SUSINCHAIN
SUSTAINABLE INSECT CHAIN

KU LEUVEN
Research Group for Insect Production & Processing

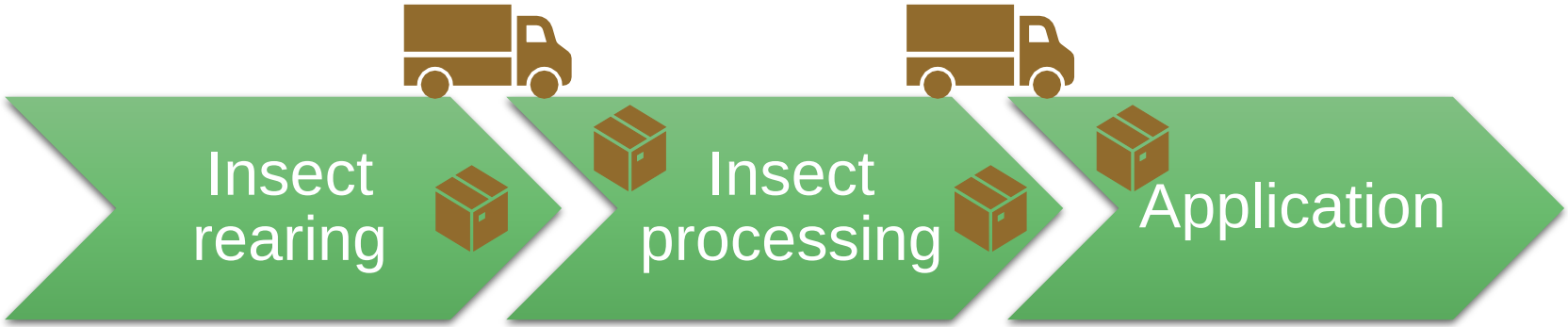
WP 3: Insect Processing

VACUUM PACKAGING AS STORAGE AND TRANSPORT STRATEGY FOR LIVING OR KILLED BLACK SOLDIER FLY LARVAE

DRIES VANDEWEYER
DARIO LACHI, DAVID DERUYTTER, MIK VAN DER BORGHT, LEEN VAN CAMPENHOUT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 861976. This document reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

The insect logistic chain



- Transport of living or killed insects
- Within or between companies/distributors/consumers/…

- Storage of living or killed insects
- Before, during or after a production or processing stage

Stabilisation!

Transport and storage of insects

	Living insects	Killed insects
Stabilisation aim	Retain high survival	Retain high product quality
Influencing factor(s)	Respiration	Killing method Microbial activity → safety!

Current practices:
- Packed in bags, boxes, …
- Open in trays

Current practices:
- Refrigerated or frozen
- Dried

Vacuum packaging?

- Technology exists, also for large quantities (bulk)
- Applied for respiring and non-respiring products
- Low investment for companies

Storage of vacuum-packaged black soldier fly larvae

1. Storage of vacuum-packaged living BSFL

   ➔ Two trials

   ➔ Survival rate and gas composition (O_2/CO_2 concentration)

   ➔ Impact of storage temperature (ambient or 15 °C)

2. Storage of vacuum-packaged killed BSFL

   ➔ Two trials

   ➔ Killing by blanching or freezing (incl. thawing)

   ➔ Gas composition (O_2/CO_2 concentration) and microbial counts

   ➔ Impact of storage temperature (ambient or 4 °C)

Storage of vacuum-packaged black soldier fly larvae

- Experimental set-up
  - 40 packages of 200 g larvae each
  - PE/EVOH/PA high barrier bags, 200 x 250 mm
  - Multivac vacuum chamber, no gases
  - Packaging and storage under following conditions:

Vacuum conditions / Storage temperature	"No" vacuum (750 mbar)	Strong vacuum (35 mbar)
Room temperature	10 packages	10 packages
15 °C (living BSFL) 4 °C (killed)	10 packages	10 packages

  - Storage in a dark environment
  - Temperature was logged

Results living BSFL

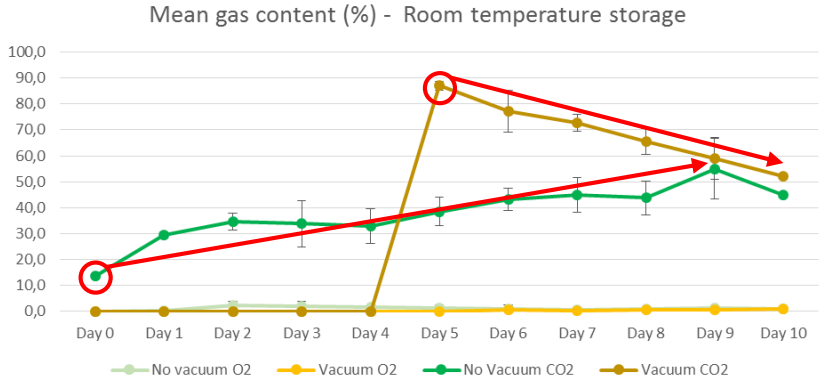
insects
MDPI
Article

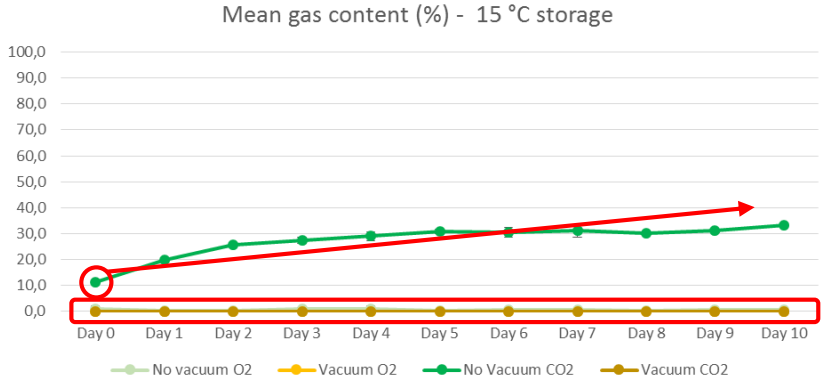
Potential of Fermentation and Vacuum Packaging Followed by Chilling to Preserve Black Soldier Fly Larvae (*Hermetia illucens*)

Leen Van Campenhout [1,2,*], Dario Lachi [1,2] and Dries Vandeweyer [1,2]

[1] Research Group for Insect Production and Processing, Department of Microbial and Molecular Systems (M²S), Geel Campus, KU Leuven, 2440 Geel, Belgium; dario.lachi@kuleuven.be (D.L.); dries.vandeweyer@kuleuven.be (D.V.)
[2] Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, 3001 Leuven, Belgium
* Correspondence: leen.vancampenhout@kuleuven.be; Tel.: +32-14-56-23-10

- Gas composition in the packages





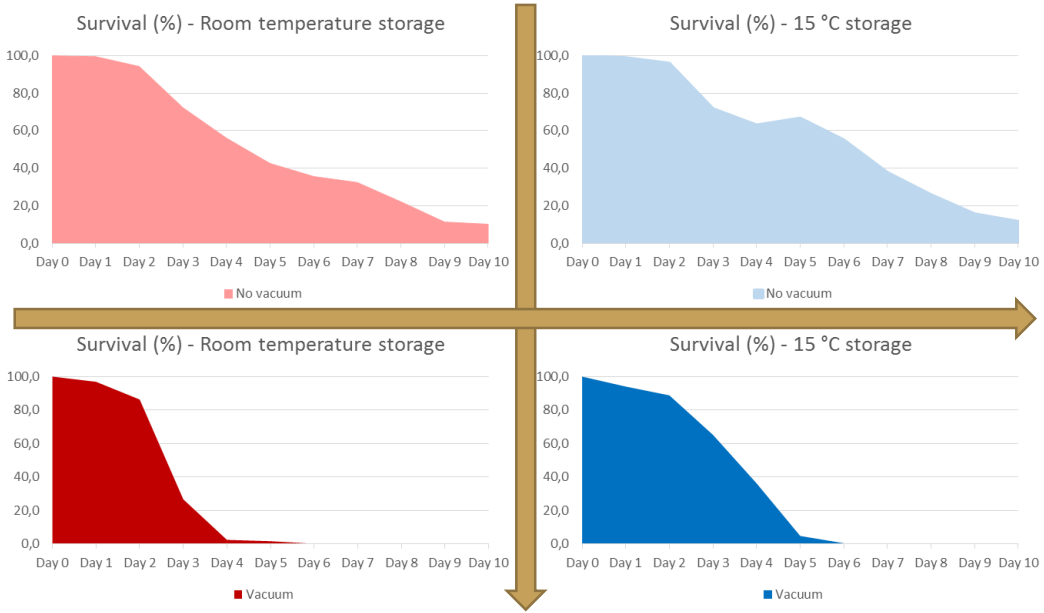
- Immediately after packaging, [CO_2] rose quickly towards 11-13%, while [O_2] dropped to 0% in packages without vacuum
- No vacuum:
  - [O_2] remained below 1.5% during the whole storage period
  - [CO_2] rose in time, towards ± 50% at room temperature storage, towards 40% at 15 °C
- Vacuum:
  - As from Day 5, vacuum in packages at room temperature was broken
  - [CO_2] has risen up to > 65-75%, but decreased in time from then → microbial activity?

➔ Rise in CO_2 slower at 15 °C

➔ Vacuum conditions remain longer at 15 °C

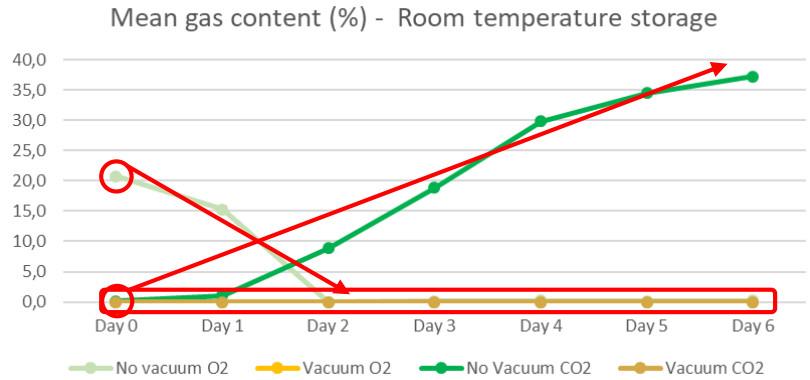
Results living BSFL

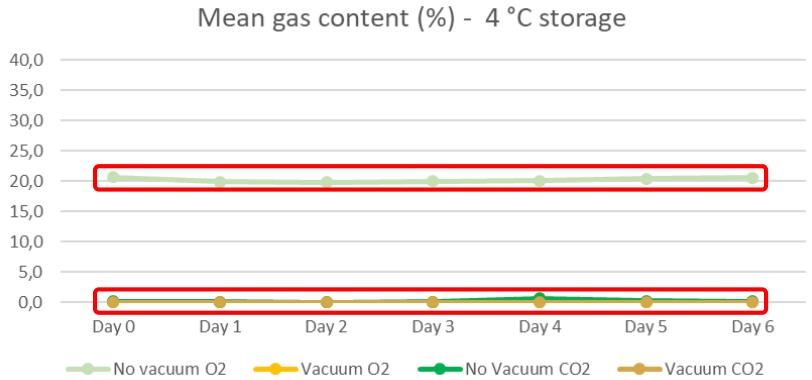
- Survival rate of the larvae
  - Impact of vacuum
    - Survival rate ↓ faster under vacuum
  - Impact of temperature
    - Survival rate ↓ faster at room temperature
    - Only 5 °C difference (19.9 ↔ 14.9 °C)!



Results killed (blanched) BSFL

- Gas composition in the packages





- No vacuum:
  - [O2] dropped to < 1% as from Day 2 at room temperature storage
  - [CO_2] rose in time, towards ± 35% at room temperature storage
  - Stable gas concentrations during refrigerated storage

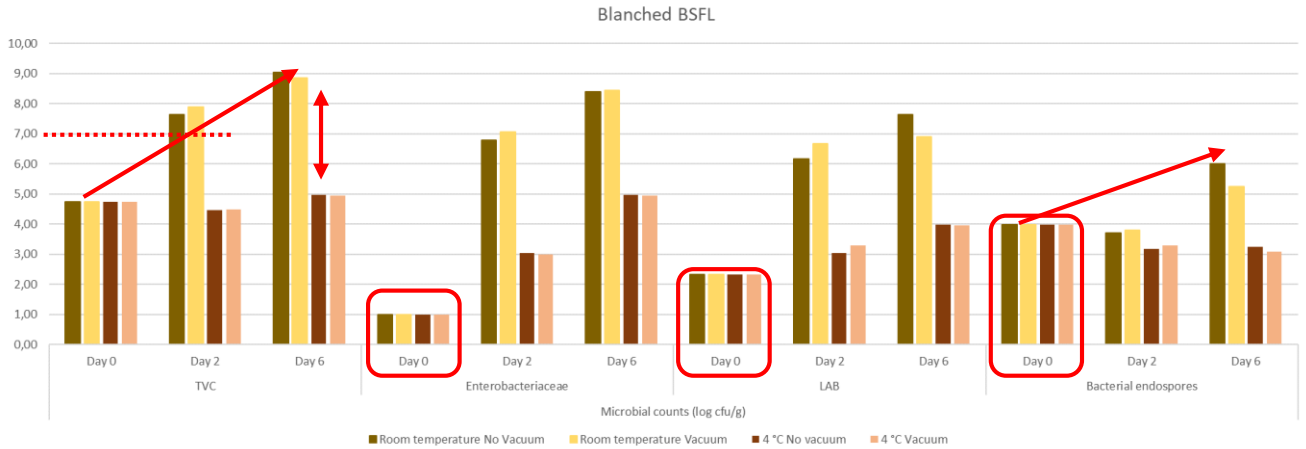
➔Microbial activity at RT
➔Important impact of storage temperature

- Vacuum:
  - Vacuum retained during whole storage period for both storage temperatures

➔No change in vacuum

Results killed (blanched) BSFL

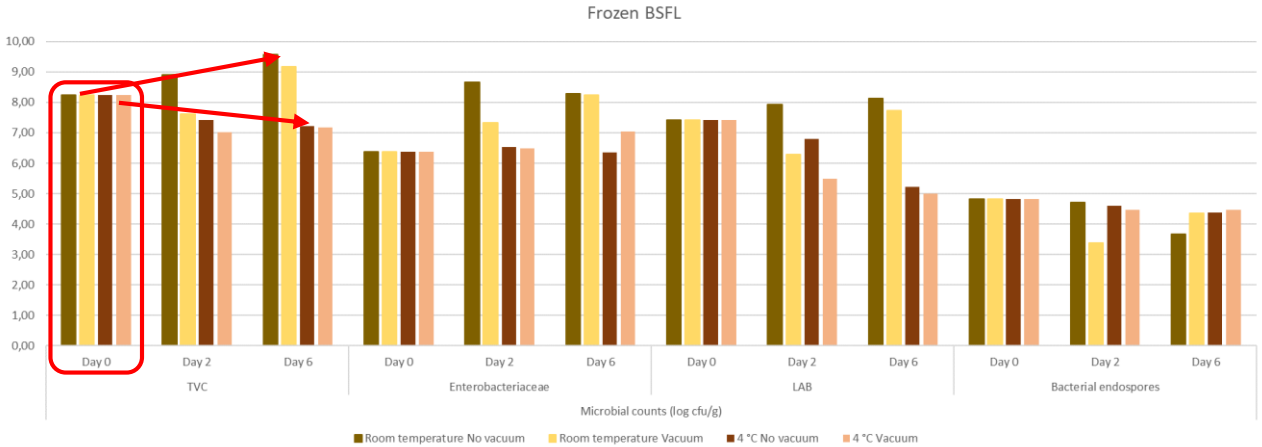
- Microbial counts



- Elimination of certain microorganisms due to blanching ➔ low impact on endospores
- Microbial growth during storage, also number of endospores increases over time
    - Spoilage level (7 log cfu/g) reached after 2 days of storage (room temperature)
- Few (no?) differences between vacuum and no vacuum
- Slower growth of microorganisms at 4 °C

Results killed (frozen) BSFL

- Gas composition changes faster due to higher microbial activity, vacuum (room temperature) is broken after a few days
- Microbial counts



- Still high amount of microorganisms after killing step ➔ High initial counts
- Microbial growth during room temperature storage; stabilisation or slight reduction of counts during refrigerated storage
- No impact of vacuum

Conclusions

1. Storage of vacuum-packaged living BSFL

   ➔ BSFL survive several days under vacuum and under high CO_2 concentration

   ➔ Survival is better at lower temperature (15 °C) compared to room temperature

   ➔ Vacuum packaging has no advantage over non-vacuum packaging

2. Storage of vacuum-packaged killed BSFL

   ➔ Initial counts (< killing method) determines microbial activity and growth

   ➔ Microbiological quality is better at 4 °C

   ➔ Vacuum packaging has no advantage over non-vacuum packaging

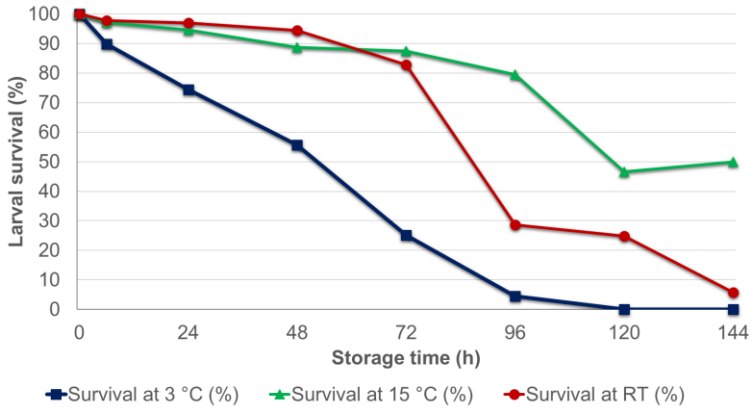
Vacuum packaging cannot replace nor improve chilled storage of living or killed BSFL

Ongoing further research

Transport and storage of living insects in water?

- From vacuum research ➔ BSFL can temporarily survive without oxygen
- Easily applicable
- Combination with washing and/or chilling
- “Pumping” of insects through/to facilities?

- First step: survival of BSFL in water at different storage temperatures



Storage in water possible for a few hours to days, preferably in water > 3 °C

KU LEUVEN
Research Group for Insect Production & Processing

inagro
RESEARCH & ADVICE IN AGRICULTURE & HORTICULTURE

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

SUSINCHAIN
SUSTAINABLE INSECT CHAIN

dries.vandeweyer@kuleuven.be

http://www.susinchain.eu

https://doi.org/10.3390/insects12080714