

# ActInPak

## **COST Action FP1405**

Active and intelligent fibre-based packaging – innovation and market introduction

The influence of product adjusted CO<sub>2</sub> emitter and modified atmosphere on shelf life and liquid loss of chicken filets

**Marit Kvalvåg Pettersen**

# ActInPak

The influence of product adjusted CO<sub>2</sub> emitter and modified atmosphere on shelf life and liquid loss of chicken filets

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Nofima



# Facts

- National food research institute, established on January 1, 2008.
- Comprises the former Akvaforsk, Fiskeriforskning, Matforsk and Norconserv
- Head office in Tromsø

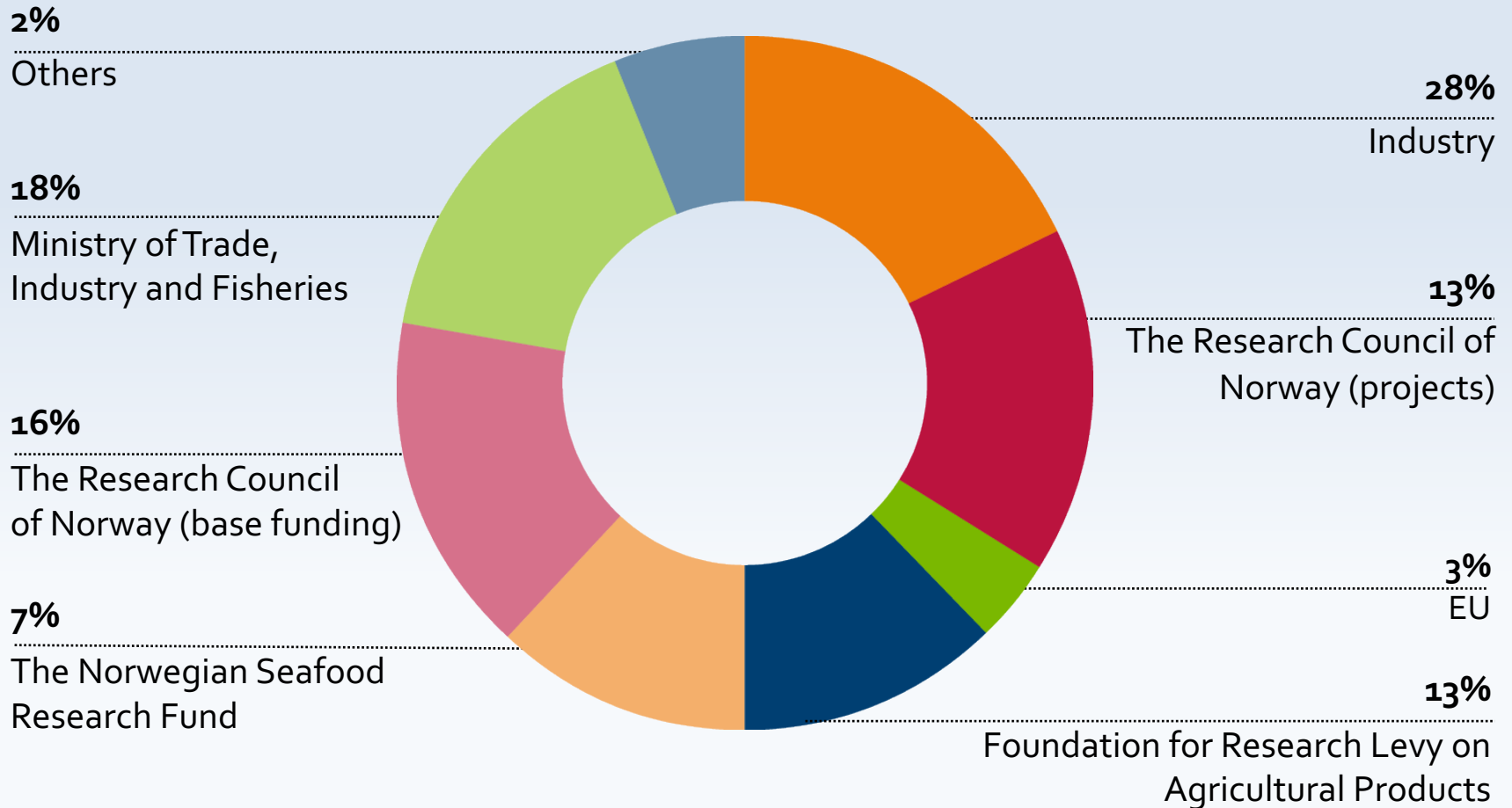
## Target markets

- Food industry and aquaculture and fisheries industry

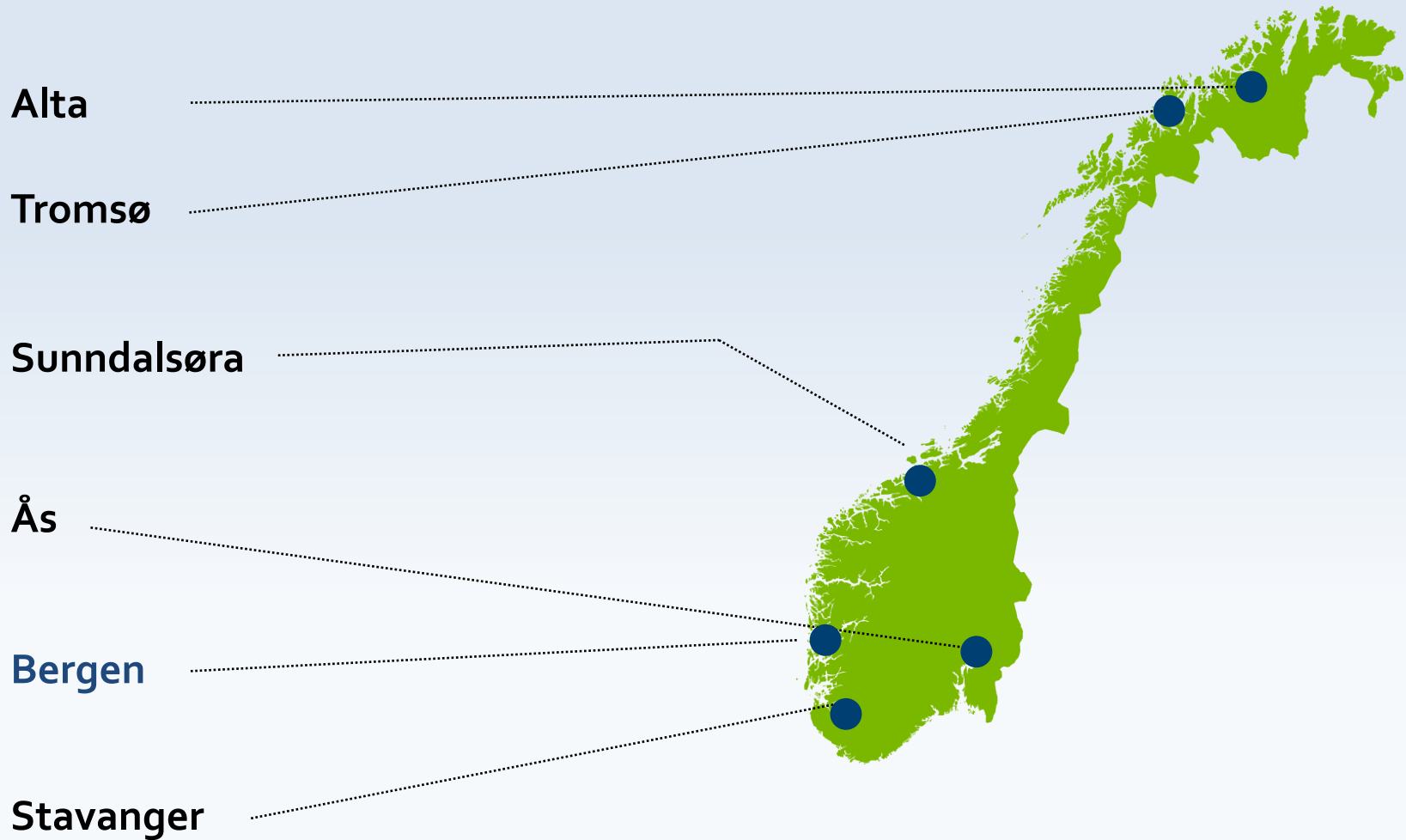
## Owners:

- State (Ministry of Trade, Industry and Fisheries): 56.8%
- The Agricultural Food Research Foundation: 33.2%
- Akvainvest Møre and Romsdal: 10 %

# Sources of income 2015



# You will find us here



# Our staff

**344** employees

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**203** Scientific personell

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**142** Employees with a PhD

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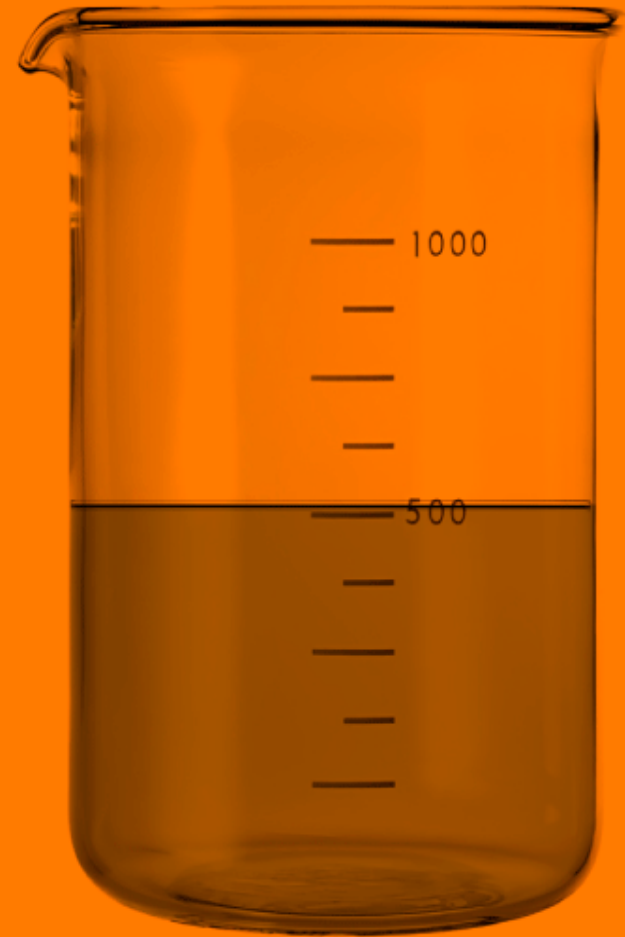


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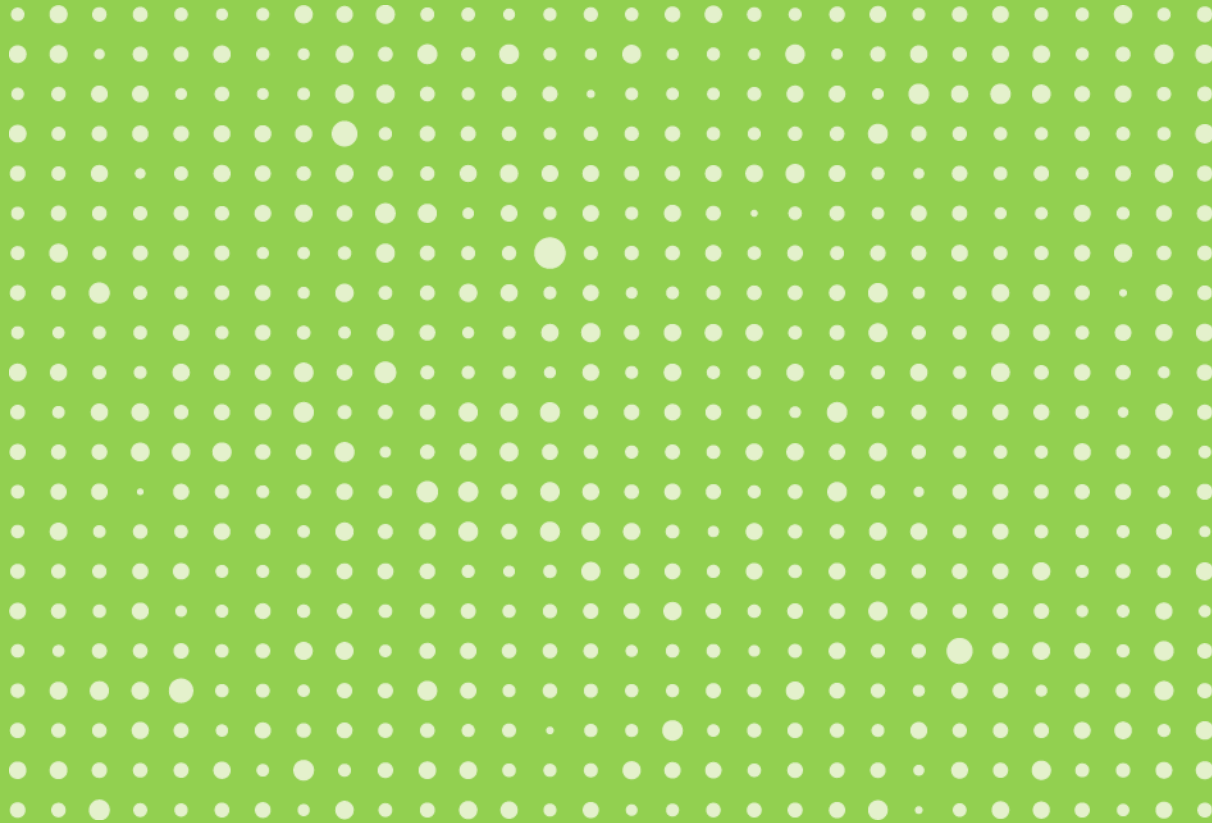
# Turnover

# 545

Mill. NOK in 2015



# Projects



650  
Projects

# Publications



**155**

**Scientific  
publications**

0,75 publications per  
scientific employee

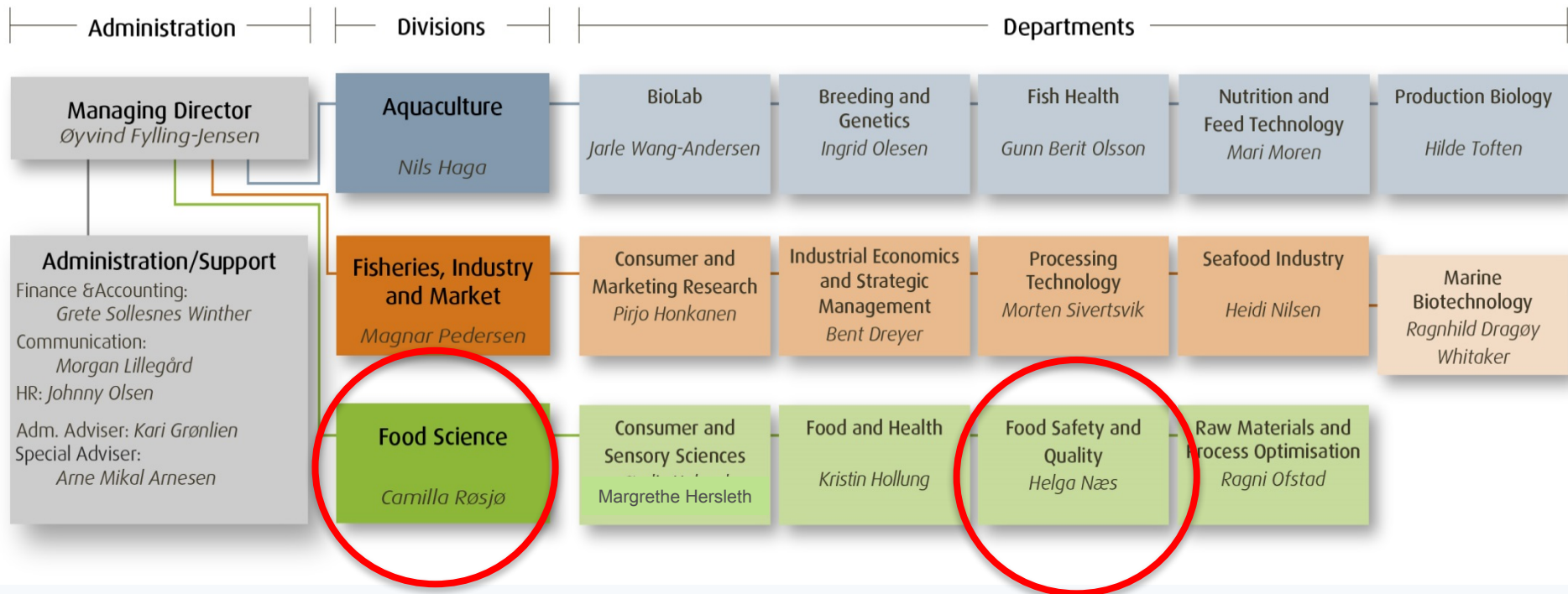
# Customers and Collaboration partners

## Outside Norway



# Organization 01.10.2016

## Nofima



# Food Science

## Food and Health

- Optimisation of products and meals in relation to health-related quality

## Consumer and Sensory Science

- Understand sensory perceptions through knowledge about food and humans
- Create business opportunities and contribute to value creation in the food industry

## Food Safety and Quality

- Contribute to safe food, optimal shelf life, reduced waste and efficient distribution

## Raw Materials and Process

### Optimisation

- Competence with raw materials, efficient production, monitoring and control



# Food Safety and Quality

Contribute to safe food, optimal shelf life,  
reduced waste and efficient distribution

## **Elimination of bacteria in the production environment and food**

Biofilm, resistance, survival and growth in relation to stress factors, packaging

## **The useful bacteria**

Starter cultures to improve the quality, Inhibiting cultures to make the product safe  
Probiotics, Production organisms for enzymes etc. Knowledge about primary metabolism

## **Dynamics between bacteria in microbial communities**

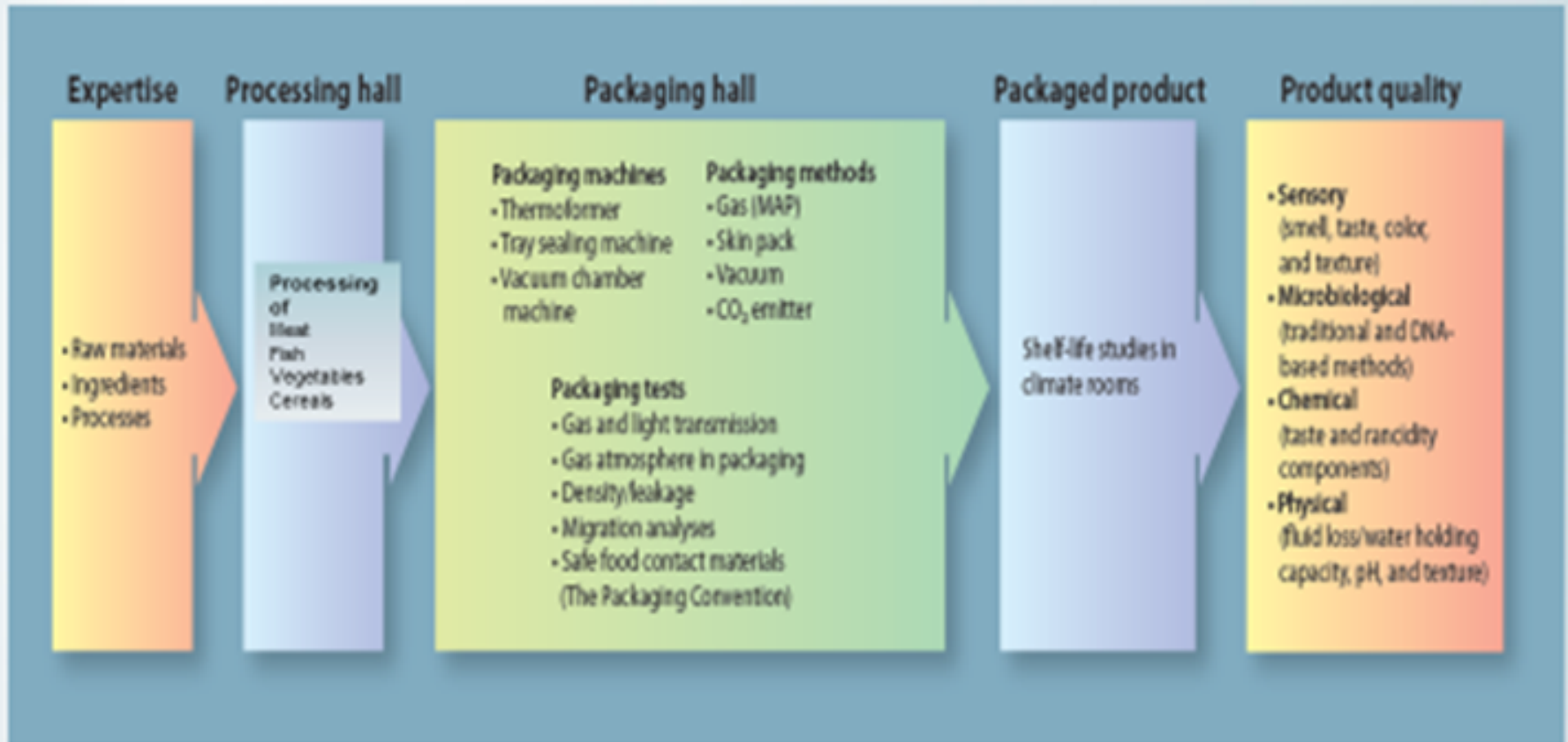
Molecular methods for studies of microbial communities in food, humans, fish and animals

## **Sustainable packaging for optimal shelf life and reduced food waste**

Interaction between product, packaging, packing method and external factors



# NOFIMA





# New and unique in Norway

## Pathogen pilot plant

Pilot plant for examine survival and growth of pathogenic microorganisms (hazard class 3) – in food and production environment .



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# ActInPak

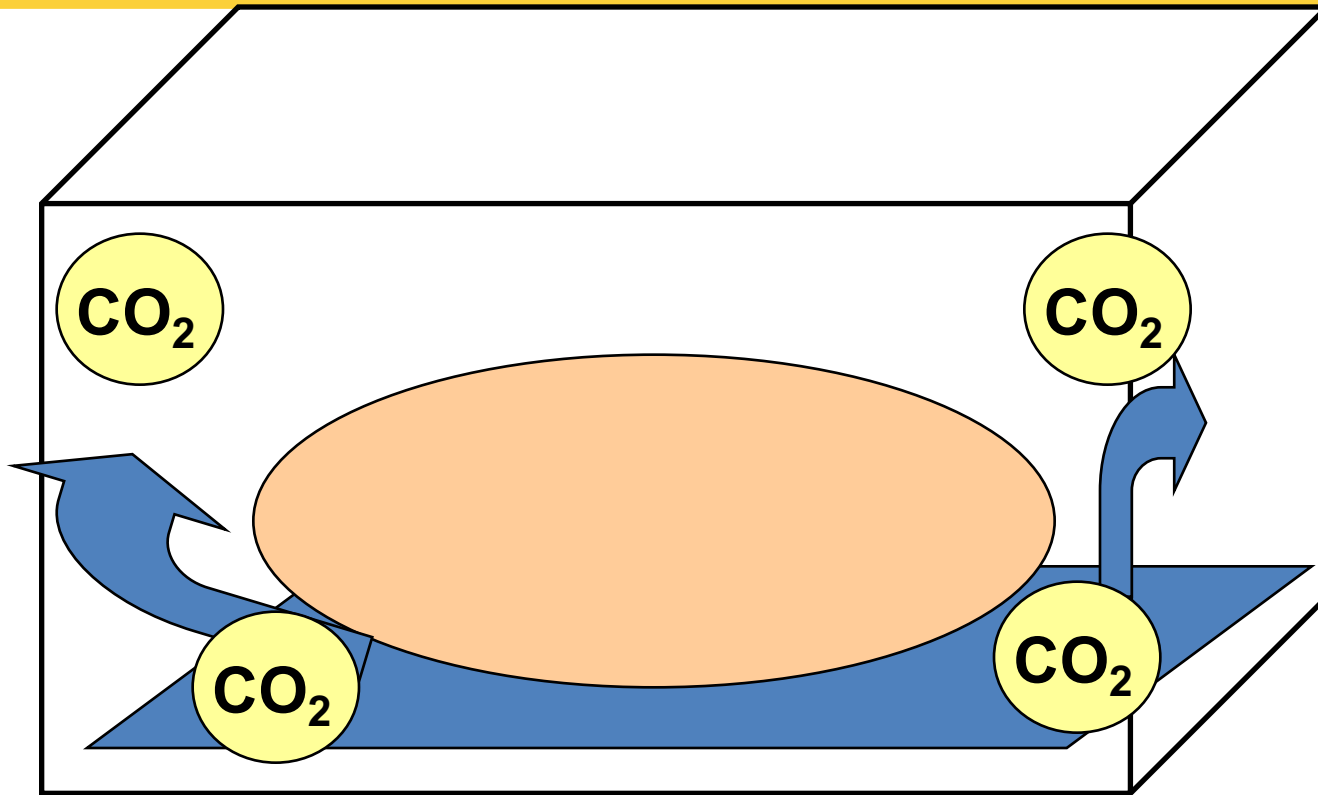
The influence of product adjusted CO<sub>2</sub> emitter and modified atmosphere on shelf life and liquid loss of chicken filets

Marit Kvalvåg Pettersen

# Background

- Increased shelf life of chicken filets
  - MAP
  - Reduced food waste
- Environmentally effective packaging systems
  - Transport efficient
  - Material efficient
- Product adjusted and optimized CO<sub>2</sub> emitter

# Active Packaging – CO<sub>2</sub> emitter



# Experiments

## Shelf life extension of chicken breast filet

### **Trial 1**

#### **Packaging**

In research institute Nofima

#### **Modified Atmosphere Packaging**

Different levels of CO<sub>2</sub>  
Liquid absorber or CO<sub>2</sub>-emitter

#### **CO<sub>2</sub> emitter**

Laboratory made:  
Liquid absorber added NaHCO<sub>3</sub> and citric acid

### **Trial 2**

#### **Packaging**

Commercial /industrial plant

#### **Modified Atmosphere Packaging**

Selected levels of CO<sub>2</sub>  
Liquid absorber or CO<sub>2</sub>-emitter

#### **CO<sub>2</sub> emitter**

Industrial produced based on information from research

# Trial 1

## Packaging material:

- APET/PE Thermoformed trays: OTR 10 cm<sup>3</sup>/m<sup>2</sup>/24 h
- Top web: PET/PE/EVOH/PE: OTR 5 cm<sup>3</sup>/m<sup>2</sup>/24 h

## Modified Atmosphere Packaging:

- 0, 30, 60 and 100% CO<sub>2</sub> supplemented with N<sub>2</sub>
- 100% CO<sub>2</sub> with CO<sub>2</sub>-emitter

## Storage and sampling:

- 4 °C for 26 days

# Trial 1

## Modified Atmosphere Packaging:

- 0, 30, 60 and 100% CO<sub>2</sub> supplemented with N<sub>2</sub>
- 100% CO<sub>2</sub> with CO<sub>2</sub>-emitter

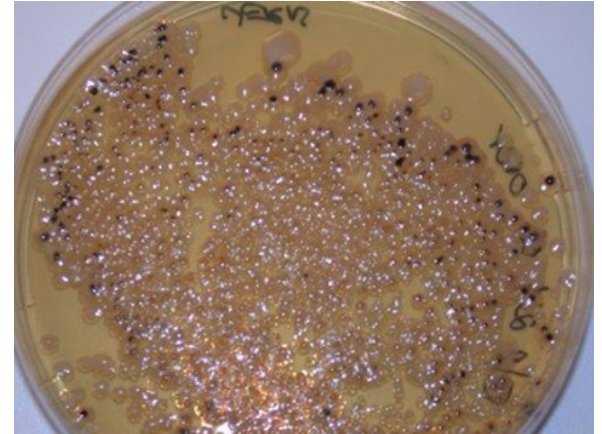
## Storage and sampling:

- 4 °C for 26 days



# Analyses – Trial 1

- Gas composition
- pH
- Drip loss
- Microbiology

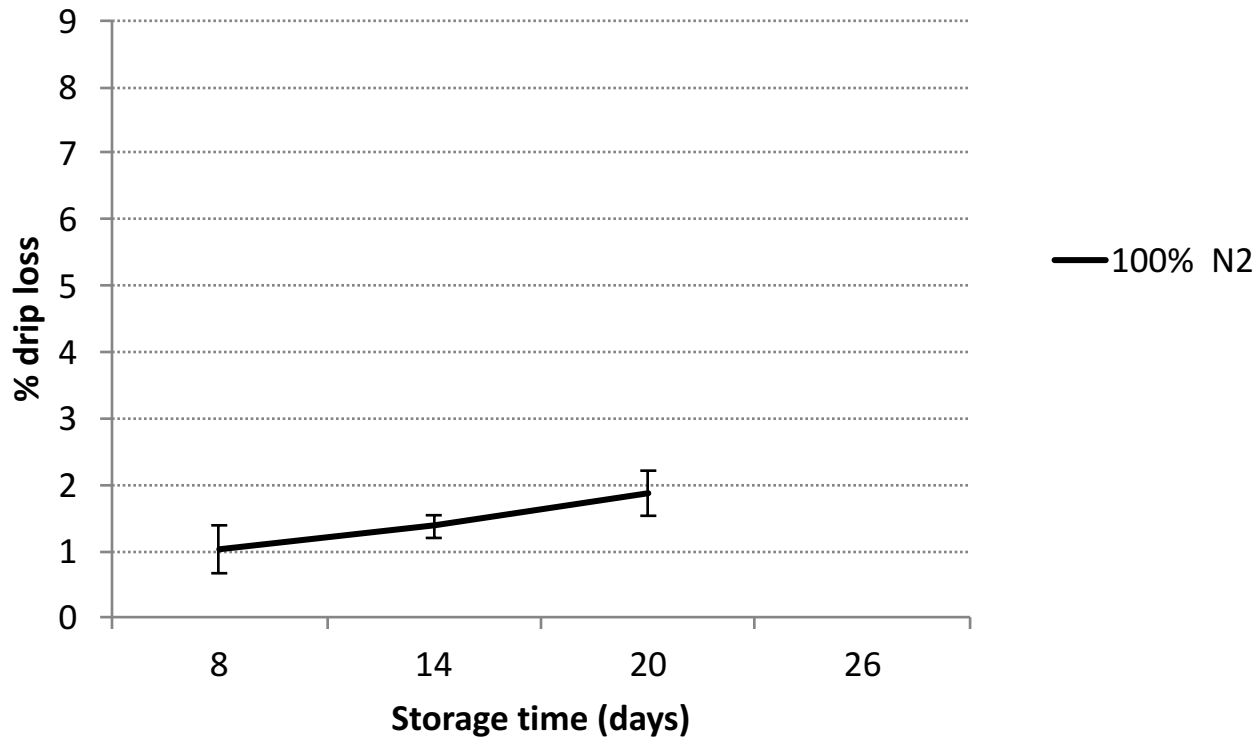


Bacteria	Agar	Incubation Temp	Incubation Time (h)	Incubation atmosphere
Total Viable Counts	PCA	30 °C	72	anaerobic
Lactic acid bacteria	MRS	20 °C	72	anaerobic
Pseudomonas	CFC	20 °C	48	aerobic
<i>Enterobacteriaceae</i>	VRBGA	37 °C	24	semi-aerobic
<i>Brochothrix</i>	STAA	25 °C	48	aerobic

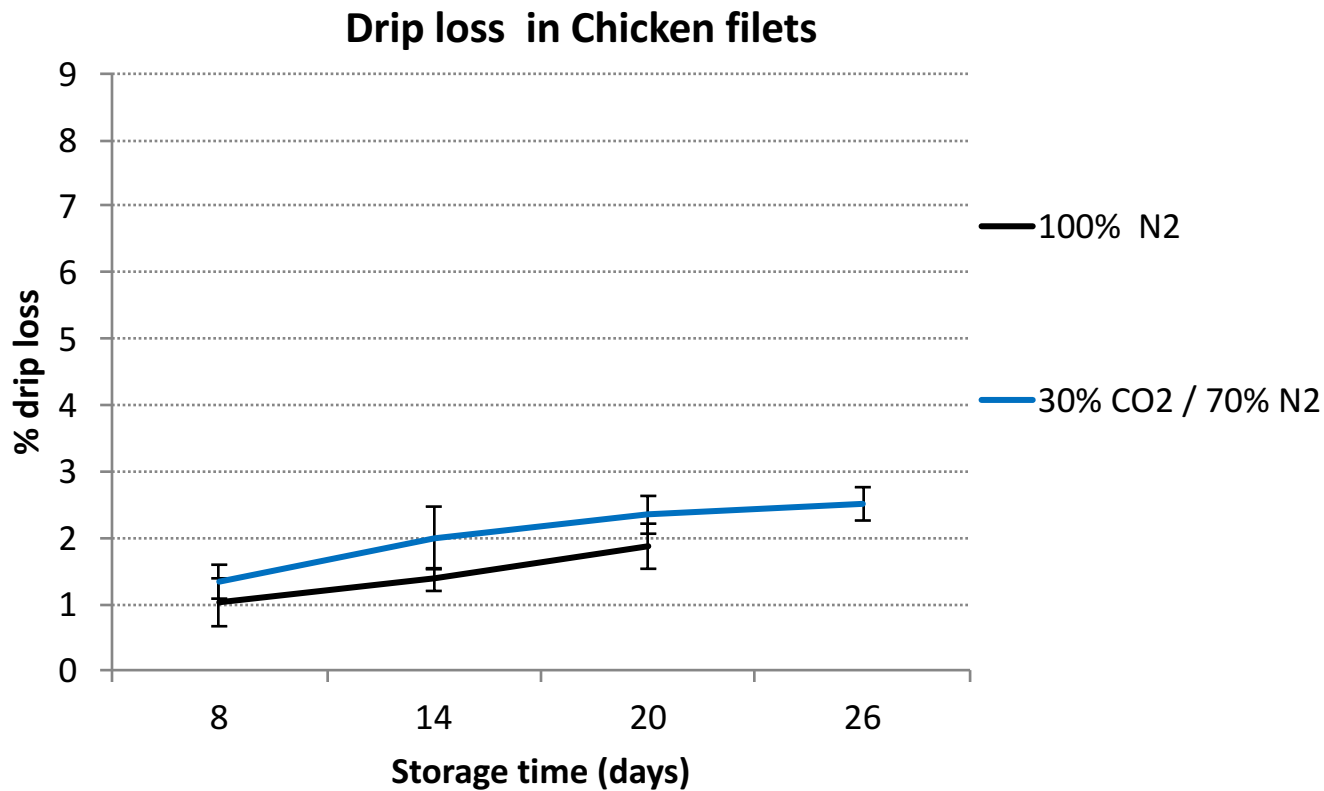
# Results

# Drip loss in chicken filets

Drip loss in Chicken filets

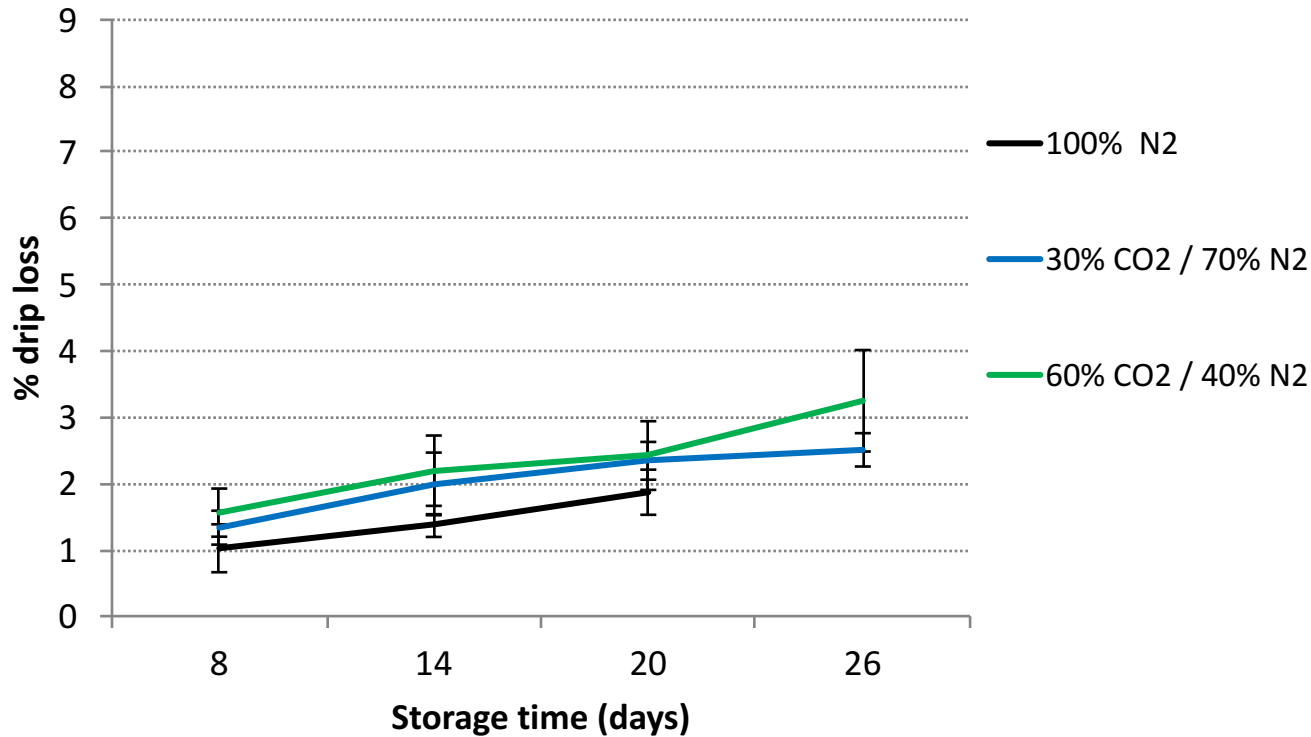


# Drip loss in chicken filets



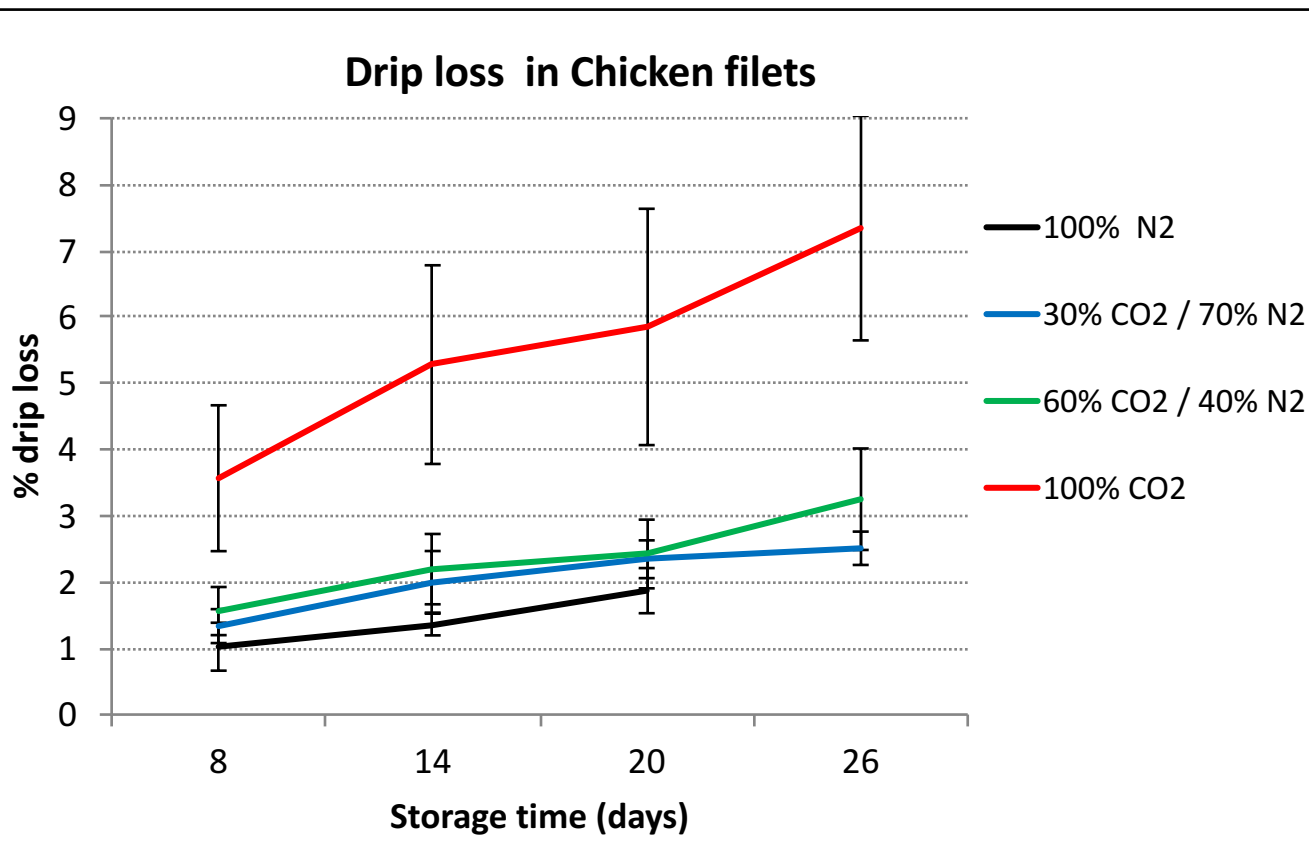
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Drip loss in Chicken filets



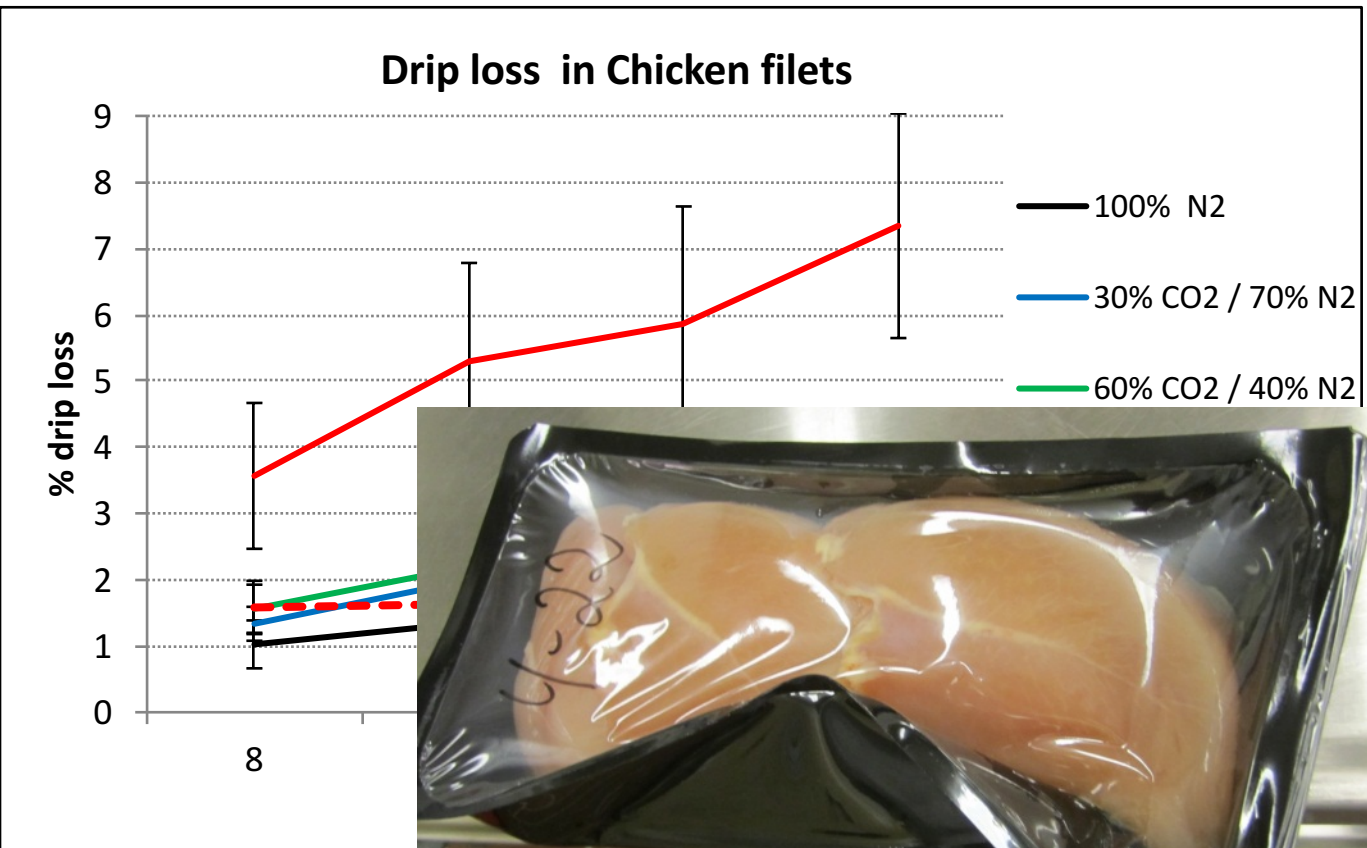
- Drip loss apparently increased with increasing CO<sub>2</sub> content

# Drip loss in chicken filets



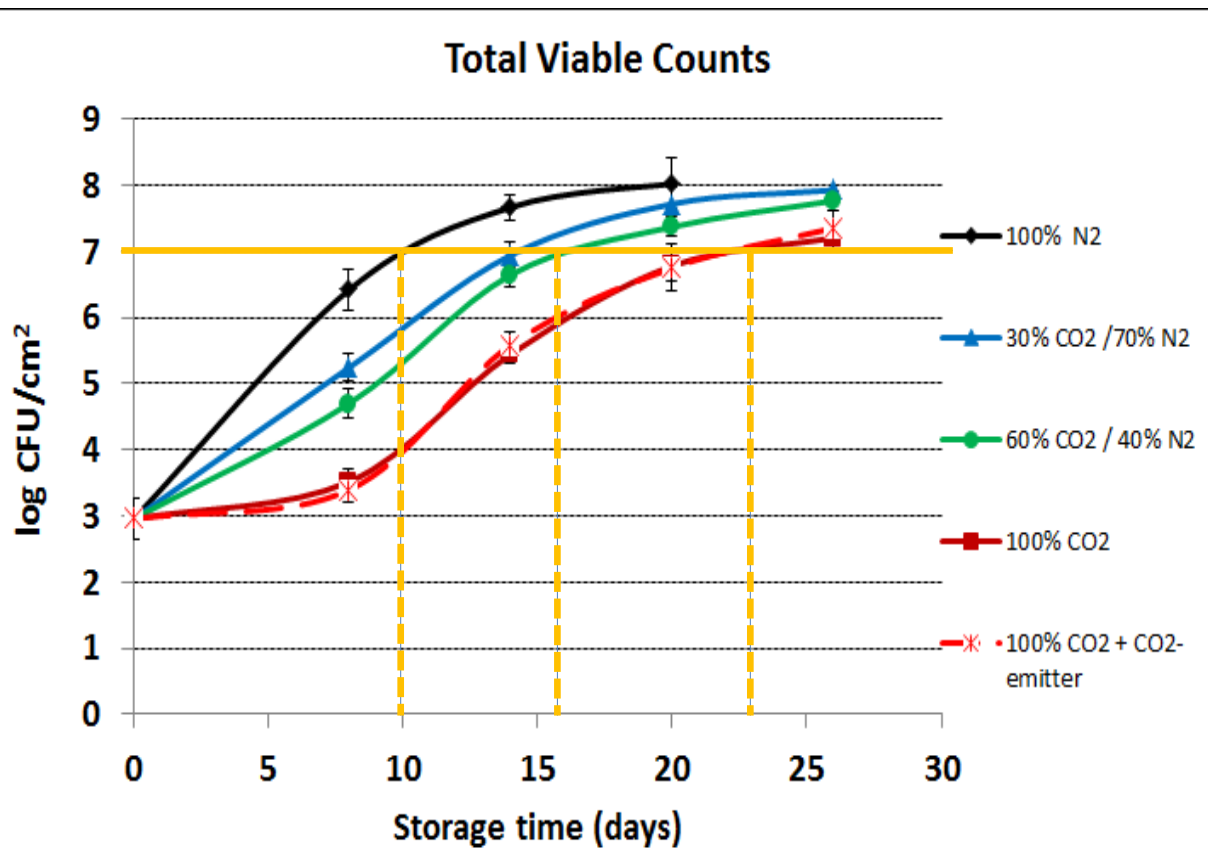
- Drip loss apparently increased with increasing CO<sub>2</sub> content
- Significant increase in drip loss between 60 and 100% CO<sub>2</sub>

# Drip loss in chicken filets



- Drip loss apparently increased with increasing CO<sub>2</sub> content
- Significant increase in drip loss between 60 and 100% CO<sub>2</sub>
- The CO<sub>2</sub> emitter significantly reduces the drip loss from 7.3 to 2.5% when 100% CO<sub>2</sub> is applied.
- This reduction is due to less collapse of the packages

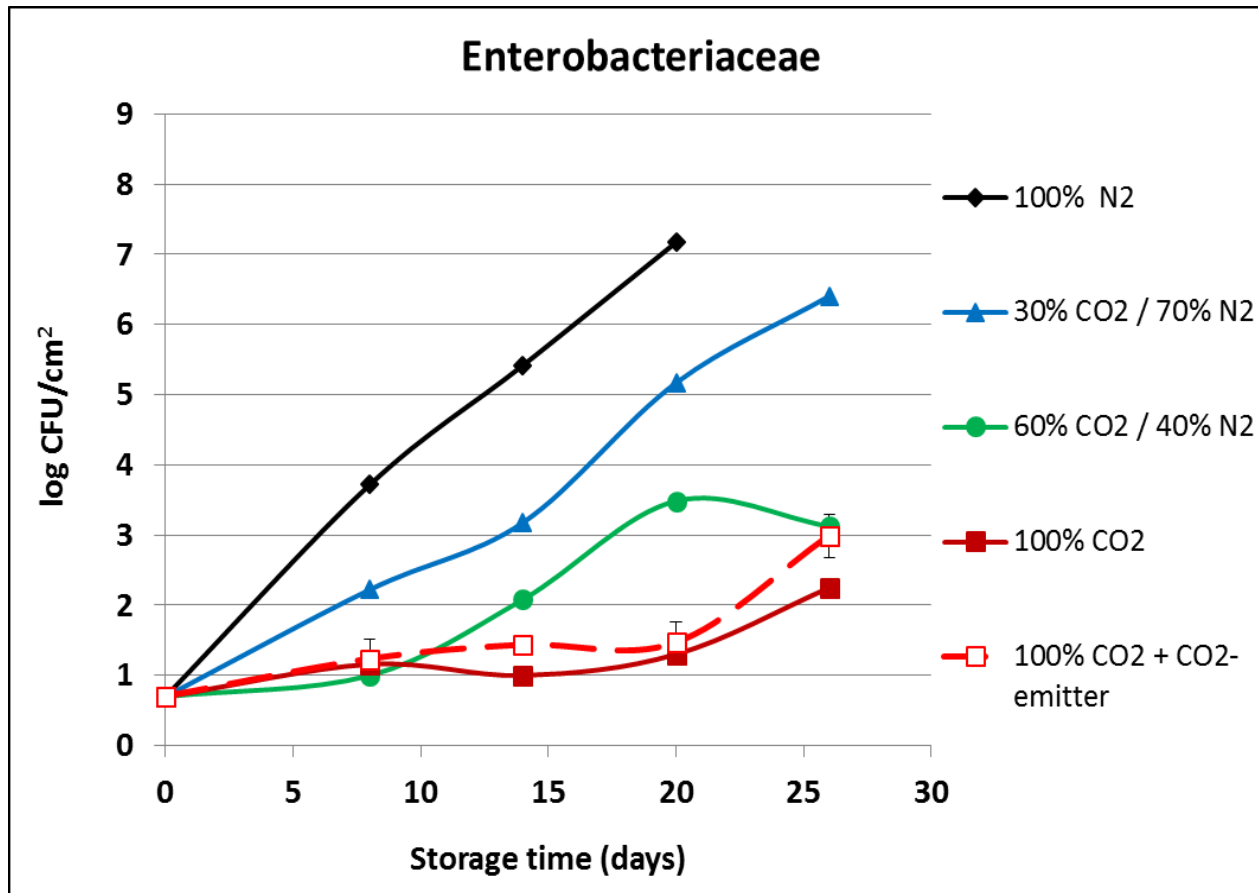
# Total viable counts of bacteria



- The growth rate of TVC is reduced with increased partial pressure of CO<sub>2</sub>
- Most retardation when increasing the CO<sub>2</sub> from 60% to 100%.
- Relatively high level of bacteria ( $10^7$  CFU/cm<sup>2</sup>) was obtained 6 -7 days later in 100% CO<sub>2</sub>, with or without CO<sub>2</sub> emitter compared to the 60% CO<sub>2</sub> samples



# Growth of Bacteria



- Increased content of CO<sub>2</sub> resulted in lower growth rate of both *Brochothrix*, and *Enterobacteriaceae*.
- Very little growth of these groups was detected at 100% CO<sub>2</sub>.
- The effect of packaging atmosphere was more pronounced for the growth of *Brochothrix*, and *Enterobacteriaceae*

# Experiments

## Shelf life extension of chicken breast filet

### Trial 1

#### Packaging

In research institute Nofima

#### Modified Atmosphere Packaging

Different levels of CO<sub>2</sub>

- High level of CO<sub>2</sub> in the atmosphere extended microbial shelf life of chicken
- Addition of CO<sub>2</sub> emitter in 100% CO<sub>2</sub> atmosphere reduced the drip loss profoundly.

### Trial 2

#### Packaging

Commercial /industrial plant

#### Modified Atmosphere Packaging

Selected levels of CO<sub>2</sub>

or CO<sub>2</sub>-emitter

uced based on  
m research

# Experiments

## Shelf life extension of Chicken breast filet

### Trial 1

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0, 30, 60 and 100% CO<sub>2</sub> supplemented with N<sub>2</sub>

- High level of CO<sub>2</sub> in the atmosphere extended microbial shelf life of chicken
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### Trial 2

#### Packaging

Commercial /industrial plant

#### Modified Atmosphere Packaging

100% CO<sub>2</sub> with CO<sub>2</sub>-emitter  
Today's packaging; 70% CO<sub>2</sub>  
CO<sub>2</sub>-emitter

duced based on  
from research

# Trial 1

## Modified Atmosphere Packaging:

- 70% and 30%
- 70% CO<sub>2</sub> and 30% N<sub>2</sub> + CO<sub>2</sub>-emitter
- 100% CO<sub>2</sub> + CO<sub>2</sub>-emitter

# Adjustment of CO<sub>2</sub>-emitter

Based on information about

- Product type
- Packaging gas composition
- Packaging size and g/p ratio



30% CO<sub>2</sub>



100% CO<sub>2</sub>

# Analyses – Trial 2

- Gas composition
- Appearance of packages
- pH
- Liquid loss
- Evaluation of off-odour
- Microbial analyses

Bacteria	Agar	Incubation Temp	Incubation Time (h)	Incubation atmosphere
Total viable counts	PCA	30 °C	72	anaerobic
Lactic Acid Bacteria	MRS	20 °C	72	anaerobic
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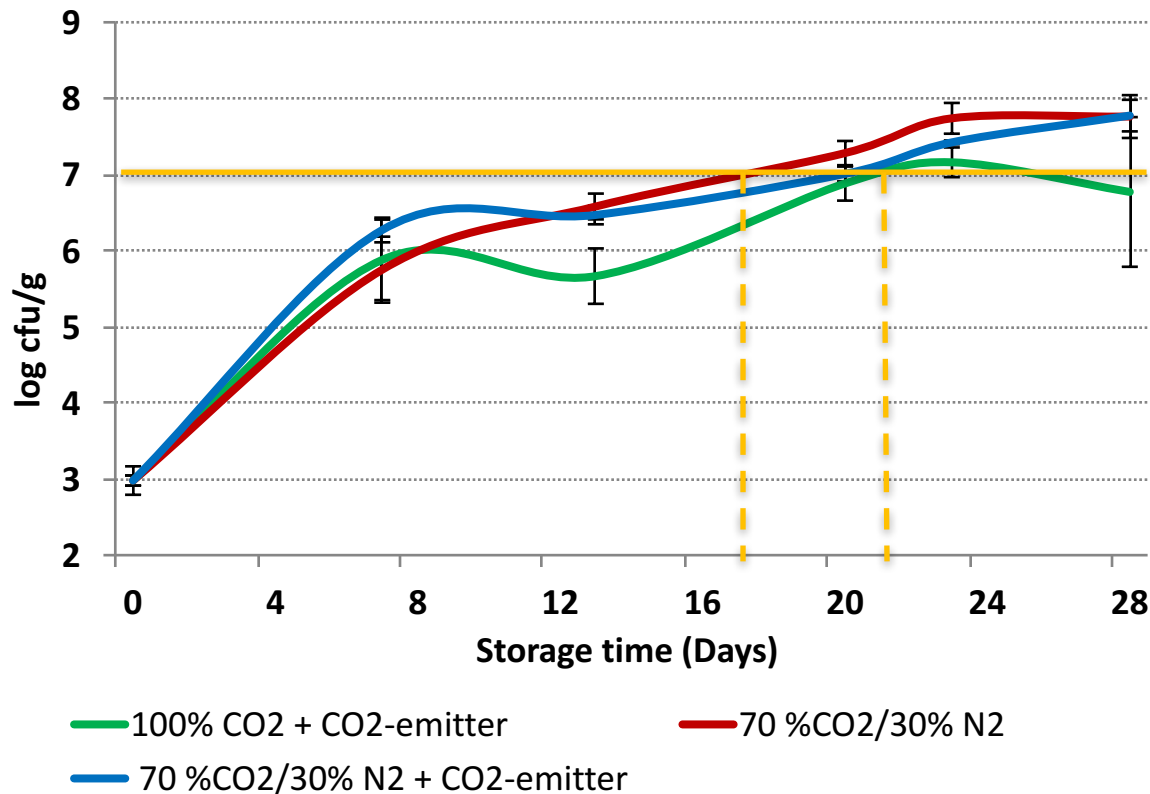
# Analyses – Trial 2

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# Bacterial growth

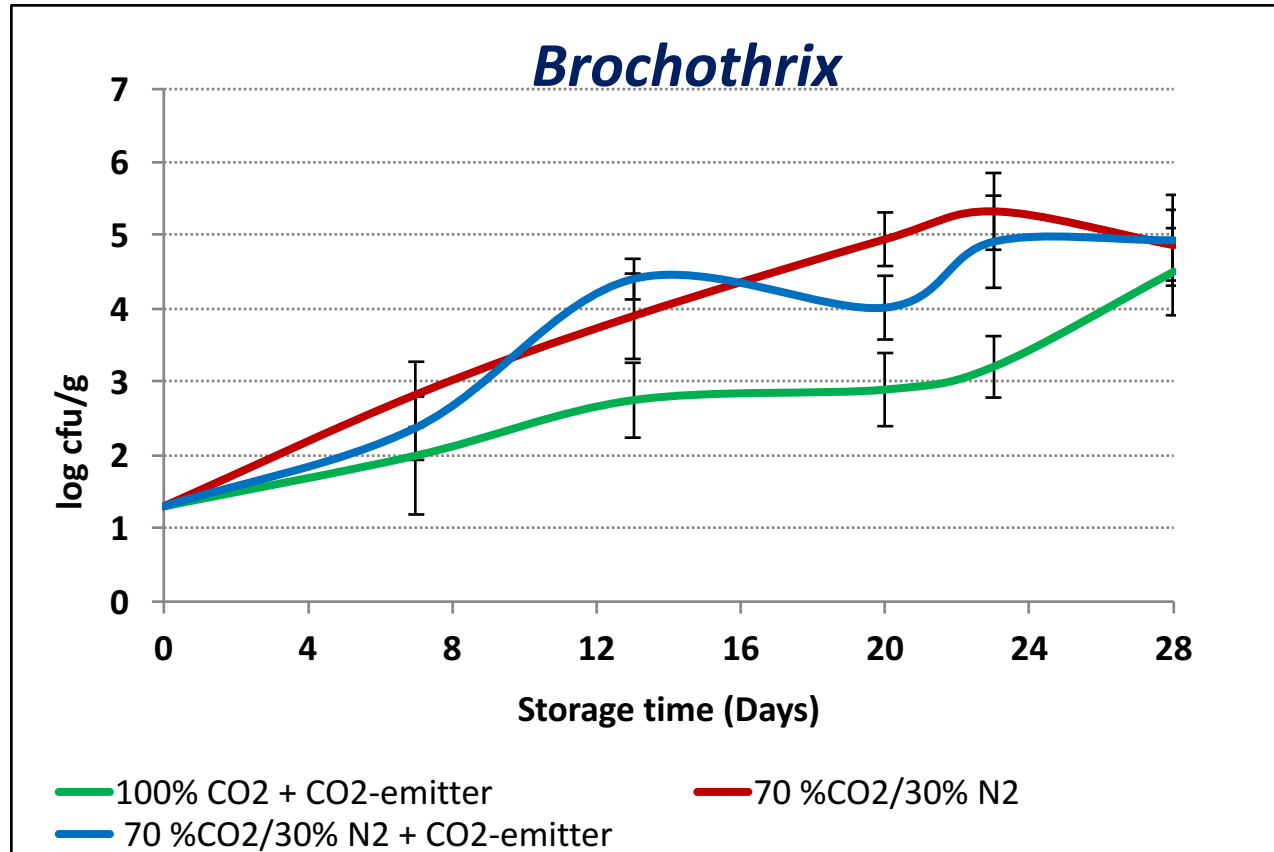
## Total Viable Counts of bacteria



- The growth rate of TVC is reduced with increased partial pressure of CO<sub>2</sub>
- Relatively high level of bacteria ( $10^7$  CFU/cm<sup>2</sup>) was obtained ~5 days later in 100% CO<sub>2</sub>, with CO<sub>2</sub> emitter compared to the 70% CO<sub>2</sub> samples



# Bacterial growth



- Very little growth of *Brochothrix* (and *Enterobacteriaceae*)
- Significantly lower growth rate was detected in 100% CO<sub>2</sub>.
- The effect of packaging atmosphere were more pronounced for the growth of *Brochothrix*, and *Enterobacteriaceae*

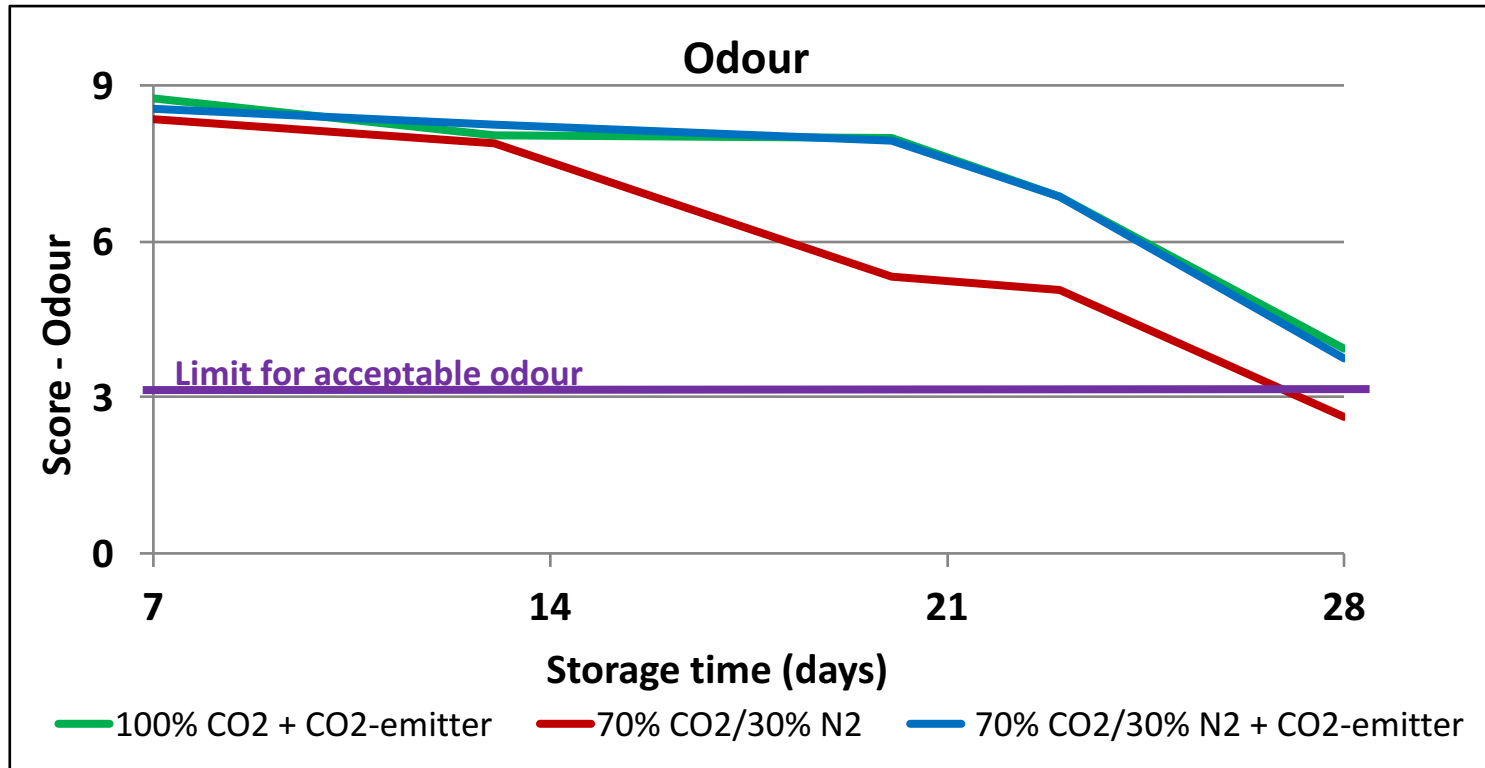
# Off-odour



Odour :

- Could be correlated to the growth of specific bacteria
- The product may also be rejected even if the bacterial load is within acceptable limits

# Off-odour



Sample with 70% CO<sub>2</sub> without CO<sub>2</sub>-emitter was evaluated as **not acceptable after 28 days of storage**

# Main Conclusion from experiments

- High level of CO<sub>2</sub> in the atmosphere extended microbial shelf life with at least 5 days
- Addition of CO<sub>2</sub> emitter in 100% CO<sub>2</sub> atmosphere reduced the drip loss of chicken profoundly.
- Addition of CO<sub>2</sub> emitter can easily be implemented at industrial packaging lines without reductions in production efficiency

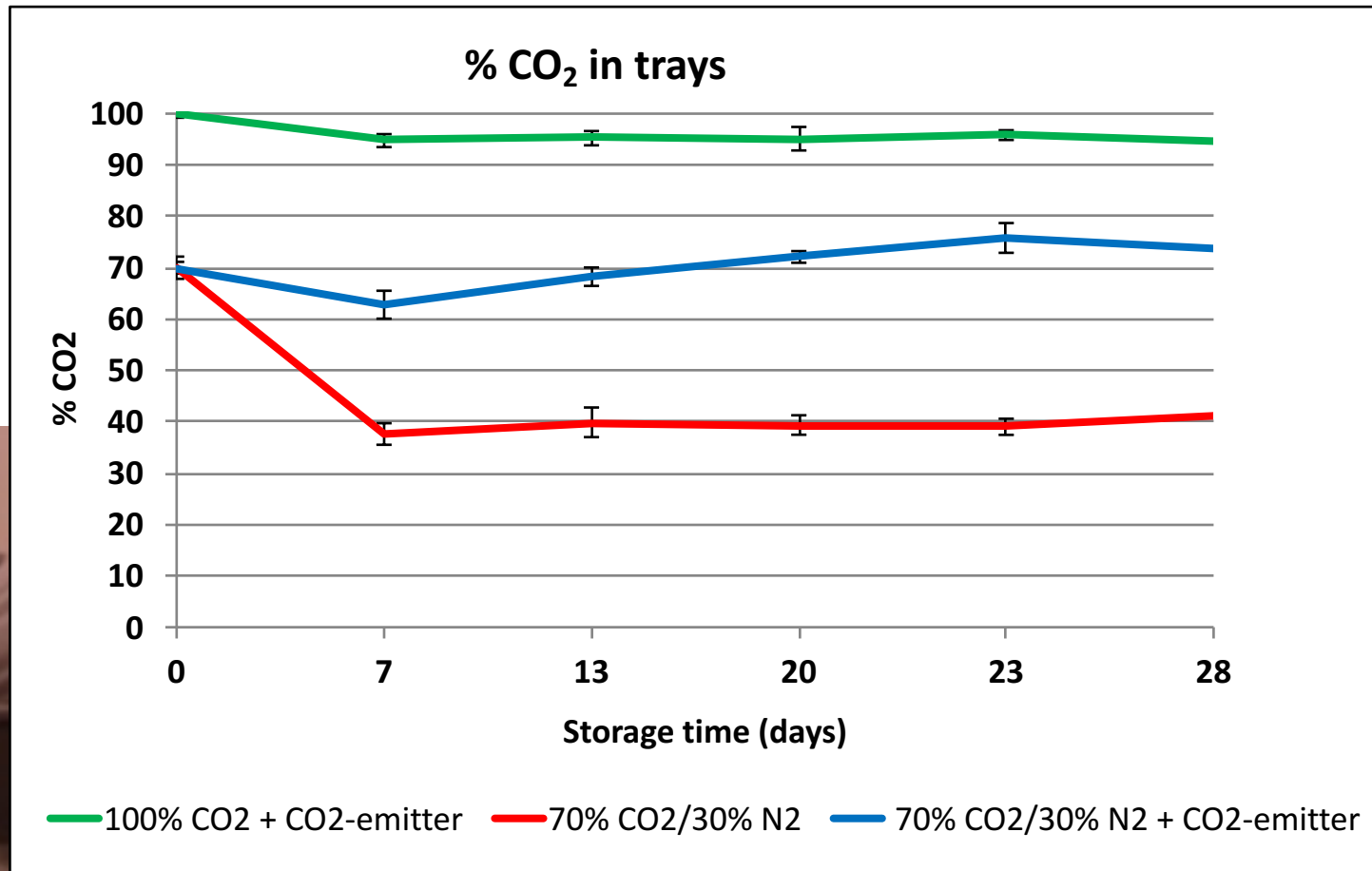


# Main Conclusion from experiments

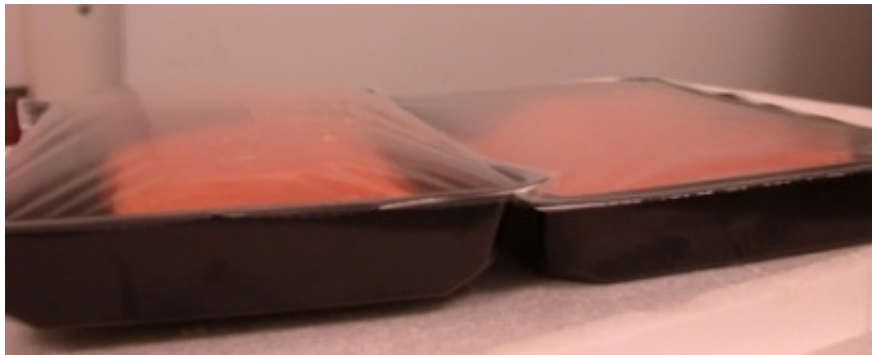
- High level of CO<sub>2</sub> in the atmosphere extended microbial shelf life with at least 5 days
- Addition of CO<sub>2</sub> emitter in 100% CO<sub>2</sub> atmosphere reduced the drip loss of chicken profoundly.
- The capacity CO<sub>2</sub> emitter must be adjusted to the product and packaging concept (gas, g/p ratio etc)
- Addition of CO<sub>2</sub> emitter can easily be implemented at industrial packaging lines without reductions in production efficiency



# Results: CO<sub>2</sub> production

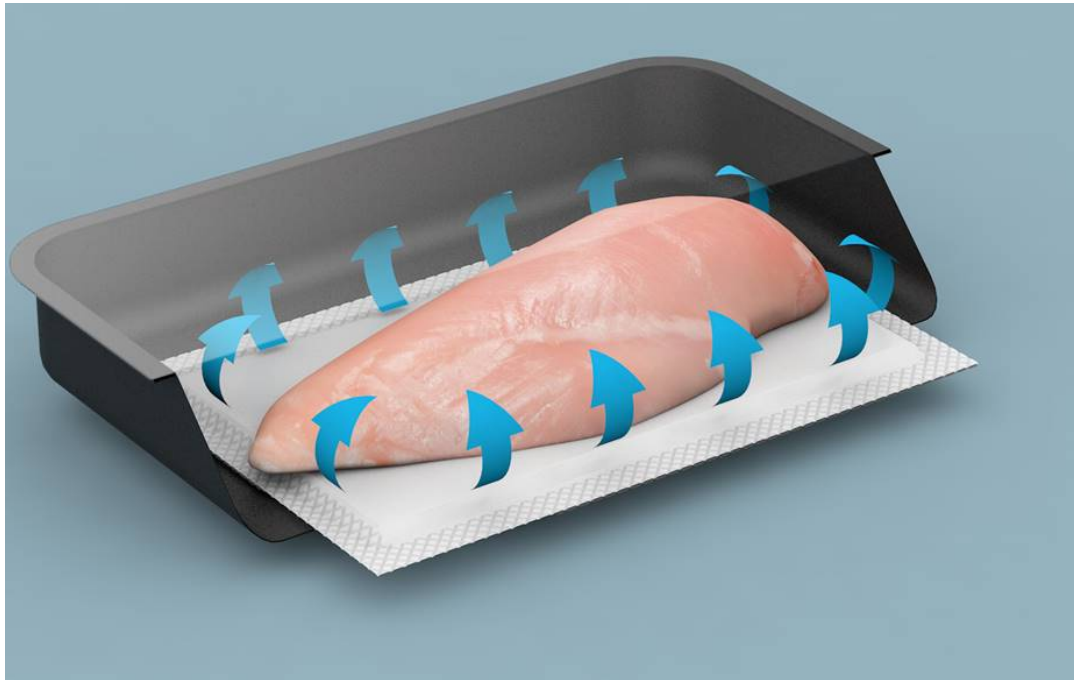


# Development and adjustment



- Gas production is of importance to inhibit the bacterial growth
- Capacity of the CO<sub>2</sub> emitter must be adjusted to the product, packaging concepts and storage conditions
  - Drip loss
  - Packaging method
  - Gas composition
  - Storage temperature
- Optimal gas production is important from a marketing and consumer point of view.

# Development and adjustment



- Substrate material construction
- Absorptions material
- Production method
- Distribution of active compounds
- Production capacities

Cooperation: Vardal Plastindustri AS

Commercial production of CO<sub>2</sub>-emitters: Cellcomb ab



**ActInPak**



# Challenges for implementing

- Production capabilities
- Level of effectiveness
- Liability
- Regulation issues
- Effect on product
- Consumer acceptance
- Effect on environment - sustainability
- Cost

# Acknowledgement

Thanks due to the

- - The Research Council of Norway for supporting the project “Food waste reduction in the value chain”,
- The Agricultural Food Research Foundation: For supporting the project “**Innovative and Sustainable packaging for optimal food quality**»
- Vartdal Plastindustri AS and Cellcomb AB for supporting the study and deliverable and production of emitters

We are grateful to Aud Espedal, Karin Solgaard, Janina Berg, Signe Marie Drømtorp og Anette Wold Åsli for skillful technical assistance.



**THANK YOU FOR YOUR ATTENTION!**



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**THANK YOU FOR YOUR ATTENTION!**



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