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ACTIVE PACKAGING: CONTROLLED RELEASE OF MICROBIAL AGENTS FROM PACKAGING MATERIALS

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NextGenPack
Next generation of advanced active and intelligent bio-based packaging for food

ACTIVE ANTIMICROBIAL PACKAGING

How to create an optimised AP?

AC mass transfer rate \ll MO growth rate

\[ C_{AC} < C_{critical} \]

MO will grow instantly, before AC is released

Controlled release technology

AC mass transfer rate \gg MO growth rate

\[ C_{AC} > C_{critical} \]

\[ \rightarrow \text{activity} \]
Active NGP film design

Why AITC?
A strong AM activity in vapour state

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

Environment T, RH

Active BioPE or PLA film

Active volatile compound

Allyl isothiocyanate

MIC < C_{AITC} < sensory threshold

t_0, \text{shelflife}

HS T, RH

BioPE or PLA film

+
STEPS

- To model H₂O 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

**5% βCD-AITC**

![](chart.png)
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  → \( C_{aitc} \geq \text{MIC} \)

Example: BioPE

By changing: Film composition

\[ 5\% \beta\text{CD}-\text{AITC} \]

\[ 1\% \beta\text{CD}-\text{AITC} \]

MIC < 1 mg/dm³
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
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  \( \rightarrow C_{aitc} > MIC \)

*Example:* BioPE

By changing:

Film composition

Headspace volume

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

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

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

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

\[ \text{V} \]

\[ \text{Vx2} \]

\[ \text{Vx4} \]

\[ \text{V} \]

\[ \text{Vx2} \]

\[ \text{Vx4} \]
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
- $a_w$ 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) H$_2$O 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