The Atlantic – 27/06/2020

The Atlantic, 04/06/2025

The Atlantic, 23/01/2024

FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF FOOD TECHNOLOGY, SAFETY AND HEALTH
RESEARCH UNIT FOOD MICROBIOLOGY AND FOOD PRESERVATION

DUURZAME VERPAKKINGEN IN DE PRAKTIJK: MICROBIOLOGISCHE VEILIGHEID EN HOUDBAARHEID

Quality days - 23/04/2026

Amber Van Reepingen, Frank Devlieghere, An Vermeulen, Peter Ragaert, Angelique Vandemoortele, Lotta Kuuliala, Mariem Somrani Achouri, Seren Oğuz

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1 Setting the scene
Context & motivatie

2 Lage O_2 & verhoogde CO_2
Effecten en mechanismen

3 Experimentele hindernissen
Praktische uitdagingen

4 Conclusies
Belangrijkste take-aways

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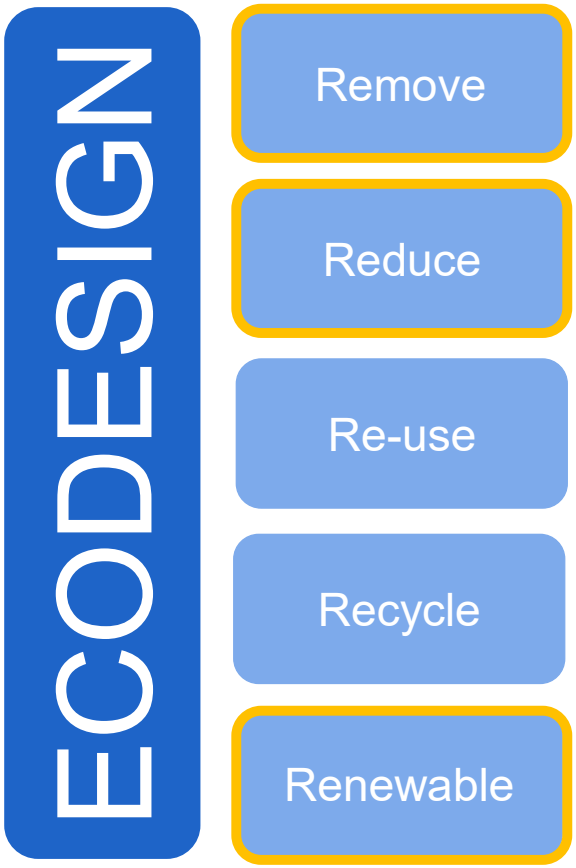
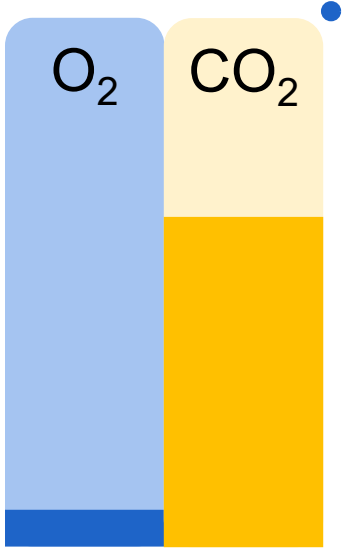
1. SETTING THE SCENE

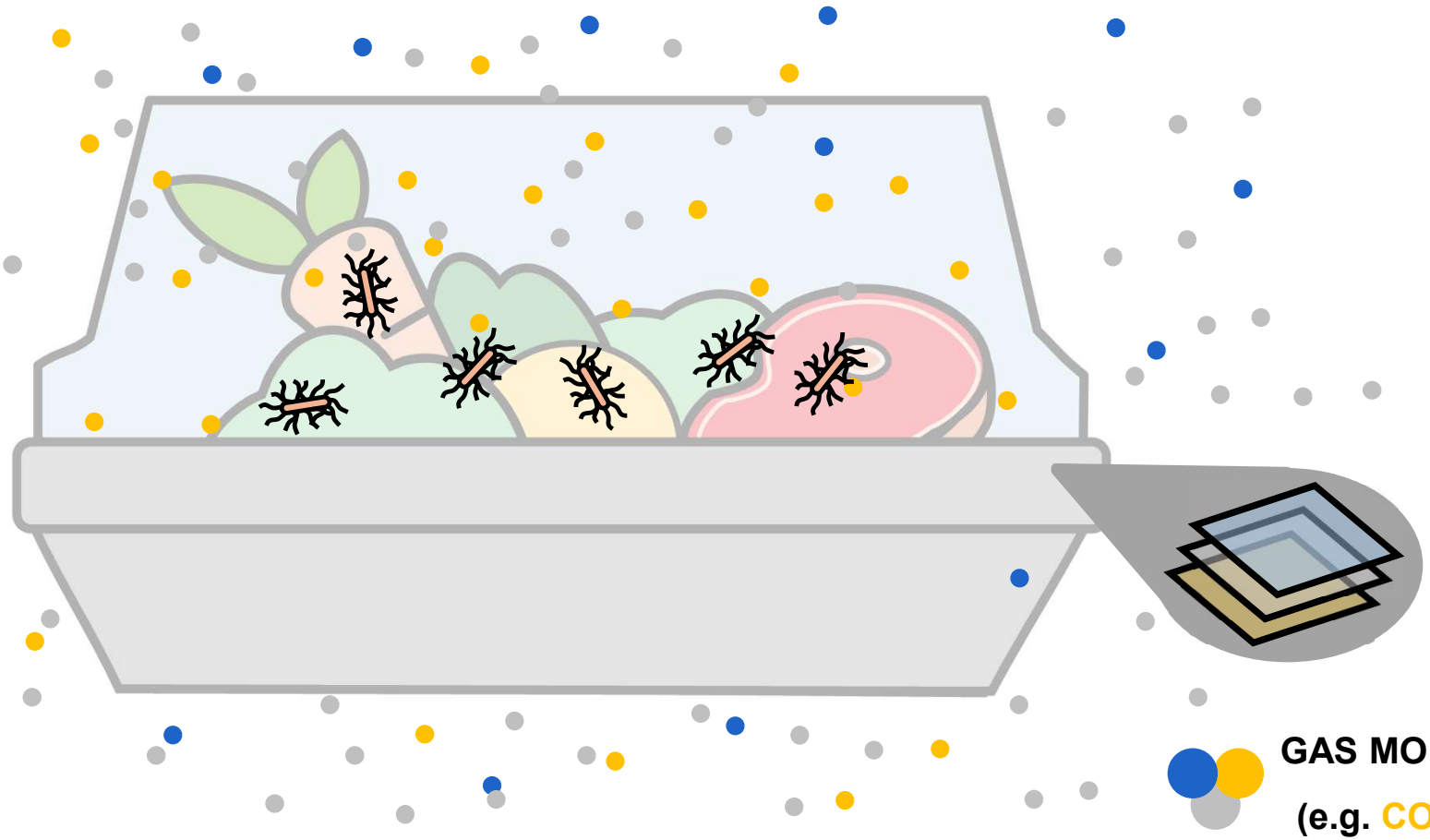
INDUSTRIE: OP WEG NAAR ECODESIGN



Verhoging gasdoorlaatbaarheid van verpakkingssystemen

VERHOGING GASDOORLAATBAARHEID VERPAKKINGSSYSTEMEN

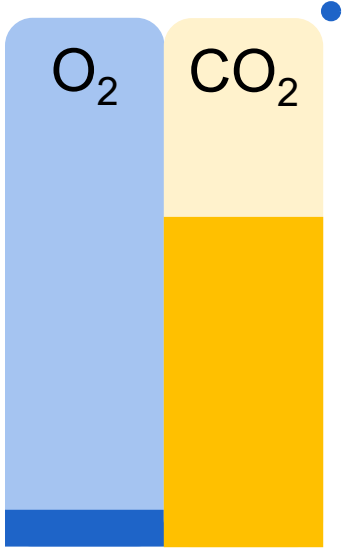


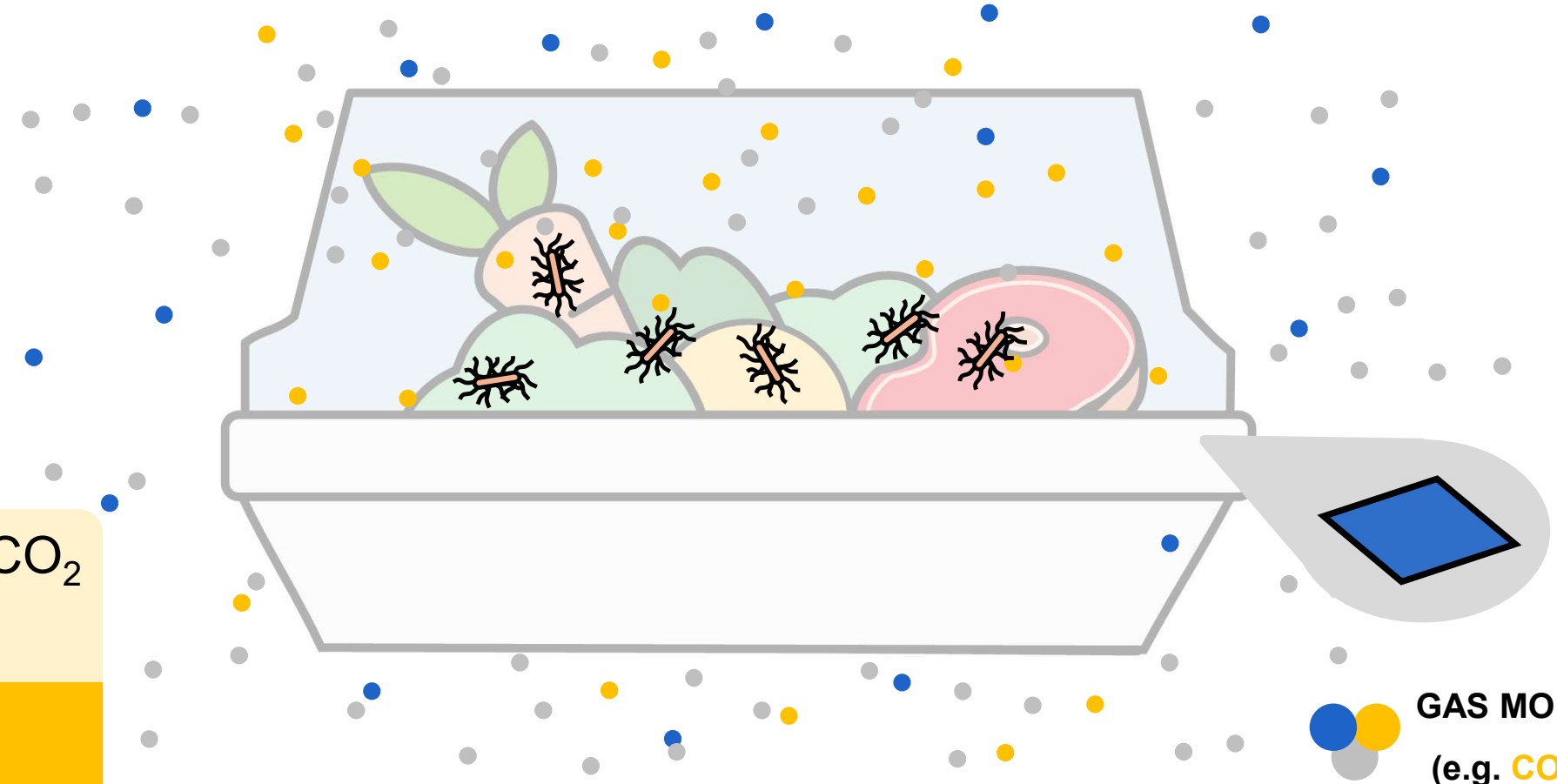


GAS MOLECULEN

(e.g. CO_2, O_2, N_2)

VERHOGING GASDOORLAATBAARHEID VERPAKKINGSSYSTEMEN





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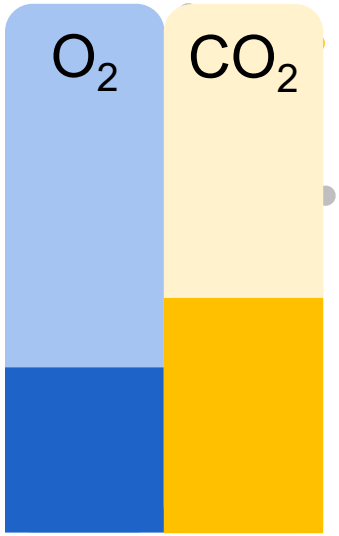
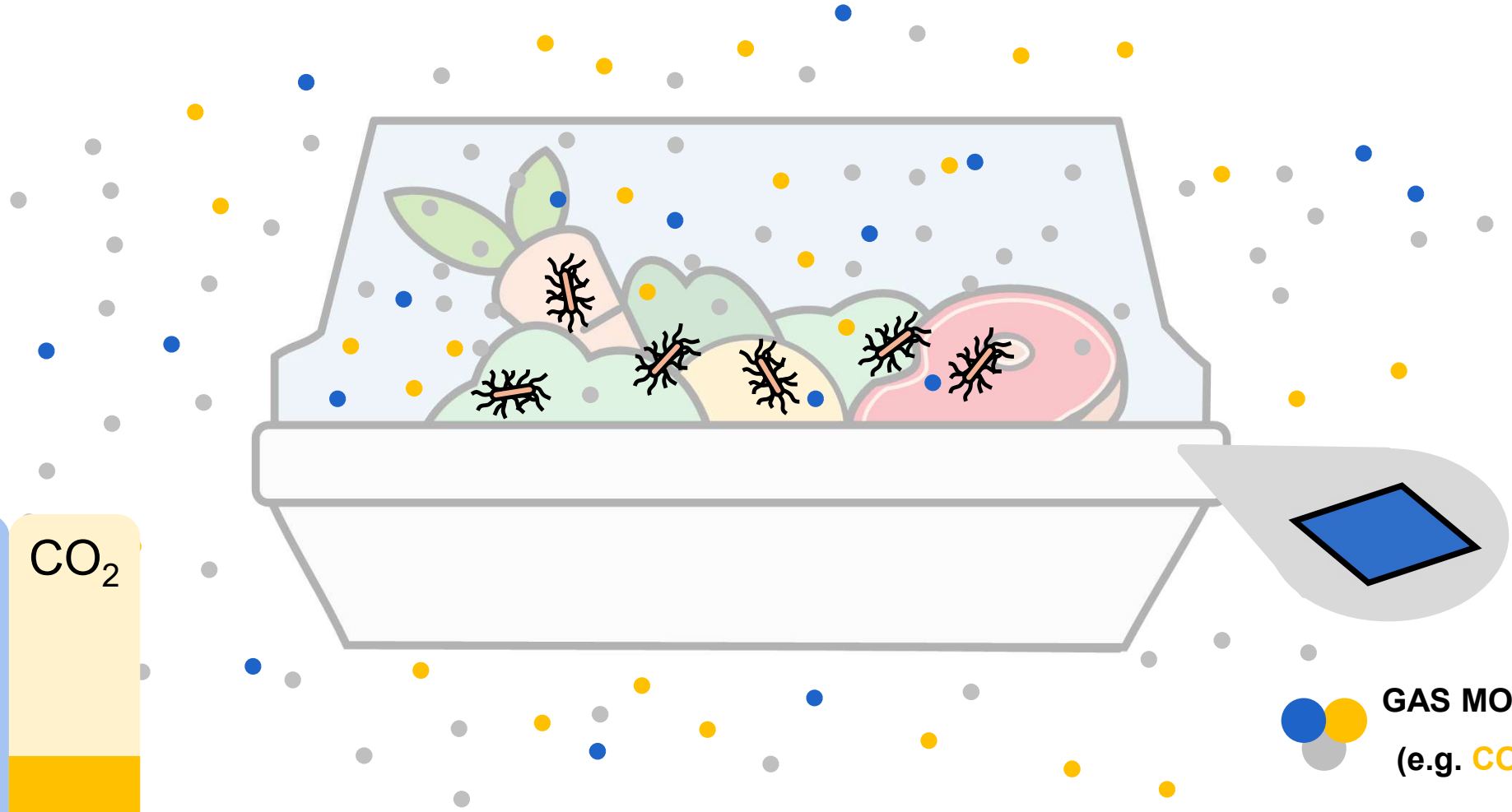
VERHOGING GASDOORLAATBAARHEID VERPAKKINGSSYSTEMEN





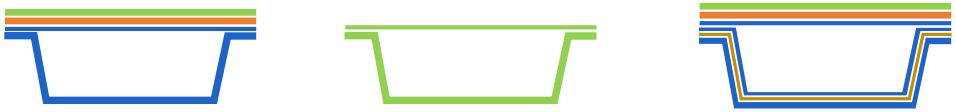
GAS MOLECULEN

(e.g. CO_2, O_2, N_2)

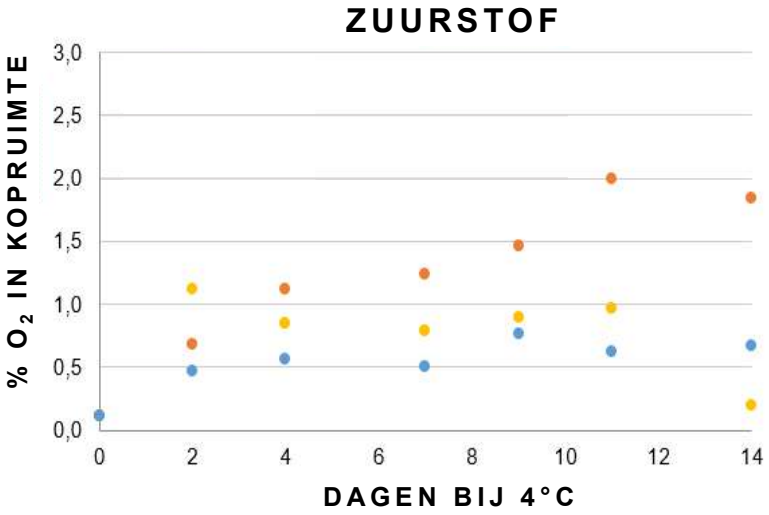
VAN HERONTWERP NAAR DUURZAMERE VERPAKKINGEN – KORTE HOUDBAARHEID

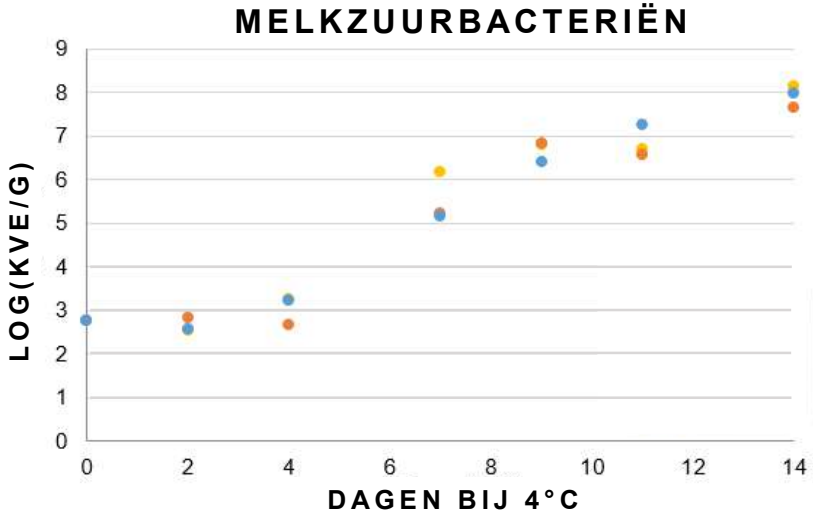
Gepasteuriseerde, ready-to-heat maaltijden onderhevig aan post-contaminatie

Top folie	OPA/PE/EVOH/PE/PP	PET	OPA/EVOH/OPA/PP
Schaal	PP	PET	PP/EVOH/PP
O_2 Barrière	**LAAG**	**MEDIUM**	**HOOG**



ALTERNATIEF 1 **ALTERNATIEF 2** **REFERENTIE**





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Coordinator Pack4Food

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MPR&S Materials and Packaging Research & Services | UHASSELT

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IBE-BVI

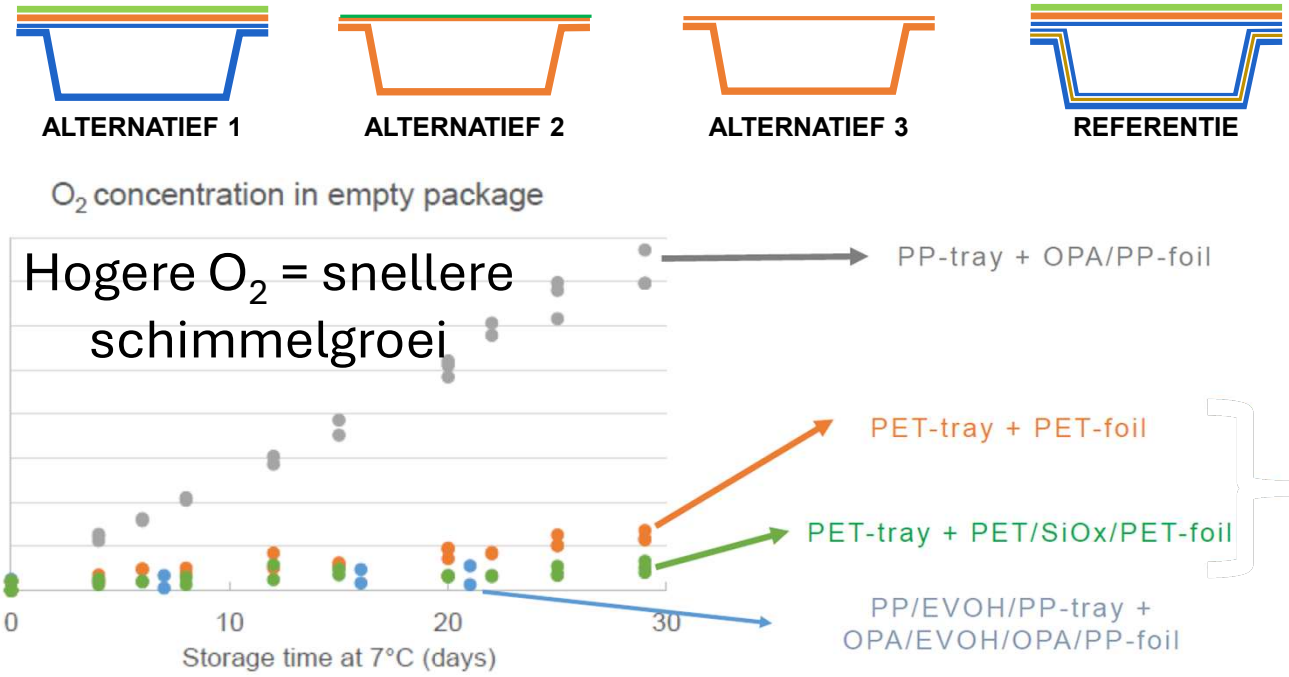
OPTI-BARRIER

Baele et al., 2020

VAN HERONTWERP NAAR DUURZAMERE VERPAKKINGEN – MEDIUM HOUDBAARHEID

Kaas in schaal met topfolie

	ALTERNATIEF 1	ALTERNATIEF 2	ALTERNATIEF 3	REFERENTIE
Top folie	OPA/PP	PET/SiOx/PET	PET	OPA/EVOH/OPA/PP
Schaal	PP	PET	PET	PP/EVOH/PP
O_2 Barrière	**LAAG**	**MEDIUM**	**MEDIUM**	**HOOG**



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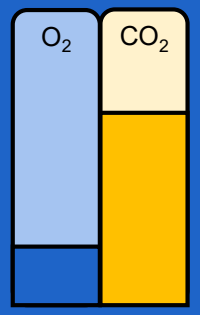

2. INVLOED VAN LAGE O_2 EN VERHOOGDE CO_2 CONCENTRATIES OP GROEI VAN MICRO-ORGANISMEN

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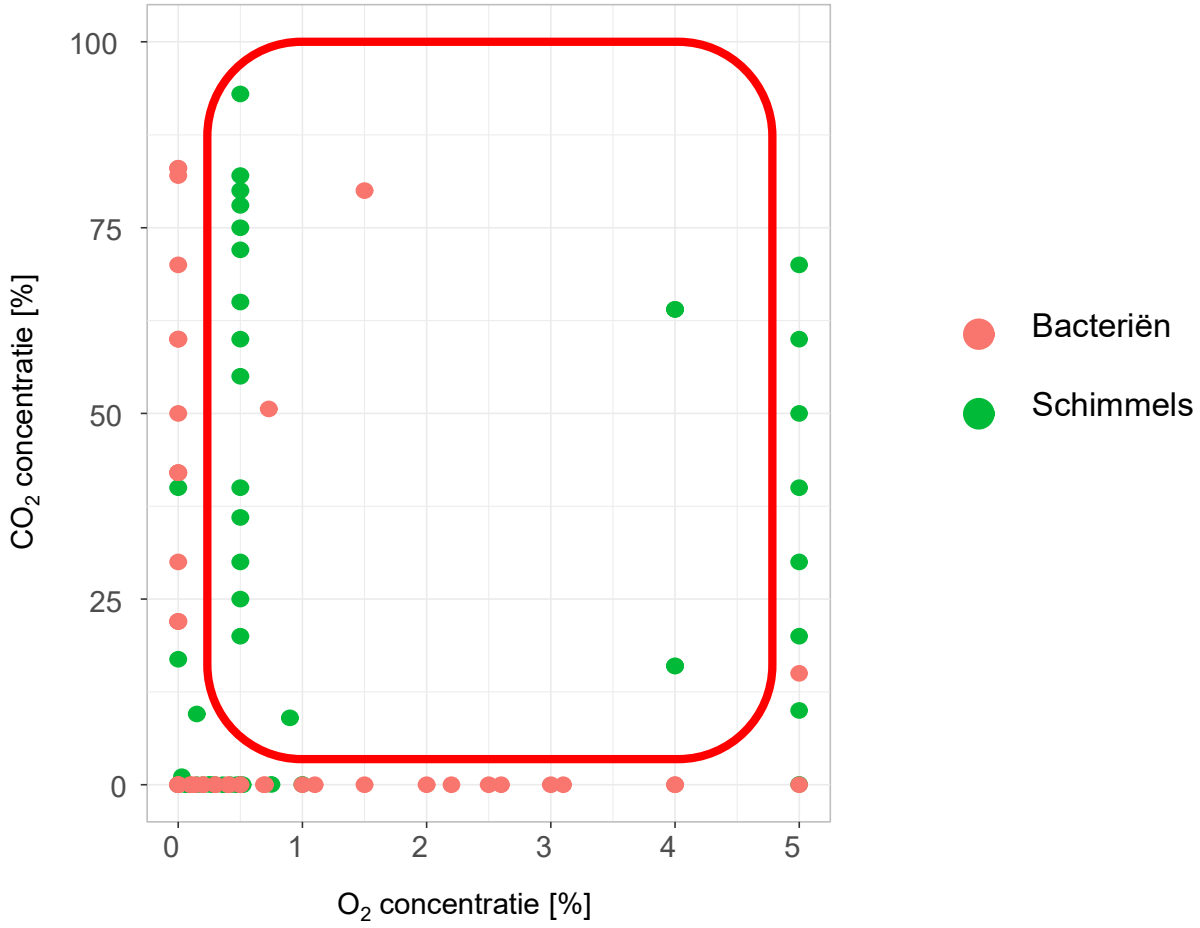
EFFECT VAN ATMOSFEER OP GROEI VAN MICRO-ORGANISMEN

Beschikbare literatuurgegevens groei micro-organismen bij specifieke combinaties O_2 (0-5%) / CO_2 (0-100%)



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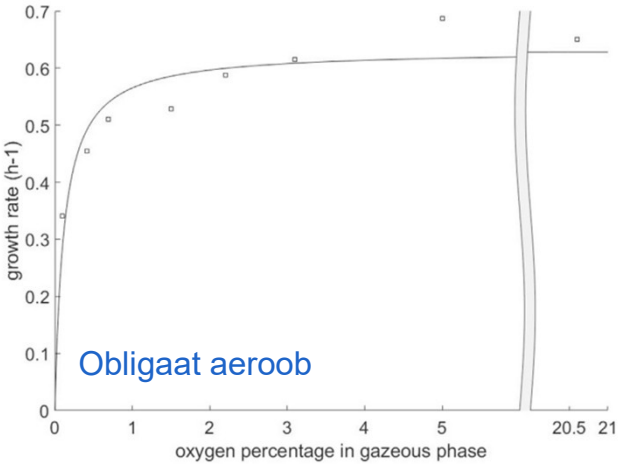
EFFECT VAN ZUURSTOF OP GROEI VAN BACTERIËN

Couvert et al. , 2019

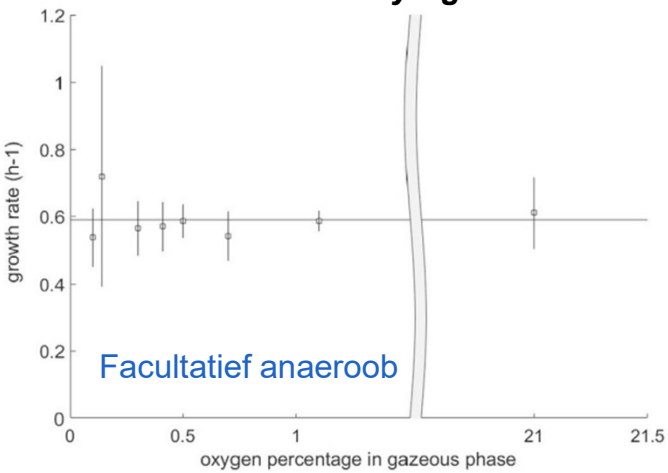
Opkweek condities:

- **25°C**
- Oppervlaktegroei
- pH = 7.4
- Vegetatieve cellen

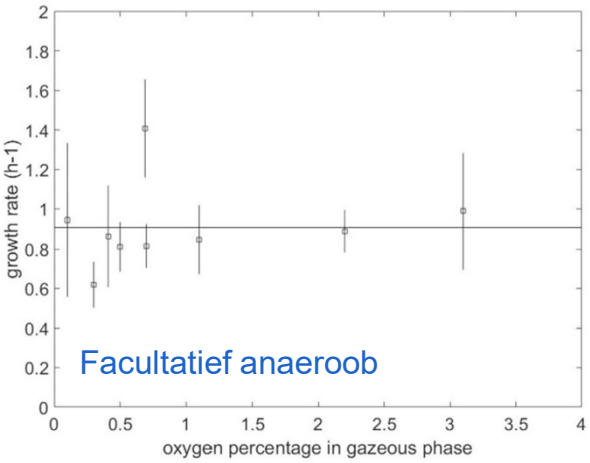
Pseudomonas fluorescens



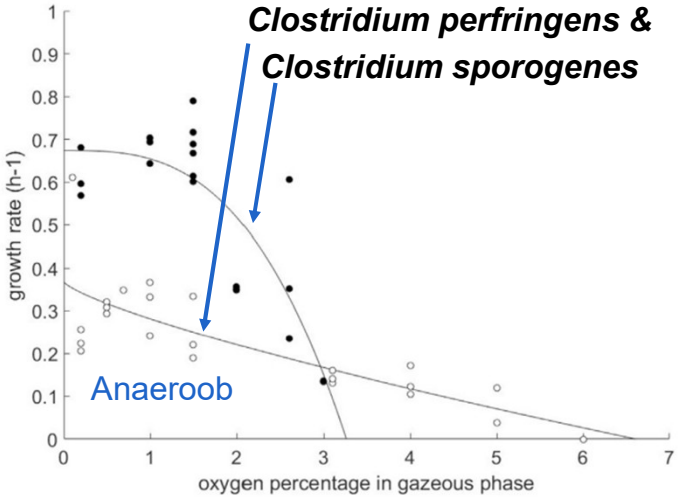
Listeria monocytogenes



Bacillus weihenstephanensis



Clostridium perfringens &
Clostridium sporogenes



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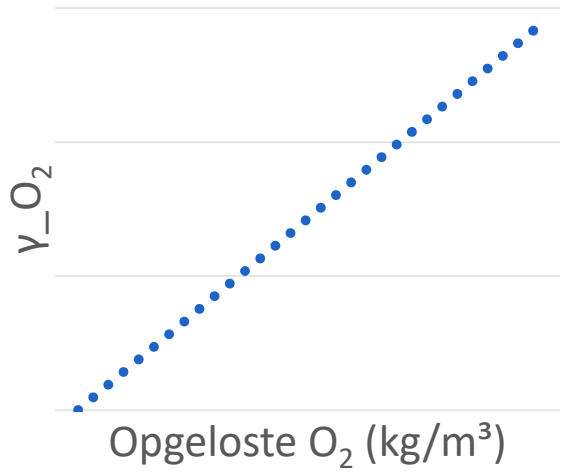
WAT MET COMBINATIE LAGE O_2-NIVEAUS EN CO_2?

$$\mu_{max} = \mu_{opt}\gamma_T\gamma_{pH}\gamma_{a_w}\gamma_{O_2}\gamma_{CO_2}\xi$$

$$\gamma_{O_2}(x,T) = \frac{C_{O_2,F}(x,T) - C_{O_2,min}}{C_{O_2,max}(T) - C_{O_2,min}}$$

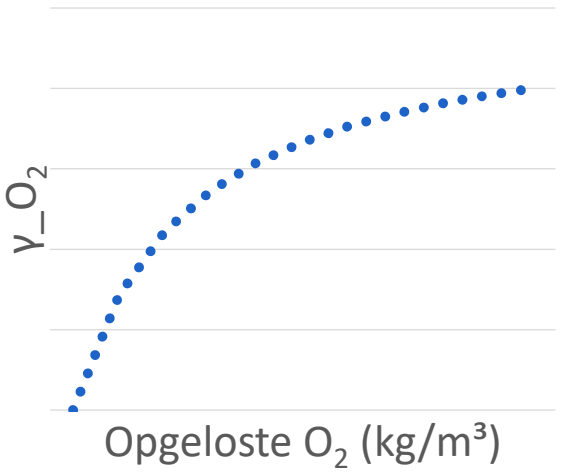
Chaix et al. , 2015



$$\gamma_{O_2}(x,T) = \frac{C_{O_2,F}(x,T)}{C_{O_2,min} + C_{O_2,F}(x,T)}$$

MONOD

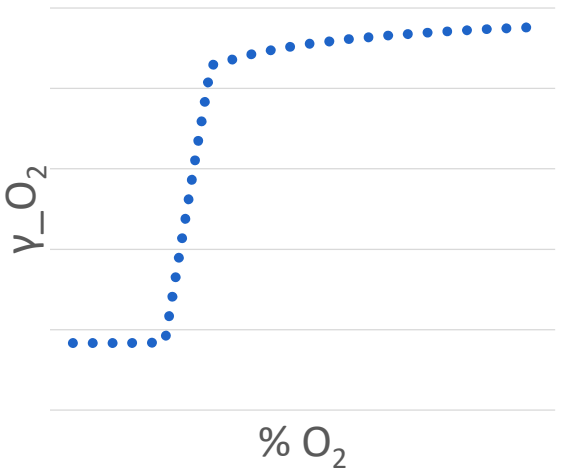
Guillard et al., 2016



$$\mu_{max} = \begin{cases} \mu_{opt_{O2}} \cdot \frac{\%O_{2,inf}}{K_S + \%O_{2,inf}} & if\ O_2 \leq O_{2,inf} \\ \mu_{opt_{O2}} \cdot \frac{\%O_2}{K_S + \%O_2} & if\ O_2 > O_{2,inf} \end{cases}$$

FACULTATIEF ANAEROBEN

Couvert et al., 2023



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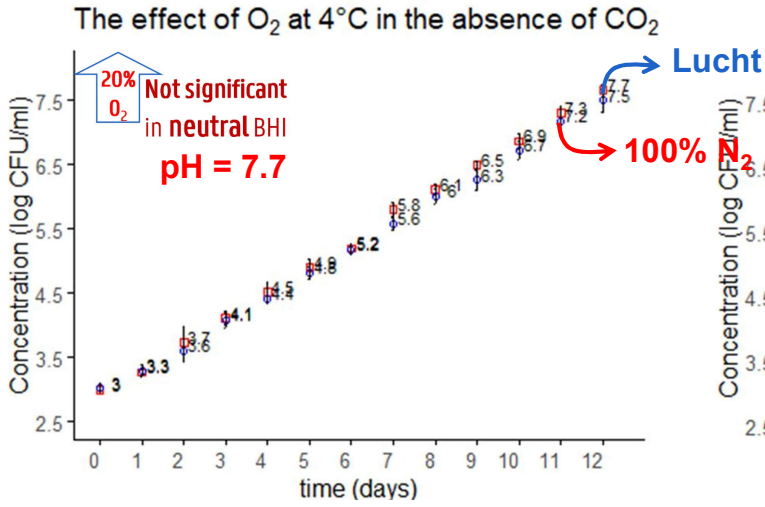
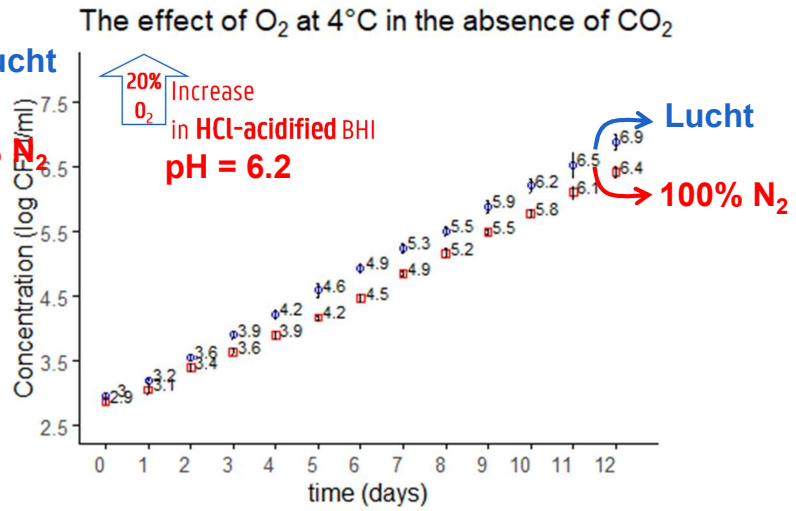
EFFECT VAN ZUURSTOF OP GROEI VAN BACTERIËN

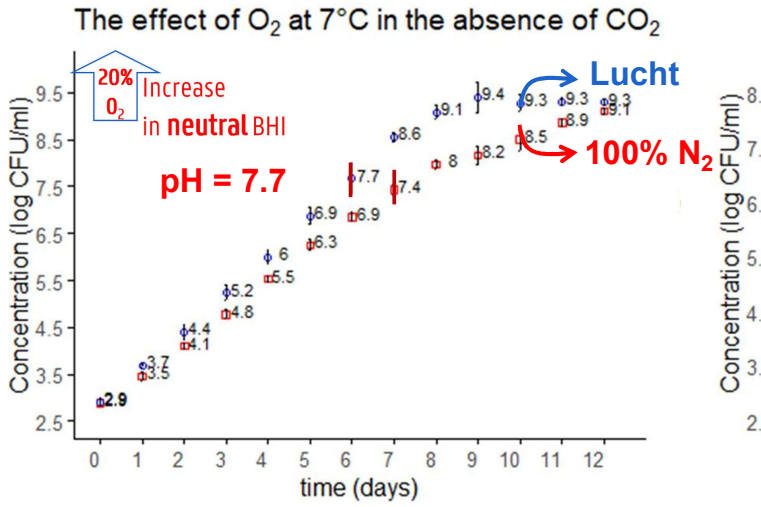
Oguz et al., 2026

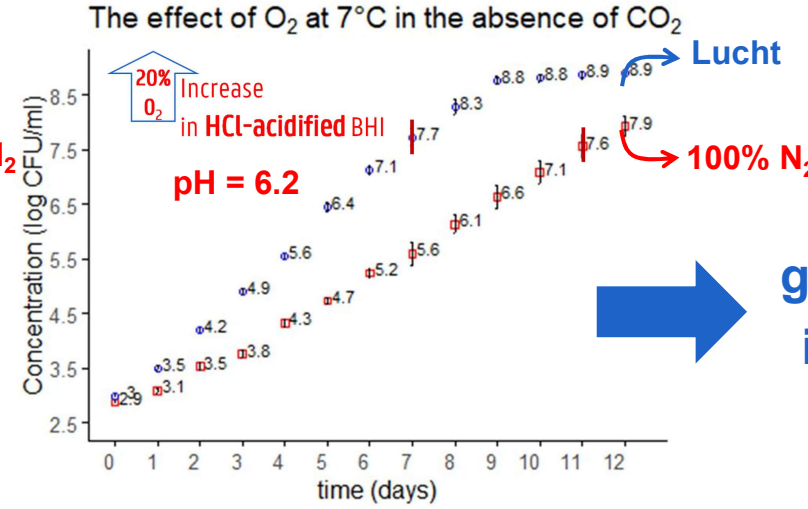
4 °C





7 °C





Listeria monocytogenes in vloeibare BHI met constante, gecontroleerde gassamenstelling

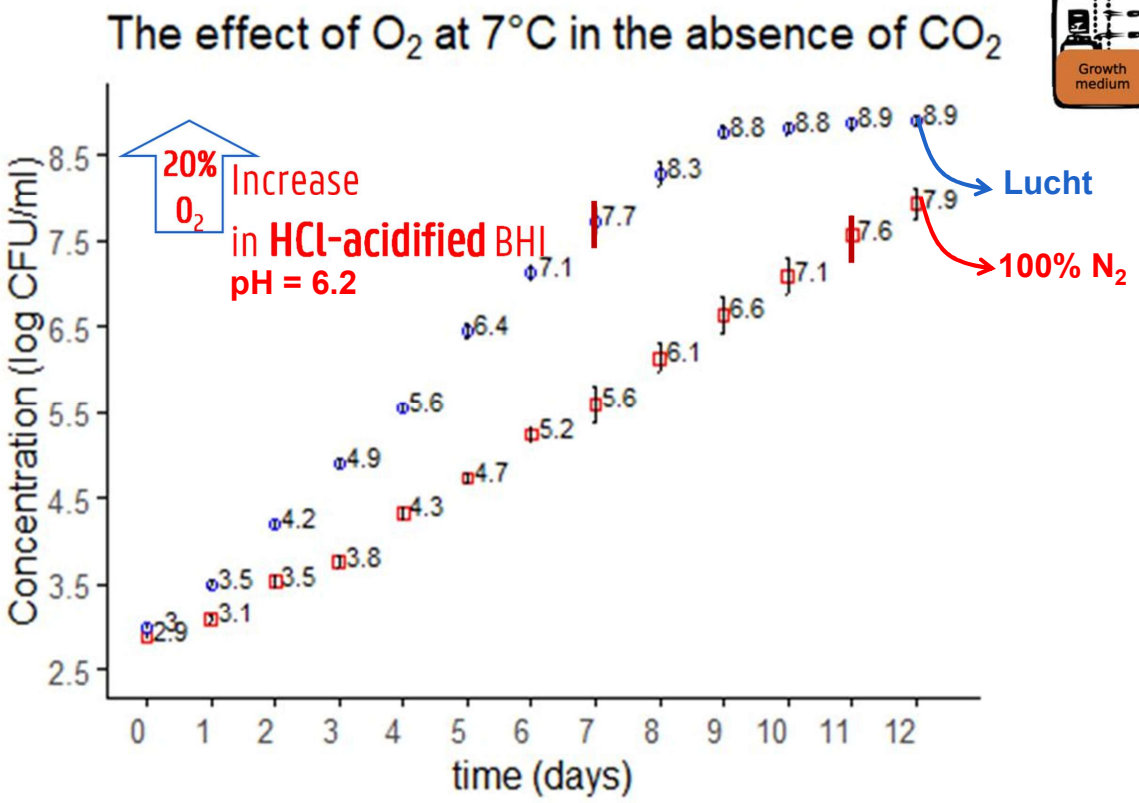
$CO_2/O_2/N_2$

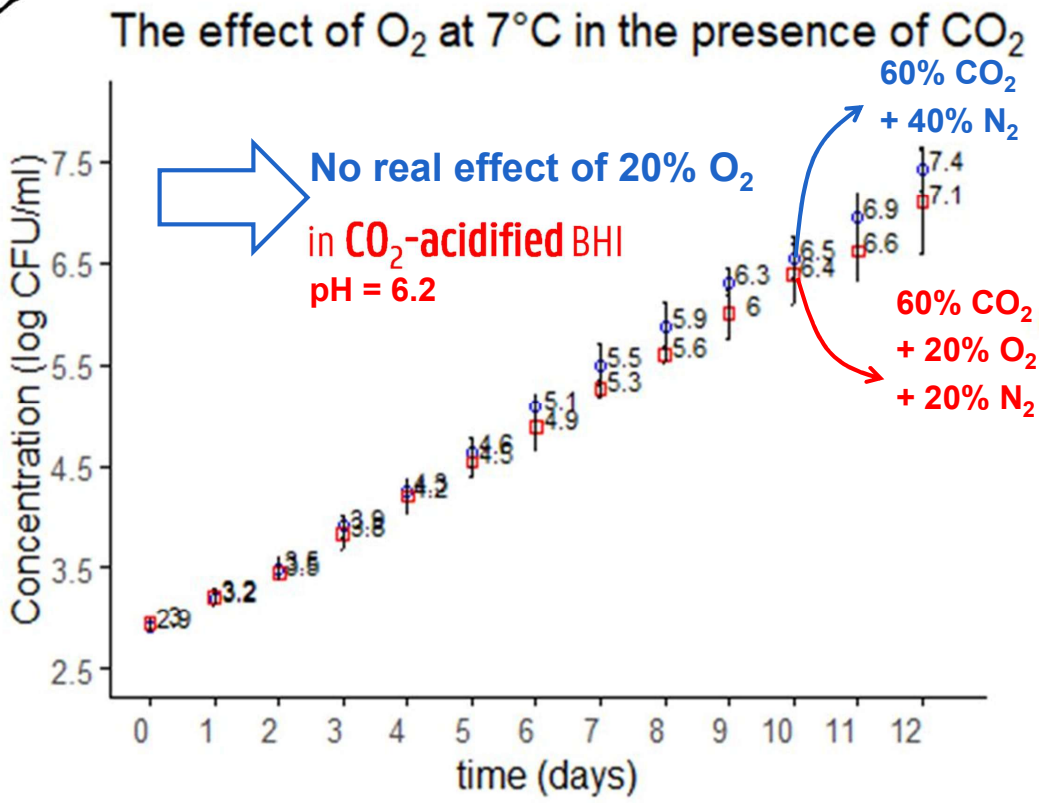
- 0/20/80
- 0/0/100

O_2-afhankelijkheid van groei in vloeibaar medium is niet onafhankelijk van andere groeifactoren

EFFECT VAN ZUURSTOF OP GROEI VAN BACTERIËN– COMBINATIE MET CO_2

Oguz et al., 2026





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EFFECT VAN ZUURSTOF OP GROEI VAN BACTERIËN

Van Reepingen et al., 2026

Stam A

Stam B

Invloed shift naar duurzamere verpakkingen hangt sterk af van **karakteristieken levensmiddel!**

Listeria monocytogenes op vaste BHI-agar bij 7°C met constante, gecontroleerde gassamenstelling

$O_2/O_2/N_2$

- 0/20/80
- 0/0/100

O_2-afhankelijkheid van groei is niet onafhankelijk van andere groeifactoren op vast medium

+ stamafhankelijk

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3. EXPERIMENTELE HINDERNISSEN

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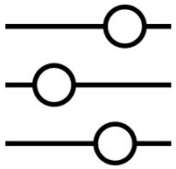
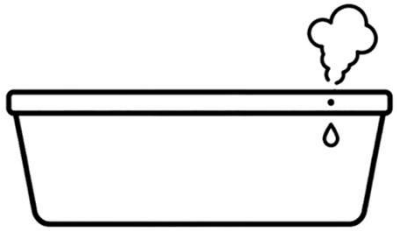
EXPERIMENTELE HINDERNISSEN

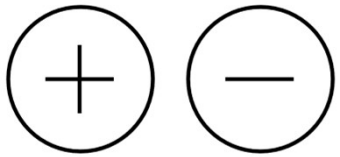
Nauwkeurige gassamenstellingsinstellingen noodzakelijk, vooral bij **lage O_2**-concentraties



Constante **controle** gassamenstelling = essentieel

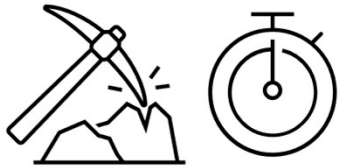


Compleet **gasdichte** systemen



Compensatie CO_2-productie + O_2-verbruik microbiële groei en **interactie voedingsmatrix**

Dynamische, goed gedefinieerde O_2/CO_2/N_2-profielen voor validatie



OD-metingen/andere geautomatiseerde methoden: moeilijk onder specifieke atmosfeer → **arbeidsintensieve** experimenten

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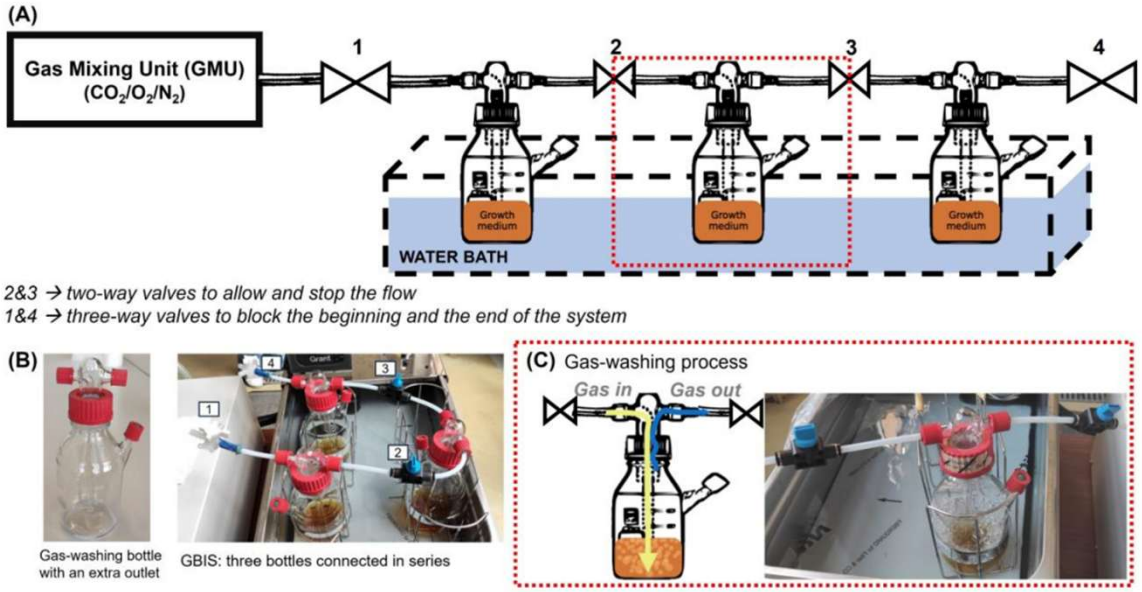
EXPERIMENTELE HINDERNISSEN



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4. Conclusies

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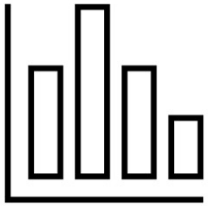
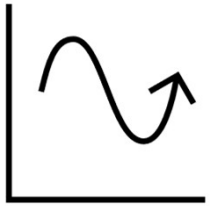
TAKE HOME MESSAGES

Verpakking evolueert snel
→ duurzamere concepten:
↓ functionele eigenschappen
→ houdbaarheid + microbiële veiligheid?

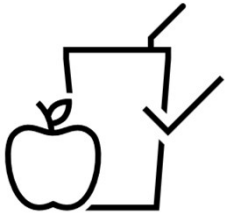


Weinig kwantitatieve informatie gedrag MO in atmosferen met lage O_2-niveaus + CO_2



Bijna geen informatie over dynamische atmosferen (~ realiteit)

Verzamelen data: arbeids-, materiaal-, en tijdrovend



Overstap naar nieuw verpakkingssysteem: Impact op verpakt voedsel?

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BEDANKT!

Frank Devlieghere

Mariem Somrani Achouri

An Vermeulen, Peter Ragaert, Angelique Vandemoortele

Seren Oguz

Lotta Kuuliala

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Ghent University

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