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Mia Kurek, Nathalie Gontard, Valérie Guillard

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ACTIVE PACKAGING: CONTROLLED RELEASE OF MICROBIAL AGENTS FROM PACKAGING MATERIALS

Mia Kurek, Valerie Guillard, Nathalie Gontard
NextGenPack
Next generation of advanced active and intelligent bio-based packaging for food

ACTIVE ANTIMICROBIAL PACKAGING

How to create an optimised AP?

Controlled release technology

AC mass transfer rate \(\ll\) MO growth rate

\(C_{AC} < C_{critical}\)

MO will grow instantly, before AC is released

AC mass transfer rate \(\gg\) MO growth rate

\(C_{AC} > C_{critical}\)

\(\rightarrow\) activity
Active NGP film design

BioPE or PLA film + Active volatile compound

Why AITC?
strong AM activity in vapour state

Why β cyclodextrine?
- Protection against thermal degradation
- To avoid premature release
- AC release \( \rightarrow f(\text{headspace RH}) \)

Active BioPE or PLA film

Why AITC?
- Allyl isothiocyanate
- In vapor state

Environment T, RH

\[ t_0 \quad \text{shelflife} \]

\[ \text{MIC} < C_{\text{AITC}} < \text{sensory threshold} \]

HS T, RH

Active BioPE or PLA film
**STEPS**

- To model H$_2$O transfer into active film
- To model the release of AITC from β-CD as function of RH
- To model AITC transfer through active film
- To couple mass transfers & AITC release kinetic to predict AITC release into HS
OUTPUTS:

→ allows calculation of active complex needed for the optimisation of packaging design

✓ evolution of AITC in the HS allows to determine the activity profile → $C_{aitc} > MIC$

**Example:**

BioPE

By changing:

Film composition

![Graph showing AITC in headspace over time](image-url)
OUTPUTS:

→ allows calculation of active complex needed for the optimisation of packaging design

✓ evolution of AITC in the HS allows to determine the activity profile → $C_{aitc} > \text{MIC}$

**Example:**

**BioPE**

By changing:

Film composition

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![Graph showing the evolution of AITC in the headspace over time. The graph includes two lines representing 1% and 5% βCD-AITC solutions, with the MIC set at < 1 mg/dm³.](image)
OUTPUTS:

→ allows calculation of active complex needed for the optimisation of packaging design

✓ evolution of AITC in the HS allows to determine the activity profile \( \rightarrow C_{\text{aitc}} > \text{MIC} \)

Example: BioPE

By changing:

- Film composition
- Headspace volume
OUTPUTS:

→ allows calculation of active complex needed for the optimisation of packaging design

✓ evolution of AITC in the HS allows to determine the activity profile → $C_{aitc} > MIC$

Example:

BioPE

By changing:

Film composition

Headspace volume

\[ \text{AITC in headspace (mg dm}^{-3}\text{)} \]

\[ 0 \quad 5 \quad 10 \quad 15 \quad 20 \]

\[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \]

\[ \text{Time (days)} \]

\[ \text{V} \]

\[ V \times 2 \]

\[ V \times 4 \]

\[ 0 \quad 5 \quad 10 \quad 15 \quad 20 \]

\[ 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \]

\[ \text{AITC in headspace (mg dm}^{-3}\text{)} \]

\[ \text{Time (days)} \]
OUTPUTS:

→ allows calculation of active complex needed for the optimisation of packaging design

✓ evolution of AITC in the HS allows to determine the activity profile  → \( C_{aitc} > \text{MIC} \)

Example:

BioPE

By changing:

- Film composition
- Headspace volume
- \( a_w \) of the HS
CONCLUSIONS

1) Developed mathematical model successfully describes controlled release of AC in the HS in order to reach MIC
2) The rate of release depends on the moisture content of the system
3) H₂O and AC distribution profiles can help in understanding the release kinetics
4) The model can be used to optimise design of active packaging
Thank you for your attention