (first filings)?	No patents.
Are there any follow-up projects planned? If yes, explain. (Contract research resulting from this project,	Yes, a follow-up PPS project has been granted in 2019, that will run from 2020-2023 (LWV19099). The 2020-2023 project will in part be an extension of this project, but focus will be in particular on circular economy / waste streams. The primary

additional funding, or new PPP projects)	objective of this new project is still to investigate the safety of insects for food and feed (i.e. accumulation / transfer, and secondarily to investigate the safety of substrates for insects (i.e. impact growth / survival). Furthermore, the work on the metabolization of mycotoxins by insects will be continued in 2 new projects, the H2020 project SUSINCHAIN, and the NWA project INSECTFEED. In each of the two projects, a PhD is appointed to perform in -depth research into this area. WFSR is involved as supervisor of both PhD's.
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<p>Deliverables/products during the entire course of the PPP (provide the titles and/or a brief description of the products/deliverables or a link to a website.</p>
<p><u>Scientific articles:</u></p> <p>Published:</p> <ul style="list-style-type: none"> • Camenzuli L, Van Dam R, De Rijk TC, Andriessen R, Van Schelt J, Van der Fels-Klerx HJ. 2018. Tolerance and excretion of the mycotoxins aflatoxin B1, zearalenone, deoxynivalenol, and ochratoxin A by <i>Alphitobius diaperinus</i> and <i>Hermetia illucens</i> from contaminated substrates. <i>Toxins</i> 10(2): 91. • Van der Fels-Klerx HJ, Camenzuli L, Belluco S, Meijer N, Ricci A. 2018. Food safety issues related to uses of insects for feeds and foods. <i>Comprehensive Reviews in Food Science and Food Safety</i> 17(5): 1172- 1183. DOI: 10.1111/1541-4337.12385. <p>To be submitted soon (<01-04-2020):</p> <ul style="list-style-type: none"> • On the effects of packaging materials in former foodstuffs as substrate for black soldier fly larvae (BSFL, <i>Hermetia illucens</i>) • On the effects of selected insecticide residues in substrates for BSFL • On the effects of selected insecticide residues in substrates on Lesser Mealworm (LMW, <i>Alphitobius diaperinus</i>)
<p><u>External reports:</u></p> <p>Not applicable.</p>
<p><u>Articles in professional journals/magazines:</u></p> <p>Article in the popular magazine VoedingsmiddelenTechnologie, 2020</p>
<p><u>(Poster) presentations at workshops, seminars or symposia.</u></p> <p>2019</p> <ul style="list-style-type: none"> • Van der Fels-Klerx HJ. 2019. Chemical food safety related to using supermarket returns for rearing <i>Hermetica illucens</i> for feed and food uses. Oral presentation at the 70th Annual Meeting of the European Federation of Animal Science City of Ghent (Belgium), 26 - 30 Aug 2019. • Meijer, N., de Rijk, T., J.J.A., van der Fels-Klerx, H.J. 2019. Effects of selected insecticides on Black Soldier Fly (<i>Hermetia illucens</i>) larvae. Poster presentation at the 70th Annual Meeting of the European Federation of Animal Science City of Ghent (Belgium), 26 - 30 Aug 2019. <p>2018:</p> <ul style="list-style-type: none"> • Van der Fels-Klerx HJ. 2018. Safety of insects for use in feed, Oral presentation at the 69th annual meeting of the European Federation Animal Sciences, held 27-31 August, Croatia. Key-note lecture. • Van der Fels-Klerx HJ. 2018. Heavy metal and mycotoxin accumulation and excretion in insects for feed and food. Oral presentation at Symposium Edible Insects: The Value Chain, 21-22 March, Ede-Wageningen, The Netherlands. Invited speaker. • Camenzuli L, Andriessen R, Van Schelt, De Rijk TC, Van dam R, Van der Fels-Klerx HJ. 2018. Tolerance of feed regulated mycotoxins by lesser mealworm and black soldier fly from artificially contaminated substrates. World Mycotoxin Forum 2018, held March 2018, Amsterdam, the Netherlands.

2017:

- Van der Fels-Klerx, HJ. Safety of insect for use in feed and food (oral presentation). NGN workshop, held 8-9 June 2017, Wageningen, The Netherlands.

2016

- HJ van der Fels-Klerx. Presentation on the safety of insects for feed/food at the NGN workshop, held 8-9 December 2016, Wageningen.
- HJ van der Fels-Klerx. Presentation on the current PPS project safety for the AF-Roadmap commission Food Safety, held 26-10-2016, Wageningen

TV/ radio / social media / newspaper:

WFSR press item in 2016 on the start of the PPS projects.

Remaining deliverables (techniques, devices, methods, etc.):

Not applicable.