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Fate of food pathogens during the rearing and processing of the black soldier fly (*Hermetia illucens*)

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Research Group for
Insect Production
& Processing

Research Group for Insect Production & Processing (IP&P)

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Campus Geel

Insect Pilot Plant

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3D Tour → https://en.insectpilotplant.be/

https://iiw.kuleuven.be/onderzoek/ResearchGroupforInsectProductionandProcessing

Mission IP&P: Research for strengthening the insect value chain as a cornerstone of the circular bioeconomy in Europe.

Agro-industrial by-products

Feed

Whole Insects

Insect Rearing

Insect

Proteins

…

Soil Improver

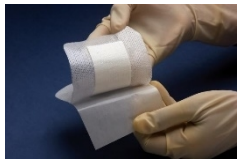
Crop protection and polli

mption

Animal consumption

Pharmaceutical, medical & technical applications

- biomaterials
- biomolecules



Focus on chemical and microbiological challenges/opportunities in the value chain

Fate of food pathogens during the rearing and processing of the black soldier fly (*Hermetia illucens*)

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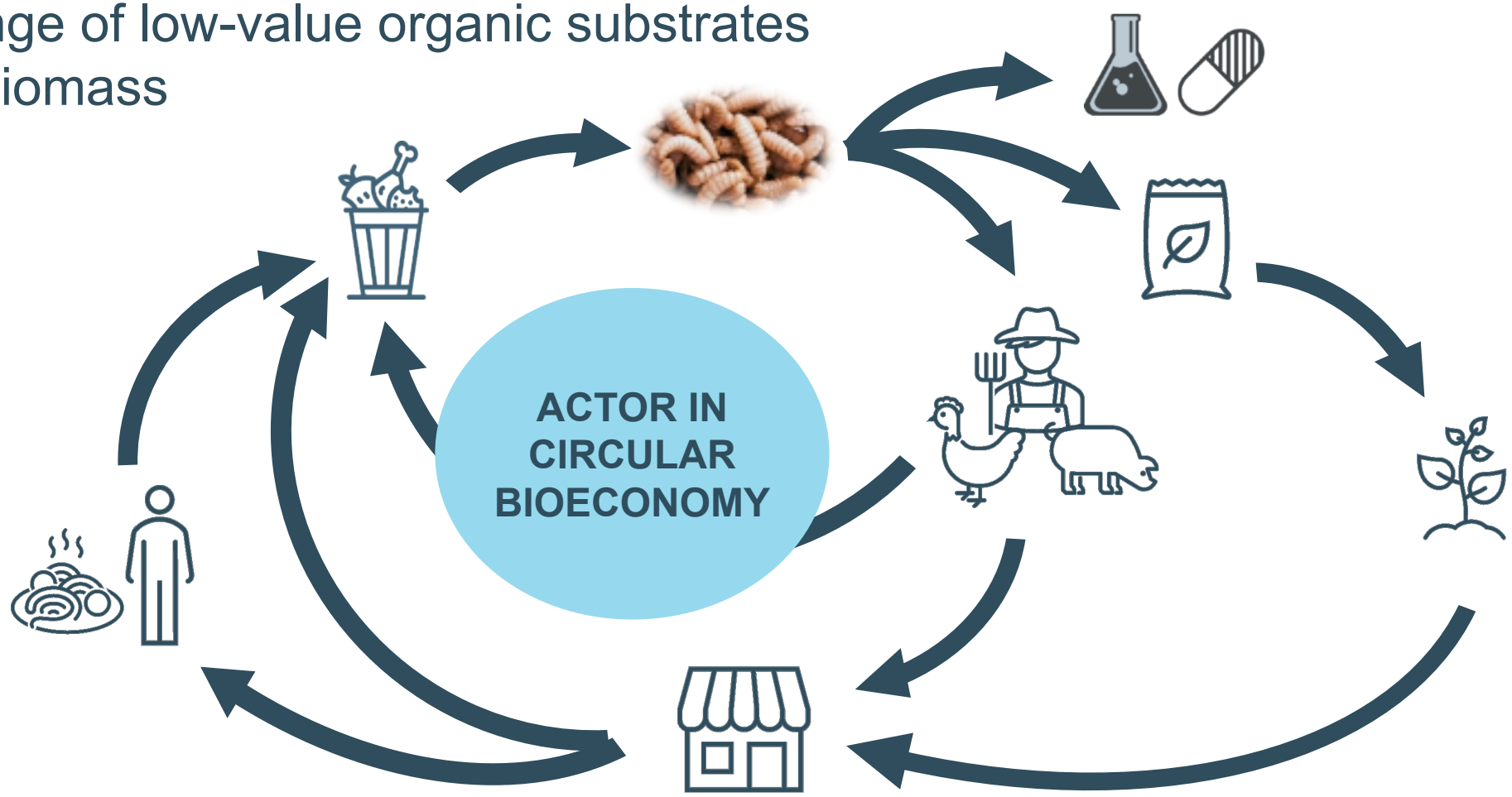
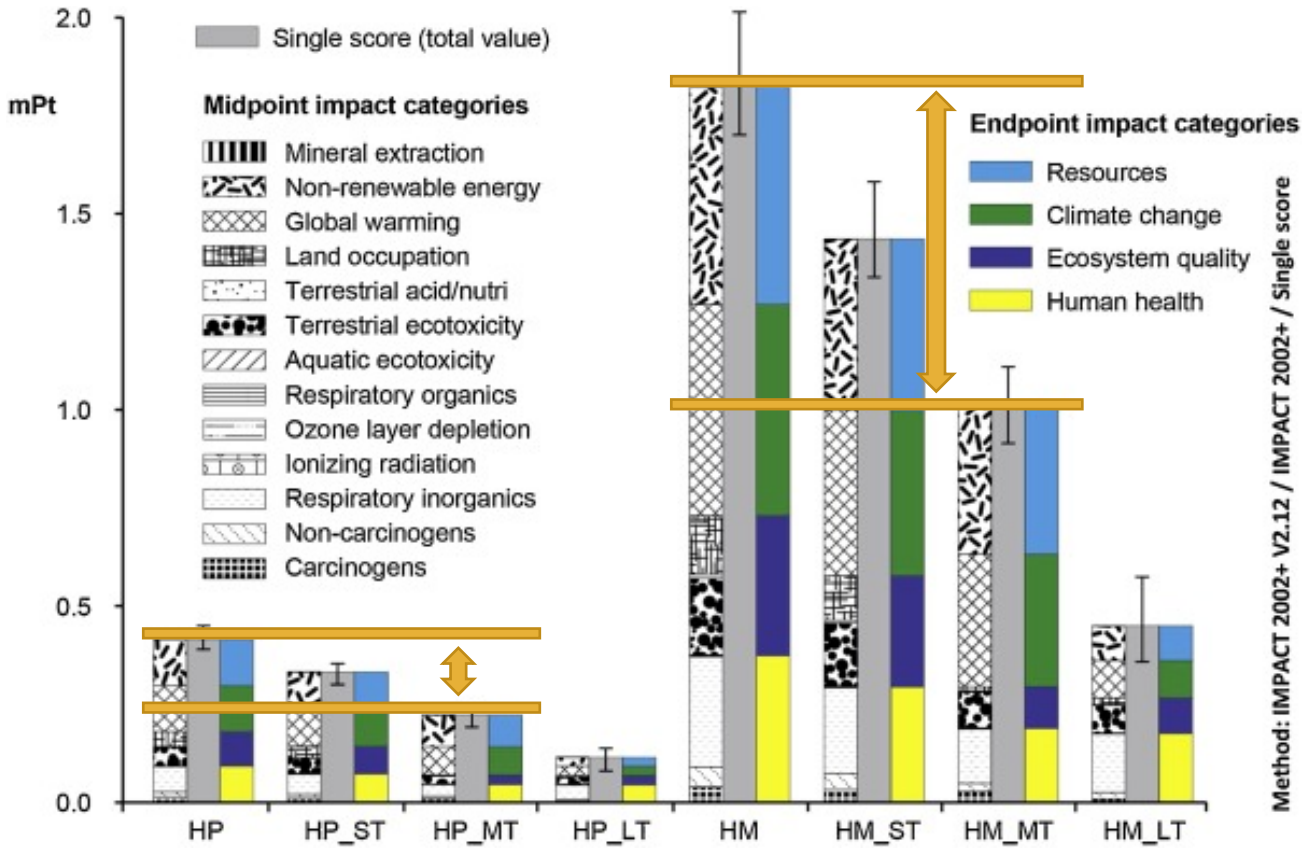
Why the black soldier fly (BSF)?

Converts a range of low-value organic substrates into valuable biomass



BSF as an actor in the circular bioeconomy

Proces optimization to enhance sustainability is crucial



Using non-utilized side streams
= can cut impact almost in half

HP = BSFL puree
HM = BSFL meal

Error bars = standard deviation
Pt = EcoPoints

ST = 25% feed conversion efficiency and energy use
MT = application of non-utilized side-streams
LT = energy supplied from renewable sources

Smetana S. et al., 2019

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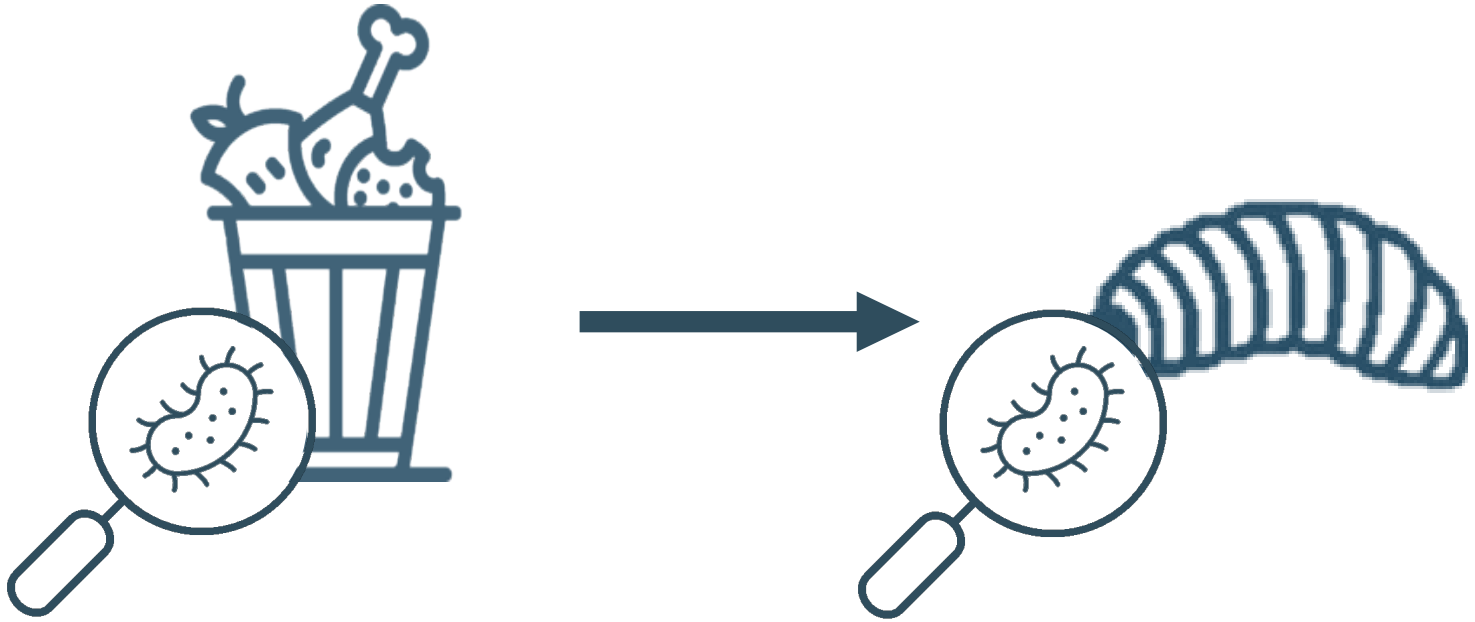
Non-utilized side-streams

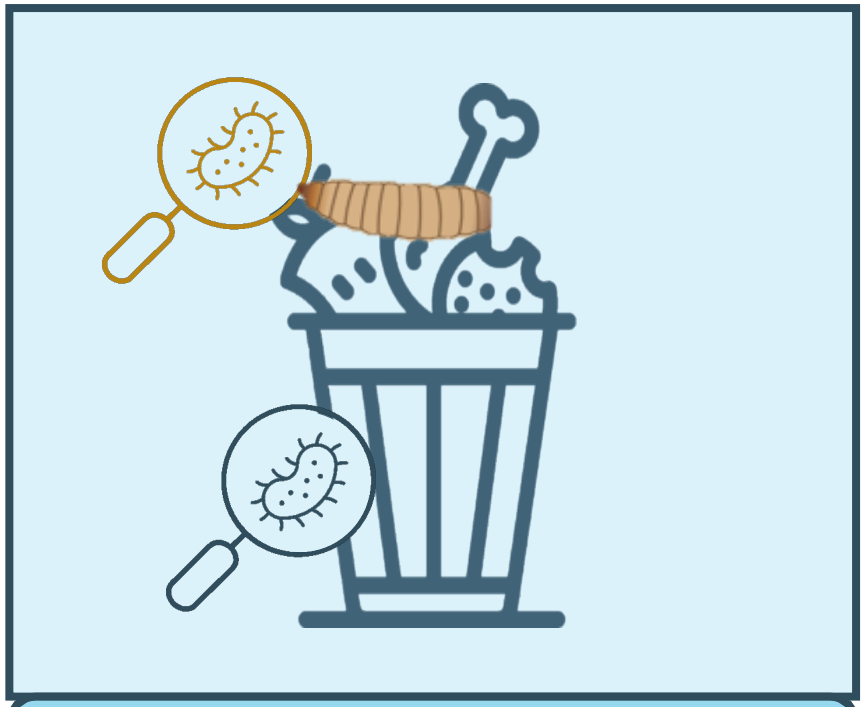
Higher microbial load of substrates → food pathogens → transmission to larvae?



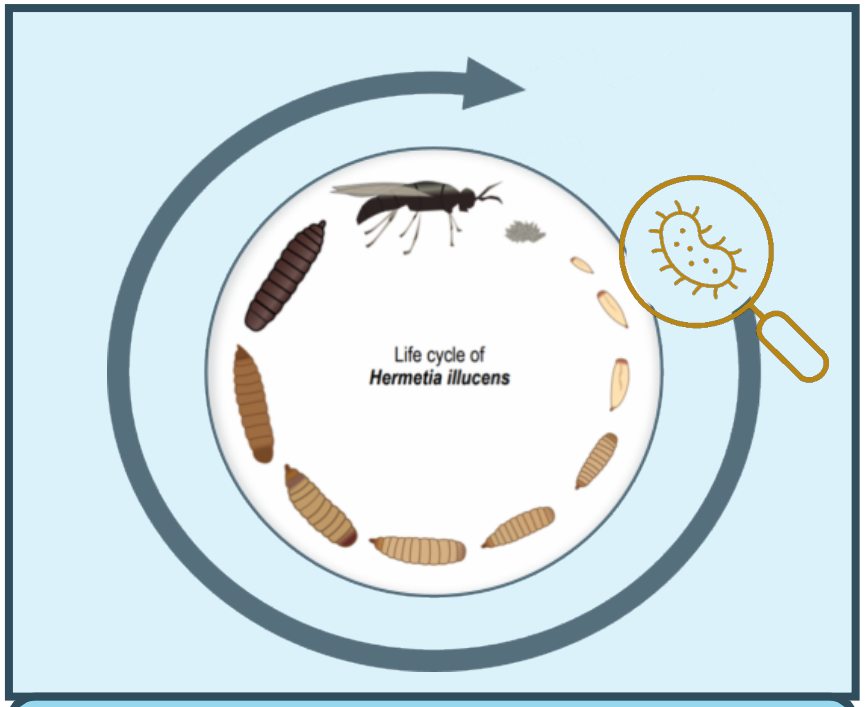
Important knowledge for design of downstream processing steps !

How did we explore these risks during rearing?

Transmission of pathogens



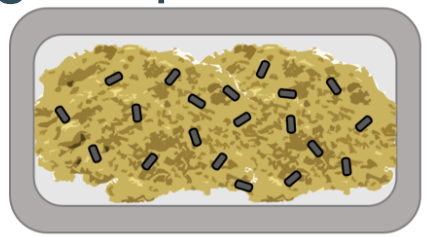
HORIZONTAL TRANSMISSION
substrate → larvae

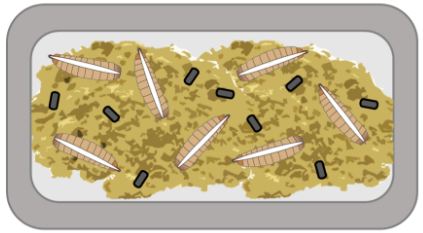


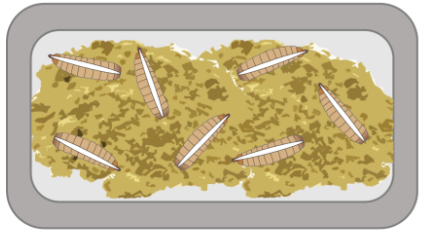
VERTICAL TRANSMISSION
life stages of black solder fly

Transmission of pathogens from substrate to larvae

Challenge-experiments: 4 different conditions







	S	S + P	S + L	S + P + L
Substrate (S)	X	X	X	X
Pathogen (P)		X		X
Larvae (L)			X	X

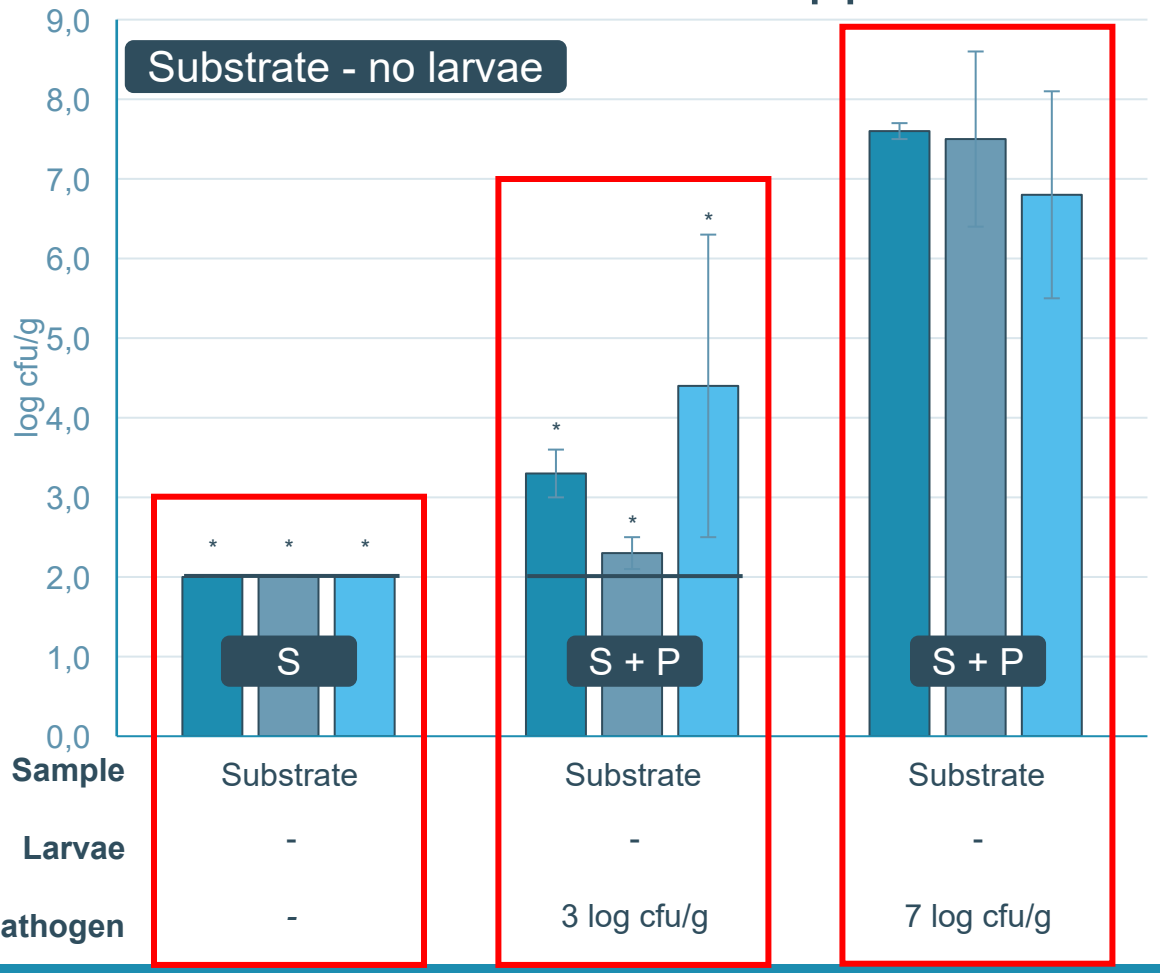
Selected pathogens: *Salmonella sp.* ➔ Gram-, non-spore forming

Staphylococcus aureus ➔ Gram+, non-spore forming

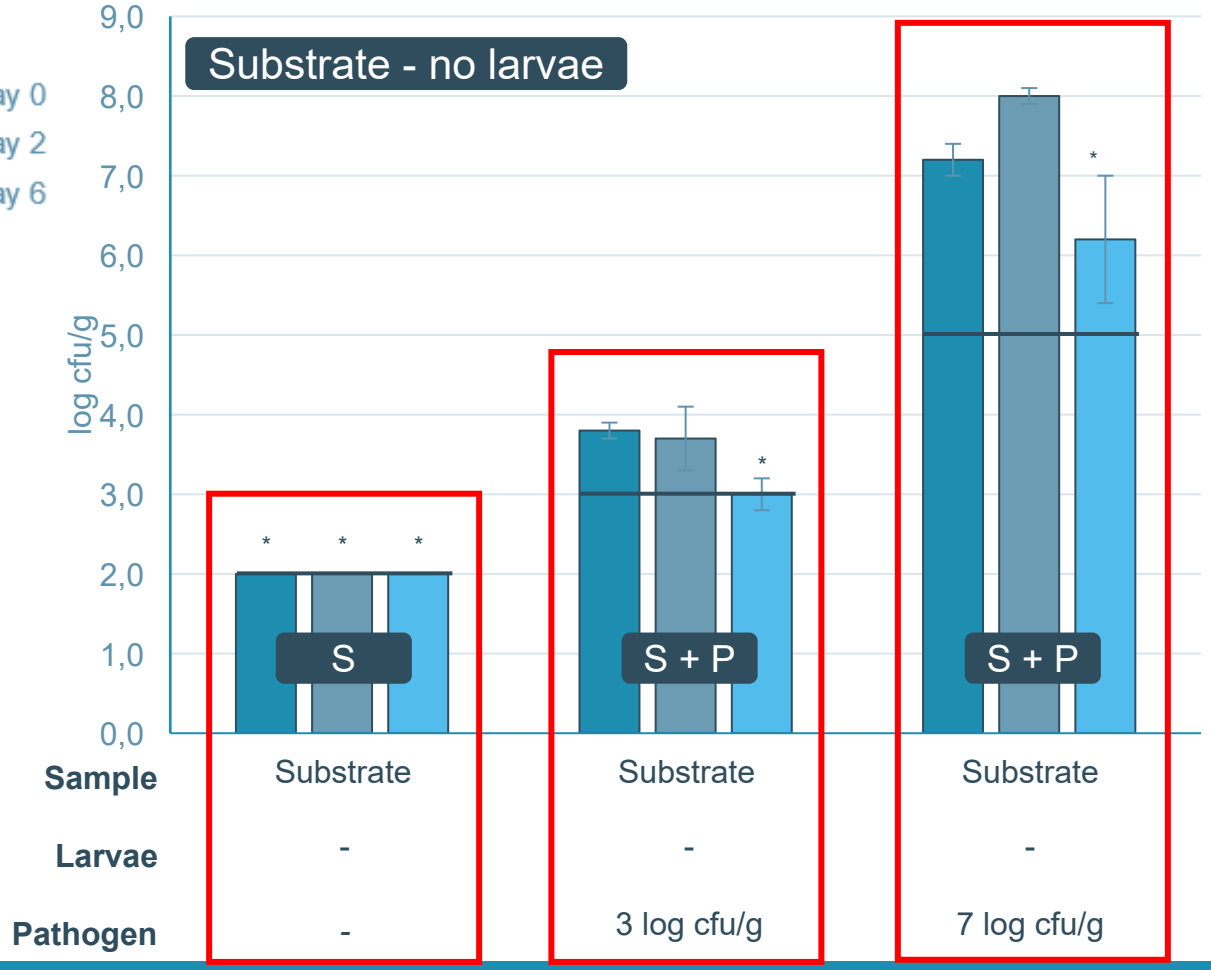
↳ Antibiotic resistance inserted to allow better detection

Transmission of pathogens from substrate to larvae

Salmonella spp.



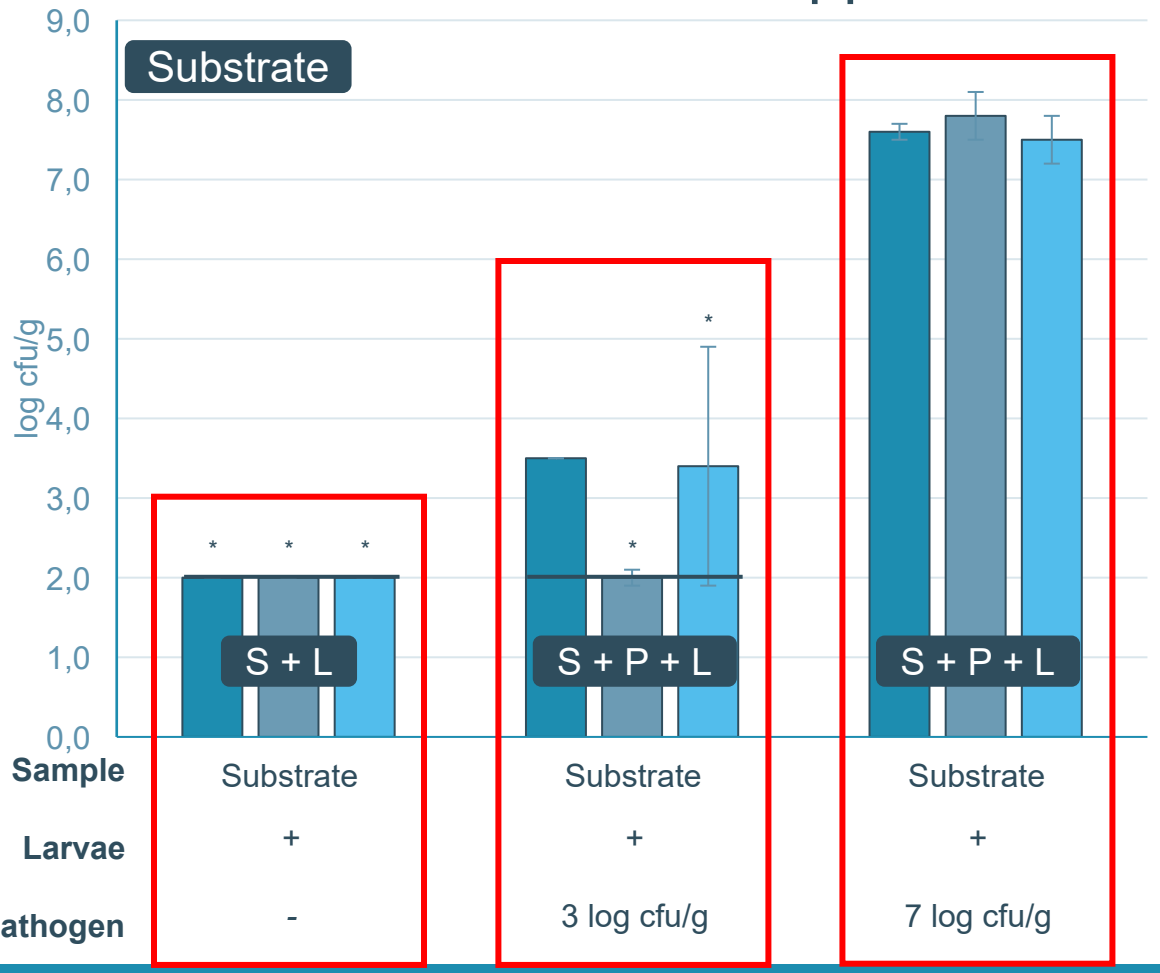
Staphylococcus aureus

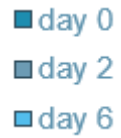


* *Staphylococcus aureus* or *Salmonella* spp. were below the detection limit (—) in at least one sample

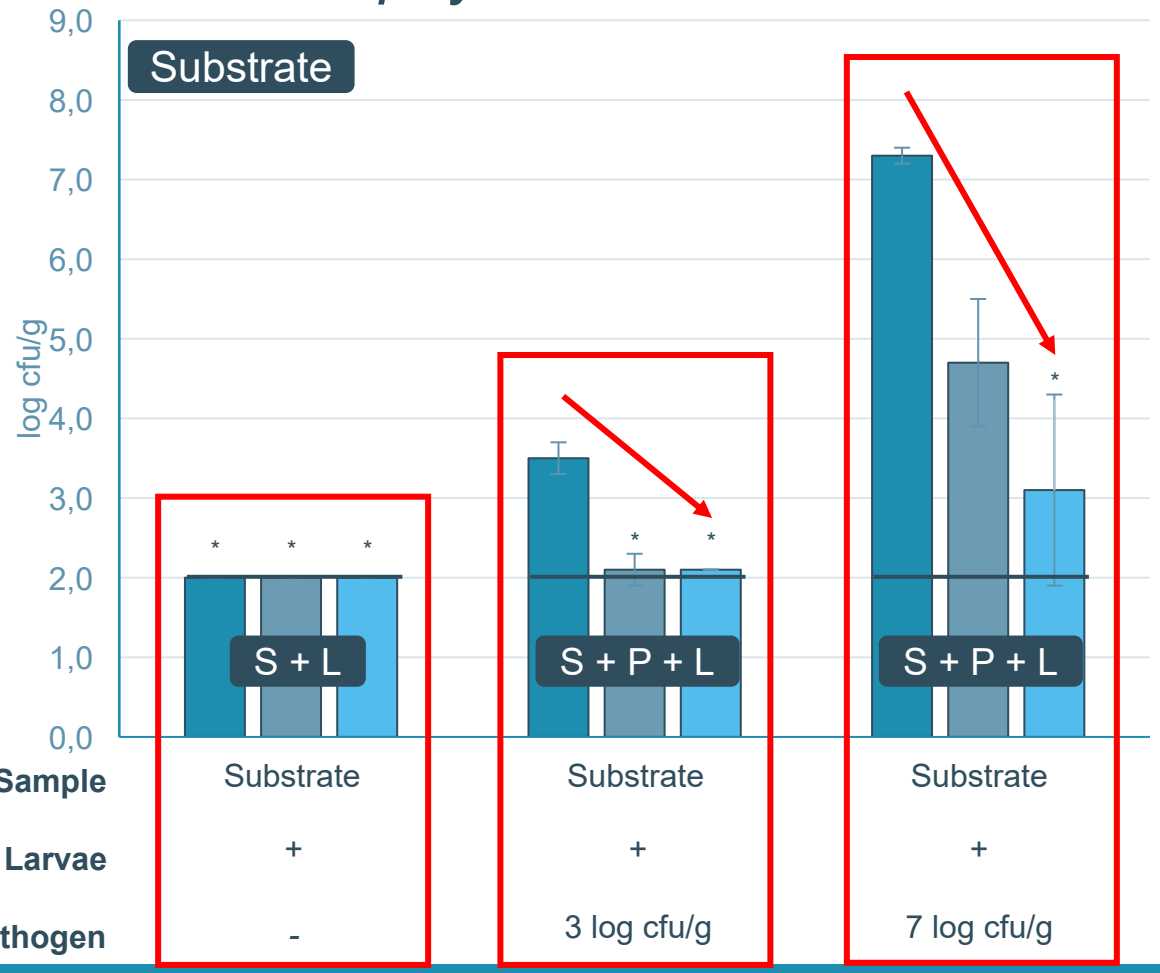
Transmission of pathogens from substrate to larvae

Salmonella spp.





Staphylococcus aureus



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Transmission of pathogens from substrate to larvae

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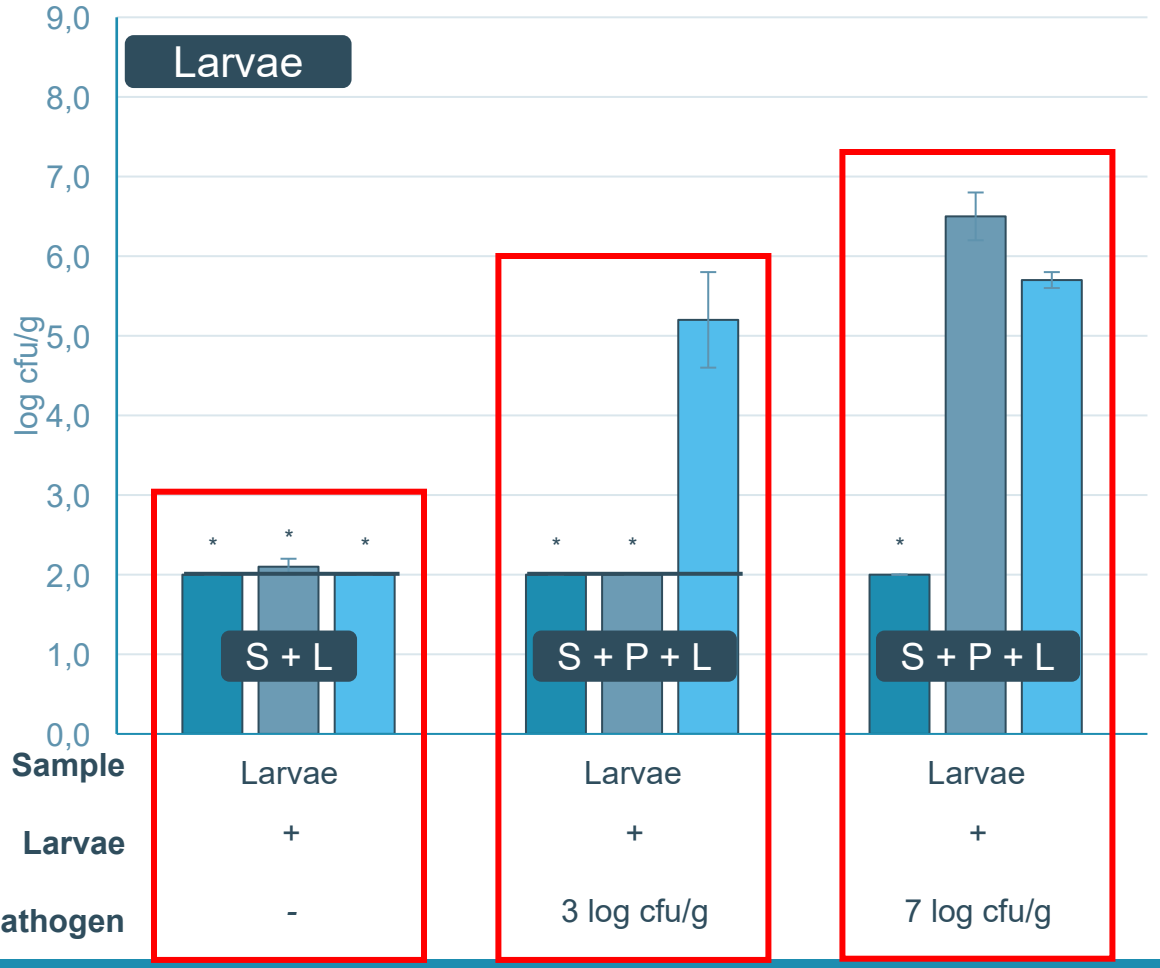
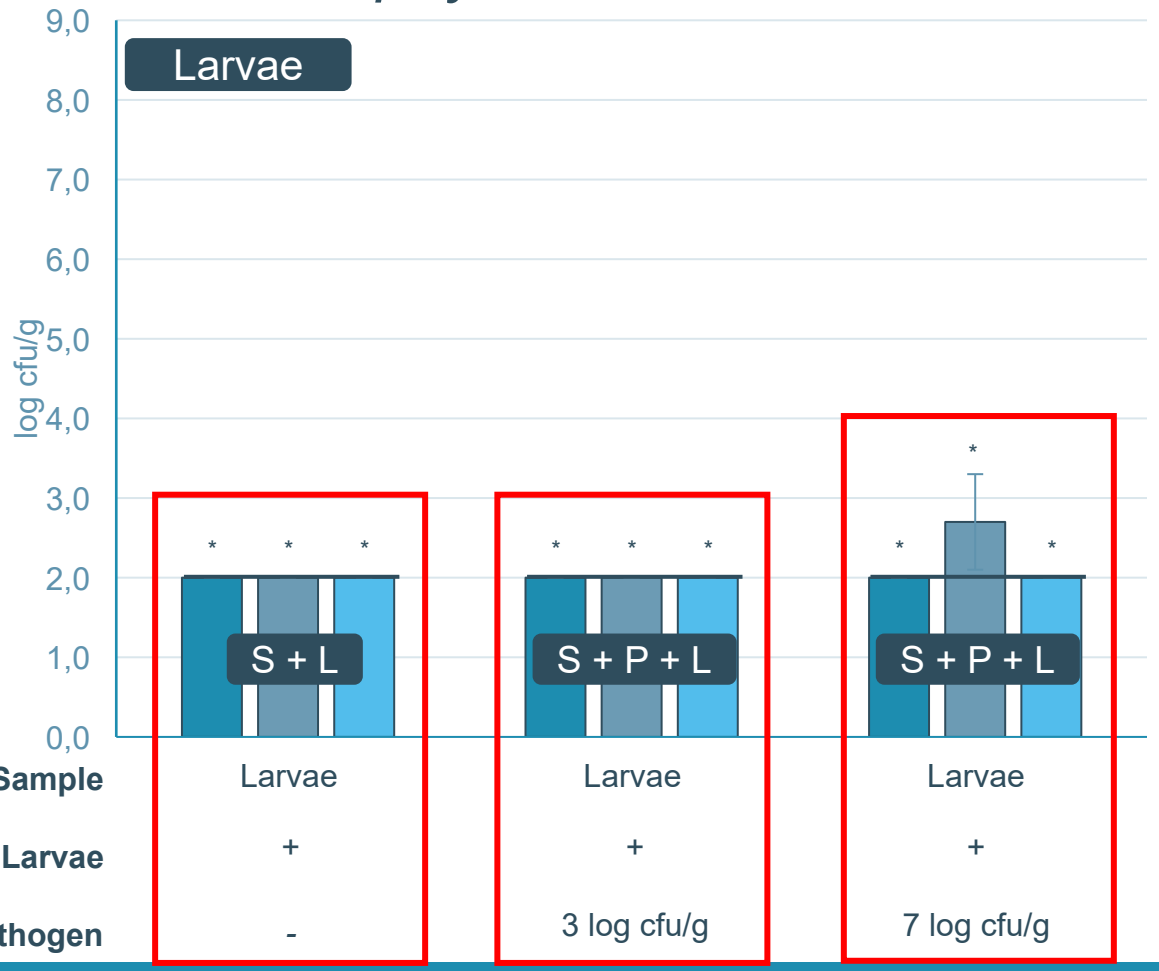


Staphylococcus aureus



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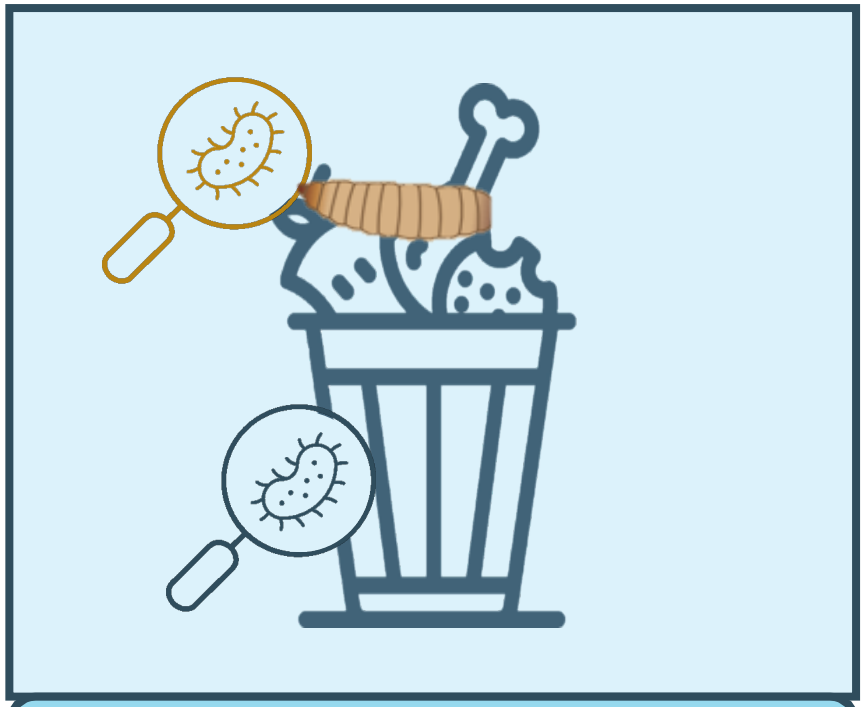
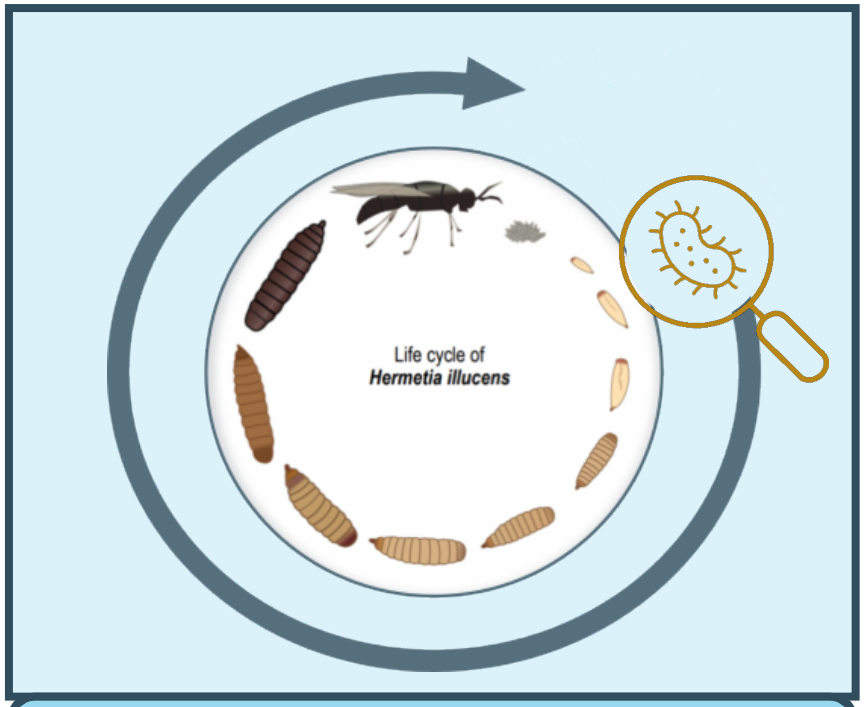
How did we explore these risks during rearing?

Transmission of pathogens

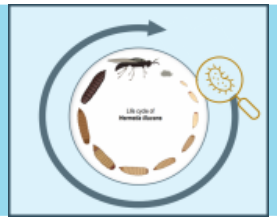


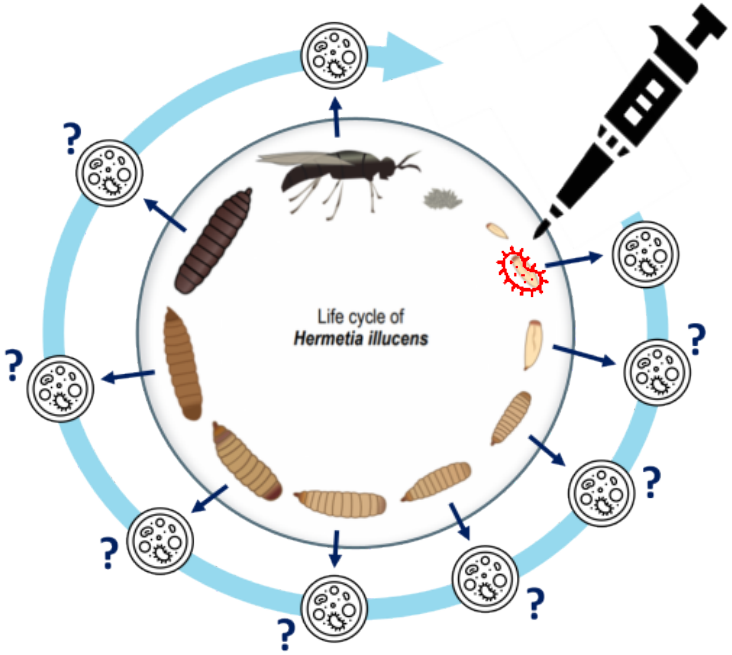
HORIZONTAL TRANSMISSION
substrate → larvae

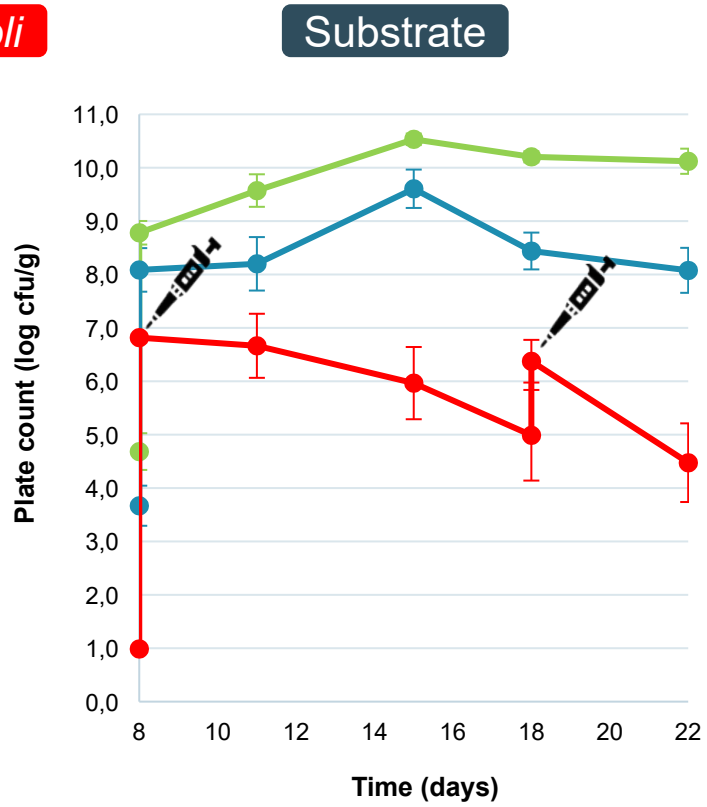


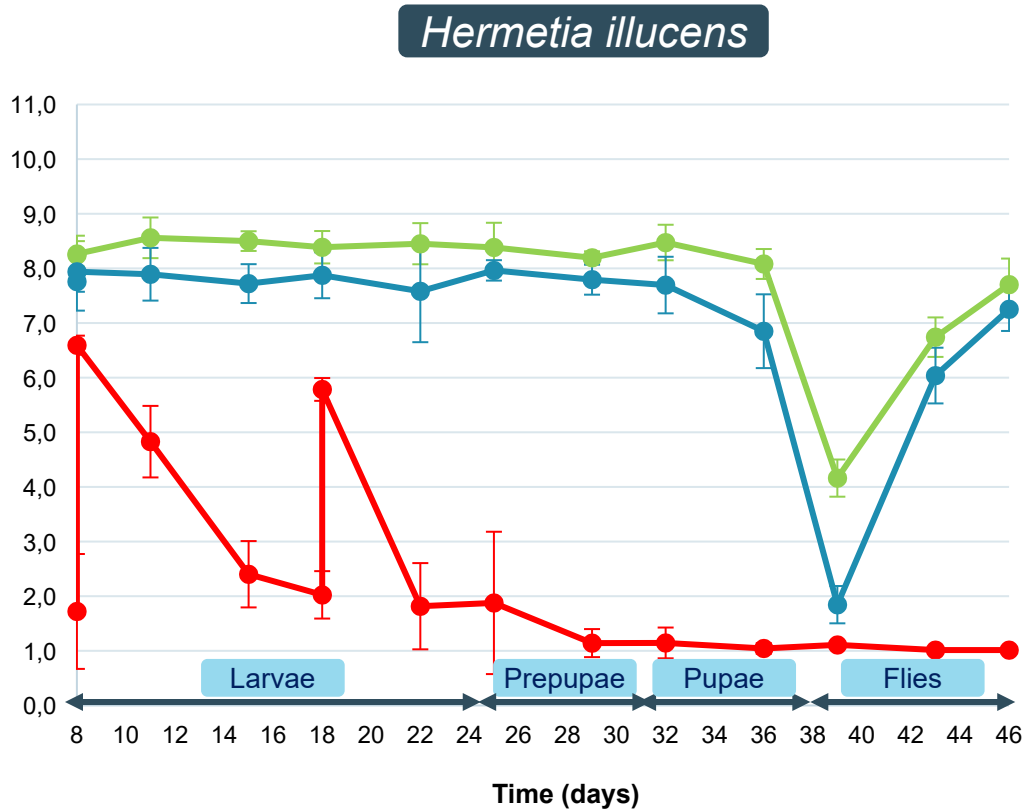
VERTICAL TRANSMISSION
life stages of black solder fly

Transmission of pathogens through the life cycle



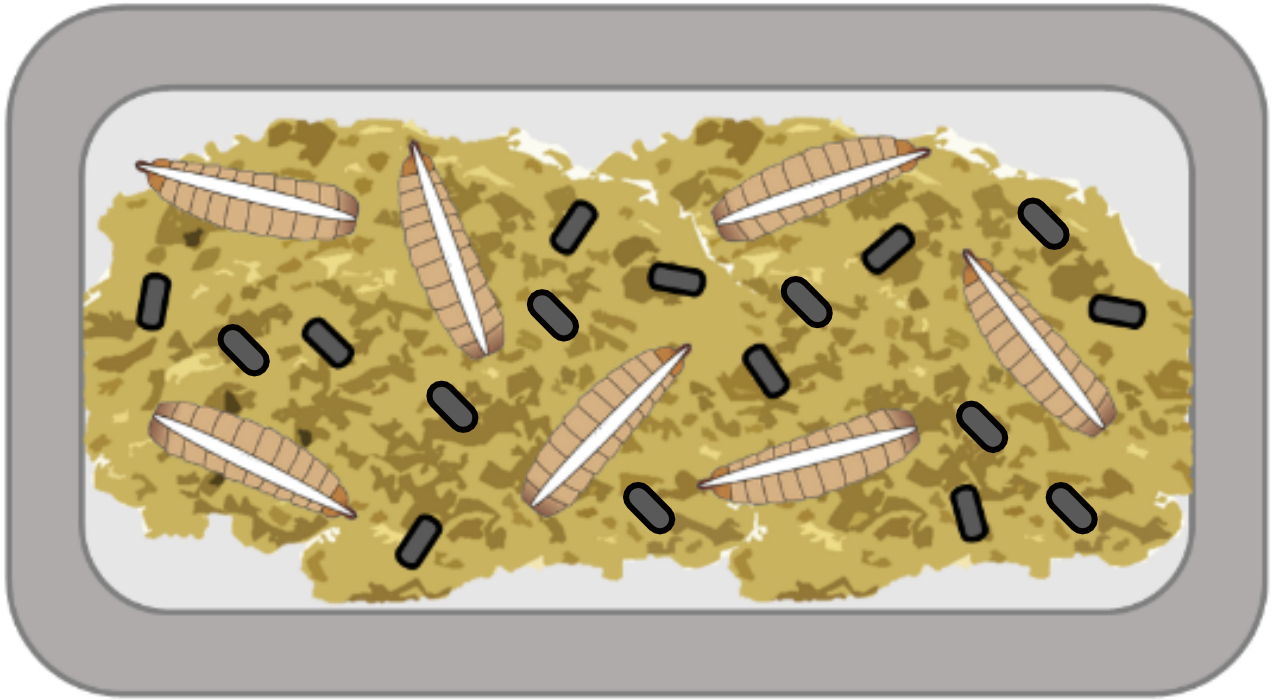






Conclusions

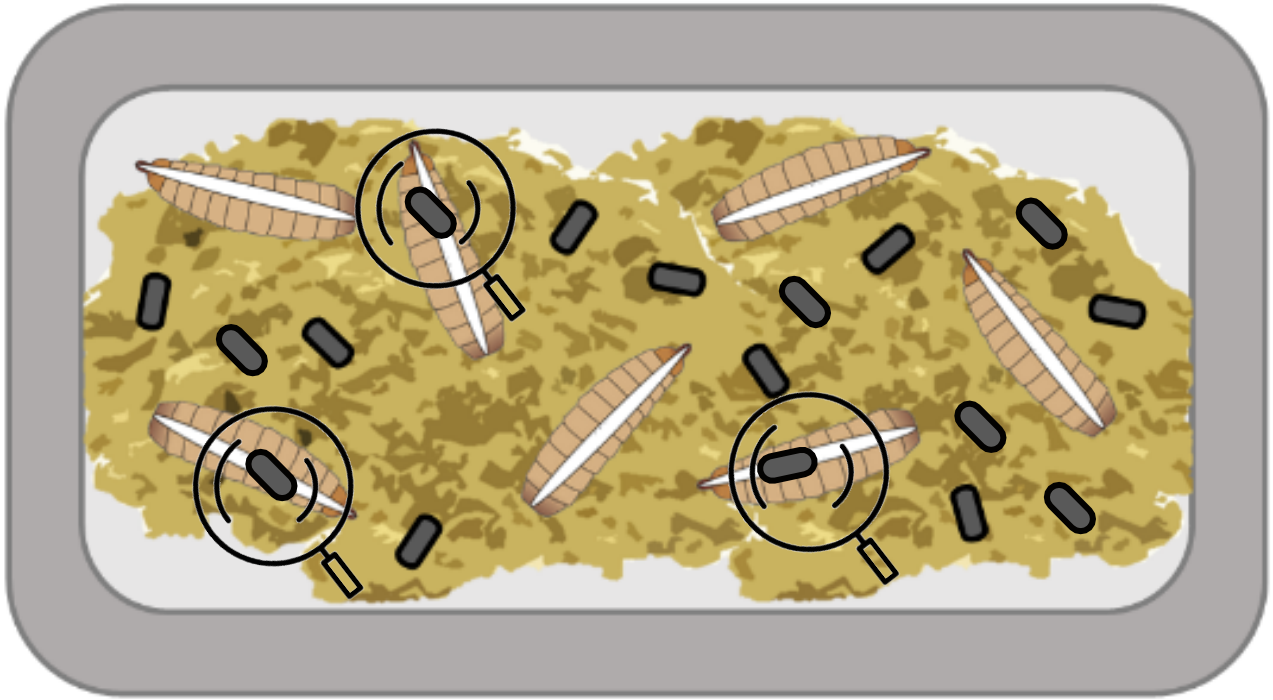
1. Not all food pathogens thrive in each substrate (here chicken starter mash)



Factor 1 = speed of food pathogen growth in substrate/residual stream

Conclusions

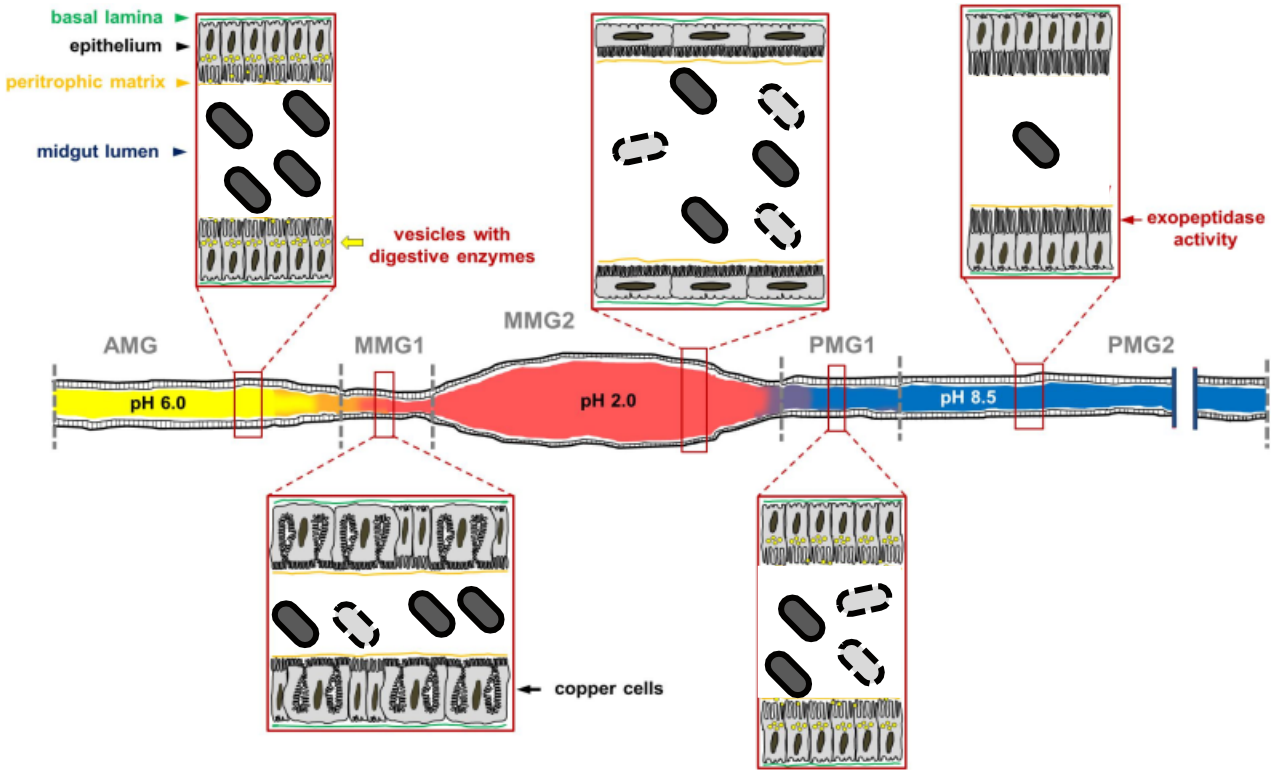
2. Passage through the BSF larval gut reduces the viable count of food pathogens



Factor 2 = rate of reduction of the food pathogen in the gut

Hypothesis

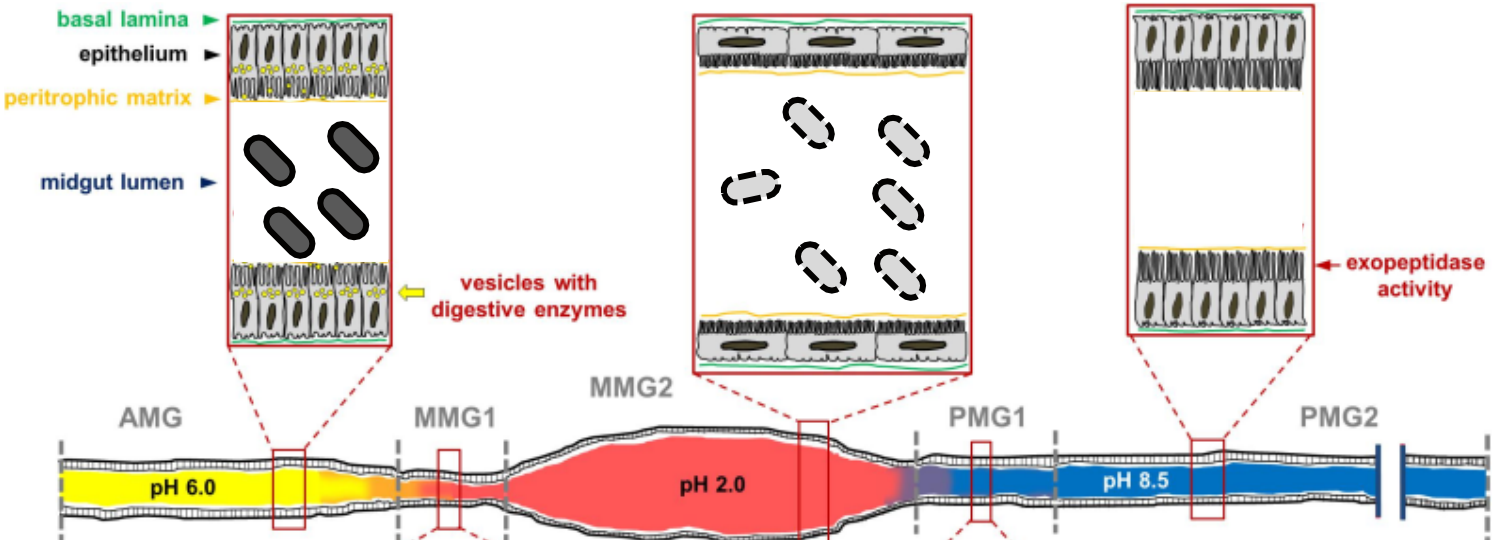
2. Passage through the BSF larval gut reduces the viable count of food pathogens



Factor 2 = rate of reduction of the food pathogen in the gut

Bonelli et al, 2019

Hypothesis



Ongoing research with University of Insubria (Varese, Italy)

Activity of those mechanisms

Presence of mechanisms to kill that specific bacteria

Sensitivity of specific bacteria to those mechanisms

Factor 2 = rate of reduction of the food pathogen in the gut

Bonelli et al, 2019

Take-away

BSF larvae can rapidly clear *S. aureus* (Gram +) and slower *E. coli* (Gram -) **from chicken feed**, but not *Salmonella* (Gram -) at 7 log CFU/g

➔ Fate of food pathogen is result of Factor 1 + Factor 2

Factor 1 = speed of pathogen growth in substrate/residual stream

Factor 2 = reduction of food pathogen in BSF larval gut

Key message:

Be careful with claims about BSF larvae's ability to reduce food pathogens in themselves and substrates

➔ **substrate and bacteria dependent**!

What's next?

- Gain insights into the underlying mechanisms behind microbe reduction
  - ➔ Collaboration with Prof. G. Tettamanti and M. Mortelli
- Explore fate of other food pathogens, especially spore-formers
  - ➔ *Clostridium perfringens* and *Bacillus cereus*
- Combine challenge tests with downstream processing steps
  - ➔ Does processing indeed reduces these risks if pathogens are indeed present?

Acknowledgments

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Research Group for
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Thank you for your attention!

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