
Monitoring the food cold chain in Europe: Development of a database tool and field test validation

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Food cold chain



- ➔ Post-harvest/processing food losses and waste: about 25% of the food production worldwide
- ➔ **60%** the food we consume is **chilled**
- ➔ **10%** the food we consume is **frozen**



The main shelf-life determining post-processing parameter in chilled/frozen food products is temperature

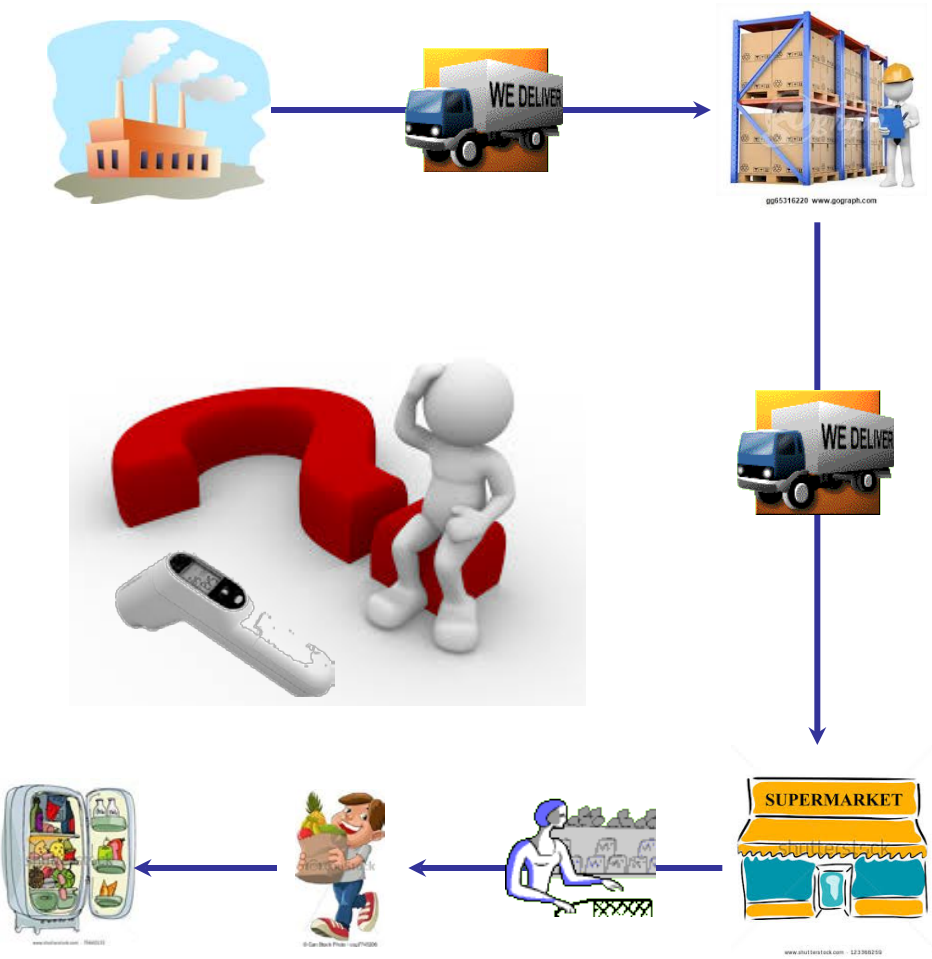
Cold chain management tools & Temperature control throughout the cold chain

- ☑ Reducing food losses and food waste in post harvest/post processing of foods
- ☑ To minimize perishable foods that are lost before consumption



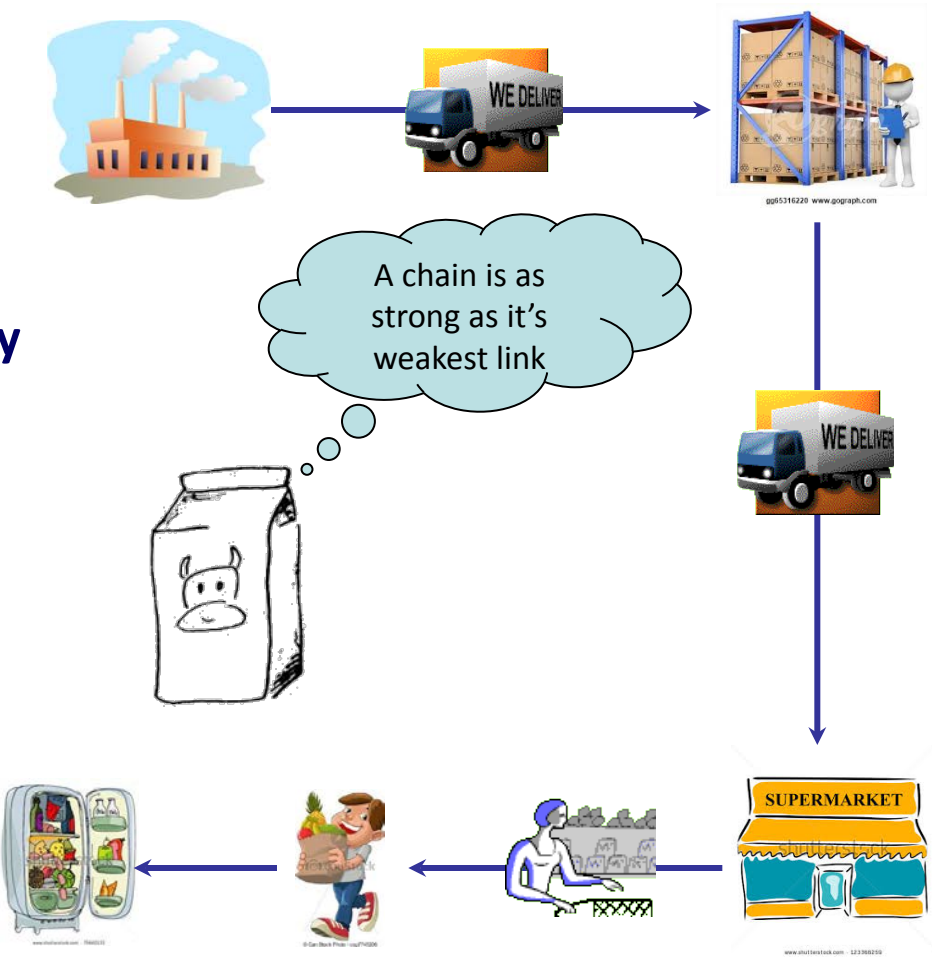
Taking cold chain's temperature

- ✓ “What if” scenarios
- ✓ Regulations
- ✓ Supply chain systems: FIFO



Taking cold chain's temperature

- ? How weak is the cold chain
- ? Which stage is the weakest link
- ? What is the impact on food quality and shelf life



Objective

- ☑ Develop a comprehensive database of the cold chain in Europe
- ☑ Monitoring the food cold chain through focused field tests in Europe
- ☑ Assess food quality at different stages of the supply chain

FRISBEE: European Union funded 4-year Project

Food Refrigeration Innovations for Safety, consumers' Benefit, Environmental impact and Energy optimization along the cold chain in Europe



Cold Chain Database development

Cold Chain Data Collection

Data from all stages of the cold chain (from production to consumption) were collected along the supply chain for products in different European regions.

- ✓ Consortium own data
- ✓ Published data
- ✓ Industry and cold chain parties (distributors, retailers)
- ✓ Associations
- ✓ Research projects



Where can I find the Cold Chain Database?



www.frisbee-project.eu



www.frisbee-project.eu/coldchaindb



Cold Chain Database



[Search Data](#) [Build Cold Chain](#) [Search Data \(demo\)](#)

- Stage/step of cold chain
 - Production stage - food chilling operation
 - Production stage - food freezing operation
 - Production warehouse
 - Transportation
 - Distribution warehouse

- Characterization of food
 - Fresh unprocessed
 - Fresh minimally processed
 - Minimally processed ready to cook
 - Processed ready to eat
 - Other

- Food product
 -
 - 4 kg whole gutted salmon
 - 4 kg whole salmon
 - 4 slices of cooked ham
 - Aubergine salad
 - Banana
 - Beef

- Country of origin
 - Belgium
 - France
 - Germany
 - Greece

- Food storage temperature range
 - Chilled
 - Superchilled
 - Frozen

- Type of food
 - Meat and meat product
 - Fish and fish product
 - Fruit and fruit product
 - Vegetables
 - Milk and milk product
 - Mixed
 - Other

- Packaging
 - Air packaged
 - Modified atmosphere packaged
 - Vacuum packaged
 - Non-packaged
 - Bulk
 - Other

- Type of Data
 - Set of temp values for a time period
 - Single temp measurement (at specified time)
 - FRISBEE field tests profiles (Greece)

Selected Results

Please make your selections on the left pane or load a previous

Cold Chain Database Records

Total Records : 10243

Mean temperature value : -4.87 °C
Minimum temperature value : -40.5 °C
Maximum temperature value : 39.3 °C

Saved Recordsets

#	Filename
1	wholeChainFrozen
2	consumer_freezer
3	Frozen_Complete Cold Chain
4	Yoghourt_Complete Cold Chain
5	Yoghourt_Consumer Transportation

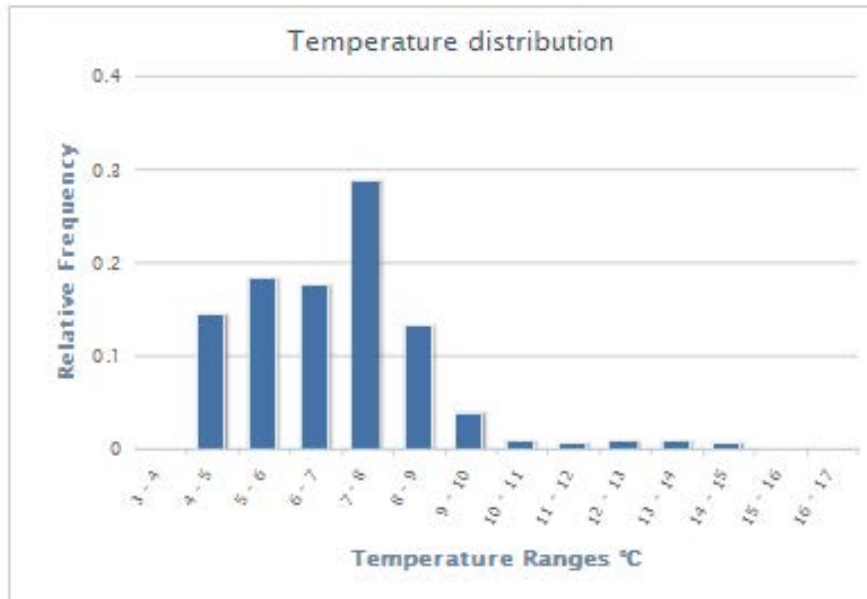
[View My Own Submitted Data](#)



3529 total measurements
Click and drag in the plot area to zoom in



New total storage time : mins. [Reload Chart](#)

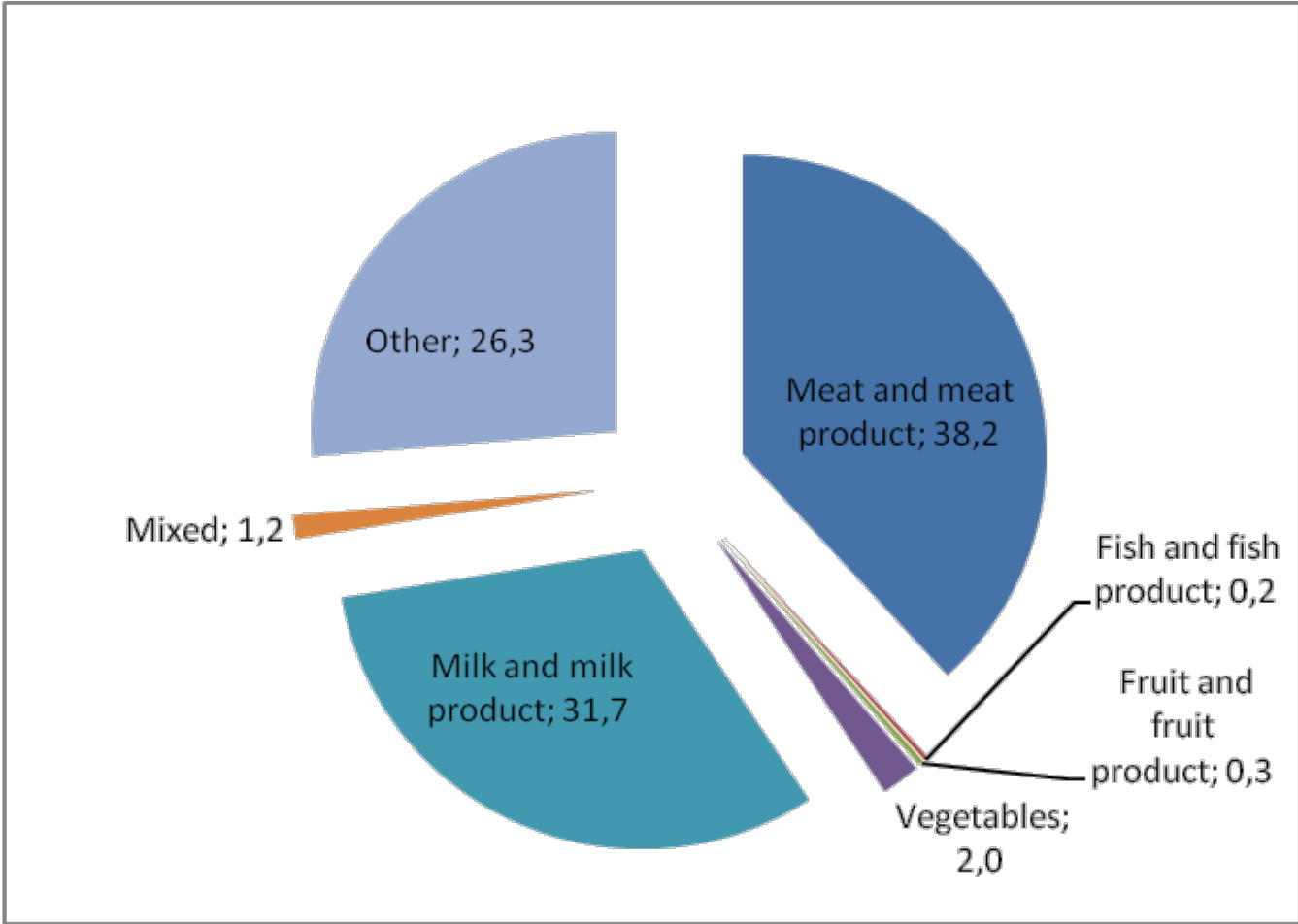


[View Metadata](#)

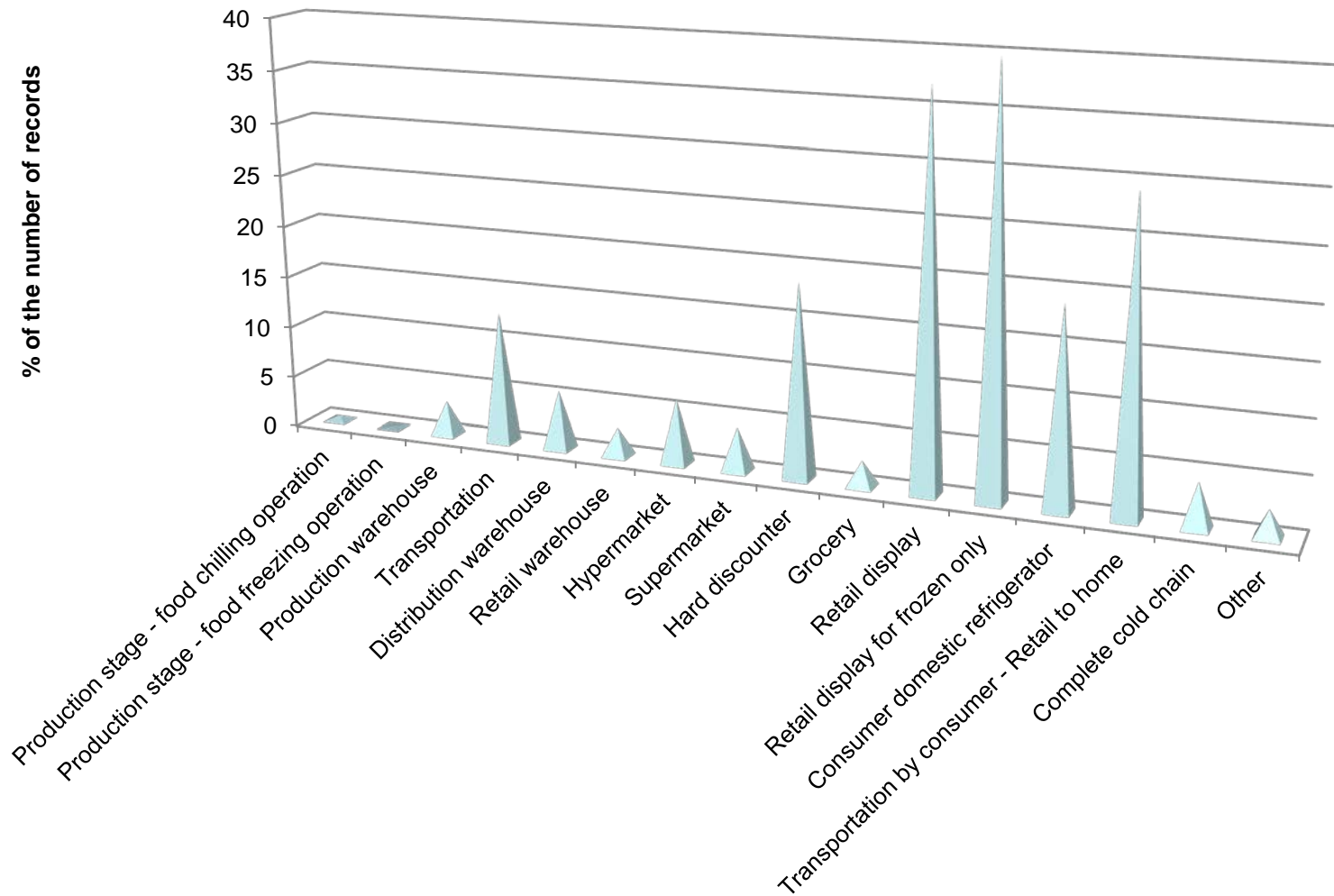
Stage/step of cold chain	Consumer domestic refrigerator
Country of origin	France
Destination country	France
Time data logger started collecting data (hrs:min)	12:00
Food storage temperature range	Chilled
Characterization of food	Processed ready to eat
Type of food	Meat and meat product
Food product	Flaky product
Packaging	Air packaged
Packaging material	
Weight/size of food	220 g
Recommended food storage conditions (°C)	2 to 4 C
Temperature of facility -setting (°C)	
Type of storage and distribution equipment	
Characteristics of storage and distribution equipment (heat transfer mode, air velocity...)	
Data collecting equipment	Data logger
Type of data collecting	



Cold Chain Database...in numbers!

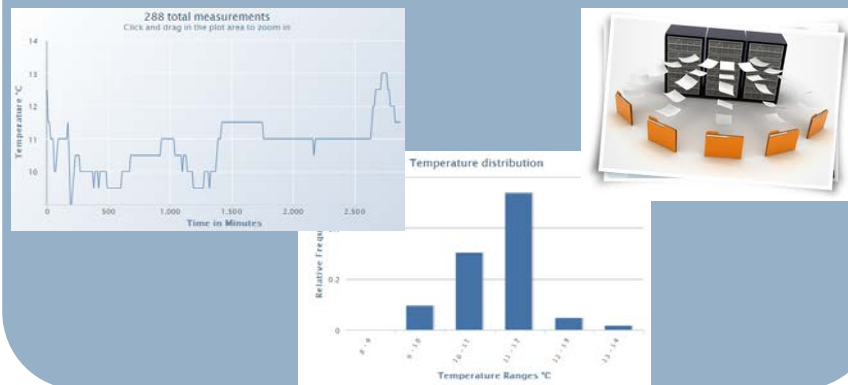


Cold Chain Database...in numbers!



Cold Chain Database tools:

Visualize & manage your own data

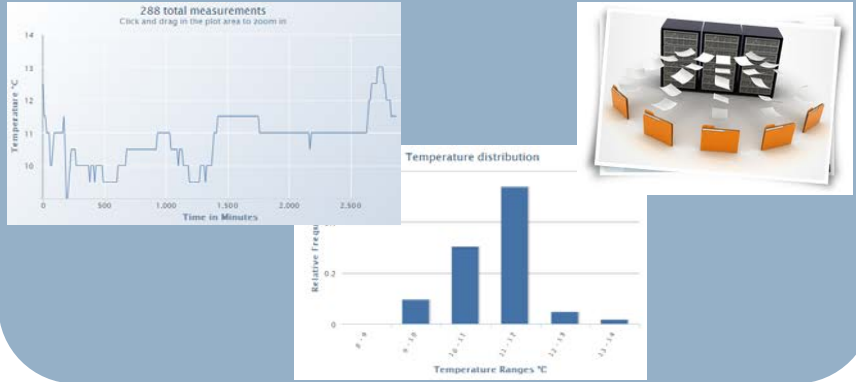


Search within almost 10.500 profiles of the European Food Cold Chain Database

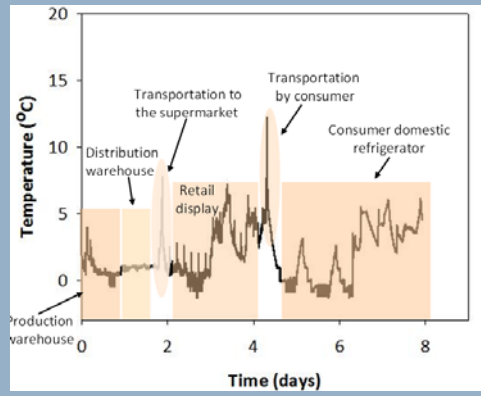
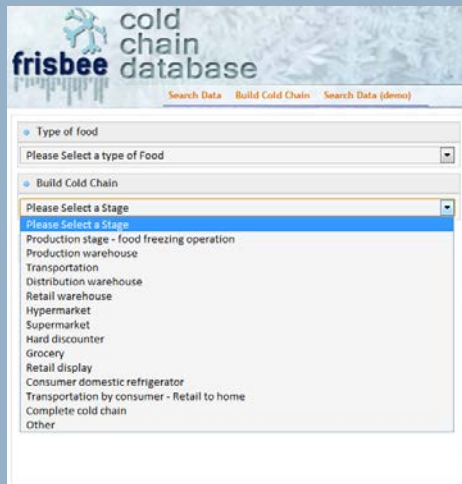


Cold Chain Database tools: Build Cold Chain Scenario Profiles

Visualize & manage your own data



Build Cold Chain Scenario Profiles

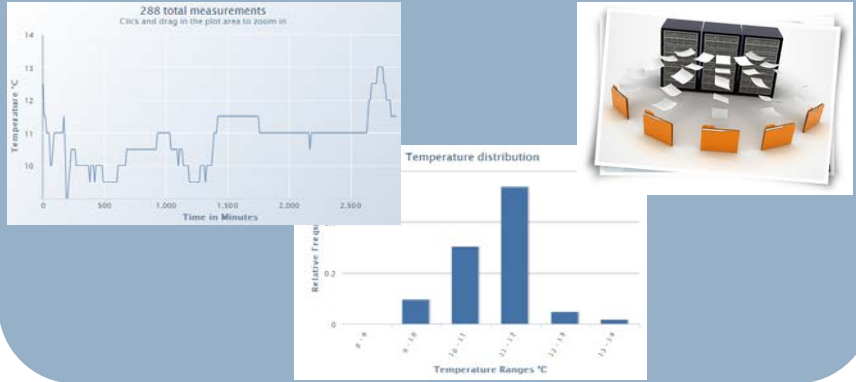


Search within almost 10.500 profiles of the European Food Cold Chain Database



Cold Chain Database tools: Determine food product quality

Visualize & manage your own data



Determine food product quality along the cold chain

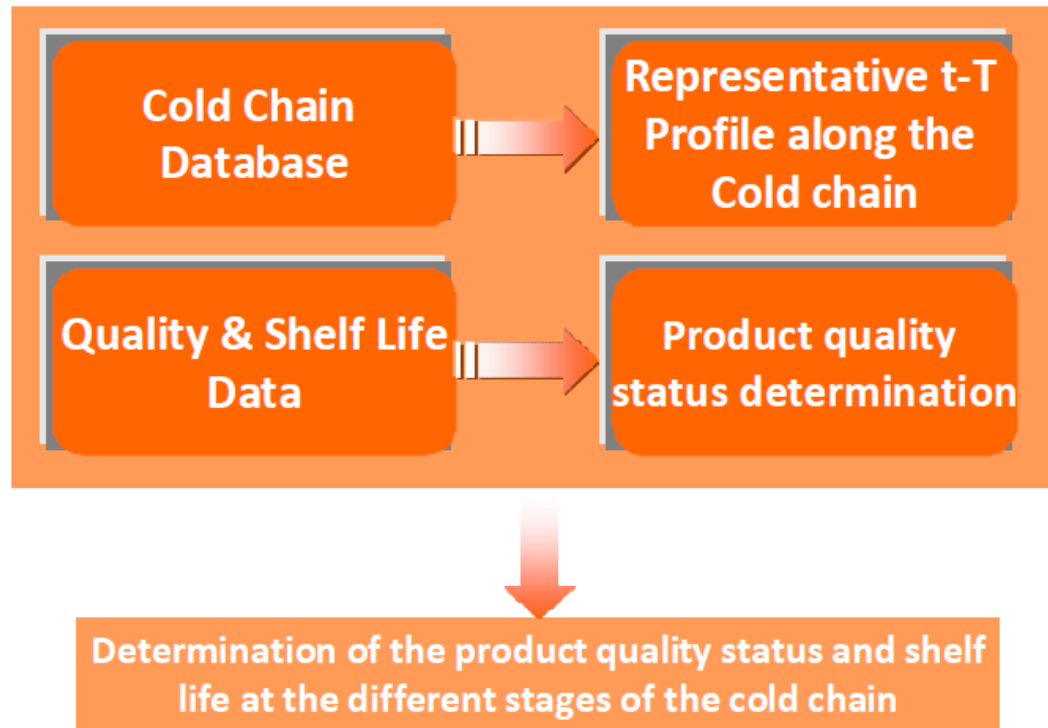
Search within almost 10.5000 profiles of the European Food Cold Chain Database



Cold Chain Predictor Software



Cold Chain Database tools: Cold Chain Predictor Software



- . The building blocks of the tool developed to predict a representative time-temperature profile correlated to food quality.



Field Test in Cold Chain in European Markets

Expanding the Cold Chain Database

Food Product and Formulation

- ✓ Meat products
(smoked ham, turkey slices)
- ✓ Incorporate miniature temperature recorders inside the food product
- ✓ From production to consumer refrigerator

Countries Involved



Field Test conducted in Greece

FOOD PRODUCT

- ✓ **Product:** Smoked turkey slices
- ✓ **Shelf life:** 2 months
- ✓ **Packaging:** An outside plastic transparent container within which the slices are placed in vacuum packed (skin packed) in a second film

FIELD TEST DESIGN

- ✓ Conducted in June, 2012
- ✓ 240 products, 24 supermarket stores, 12 cities in Greece

DATALOGGER

- ✓ Mini Nomad RFID temperature logger
- ✓ Omega Engineering Inc.



Field Test Design-Greece



Field Test Cold Chain Stages

Production/Production Warehouse
~12 hours



Distribution Warehouse
2 distribution centers



Supermarket Warehouse and Display
24 supermarkets stores in 12 cities



Consumer transport



Consumer domestic refrigerator

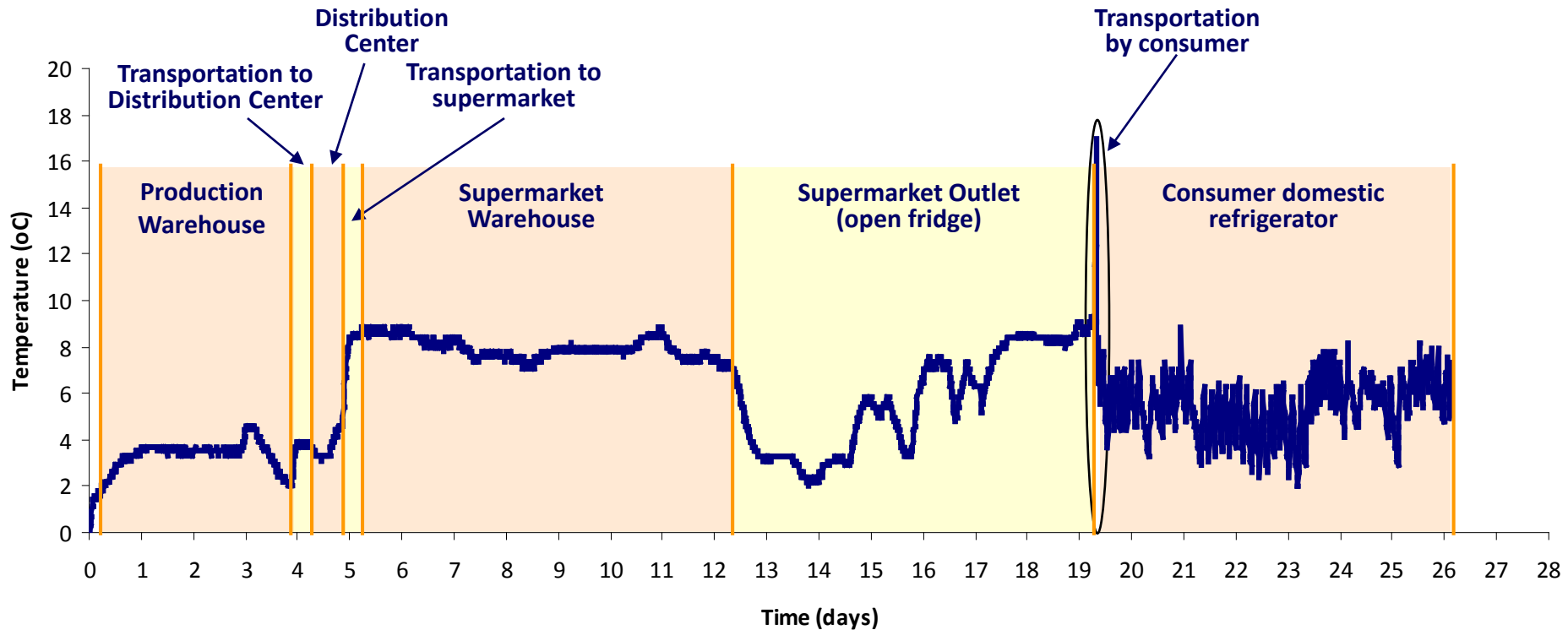


Field Test Photos

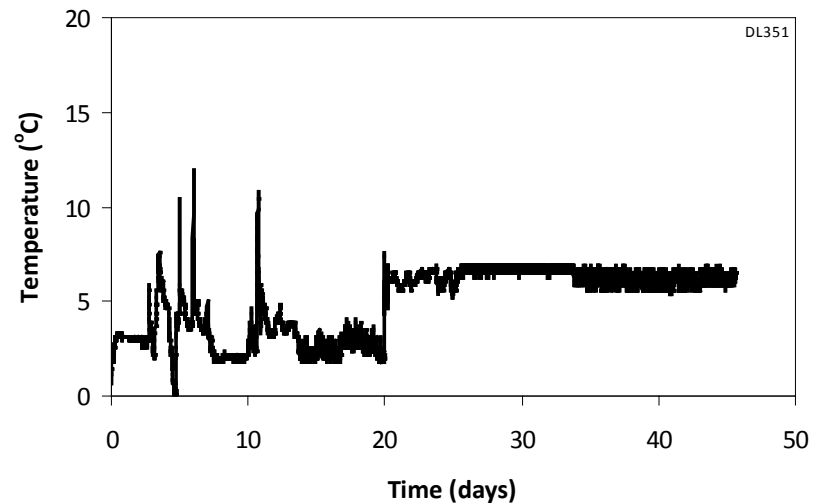
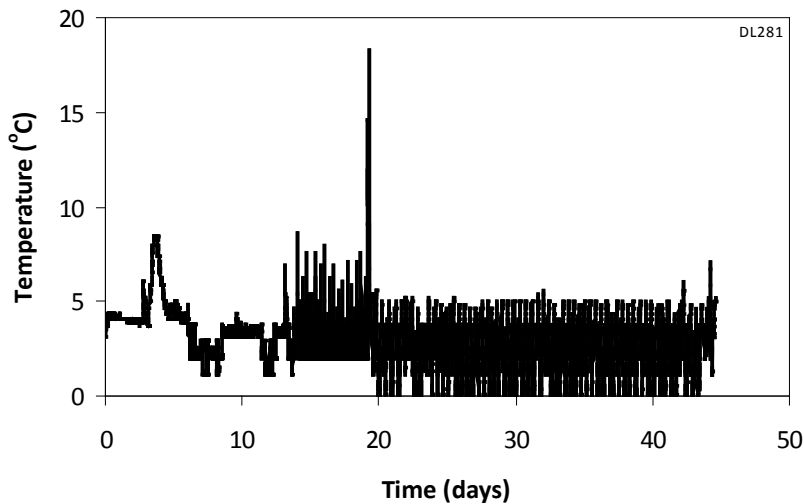
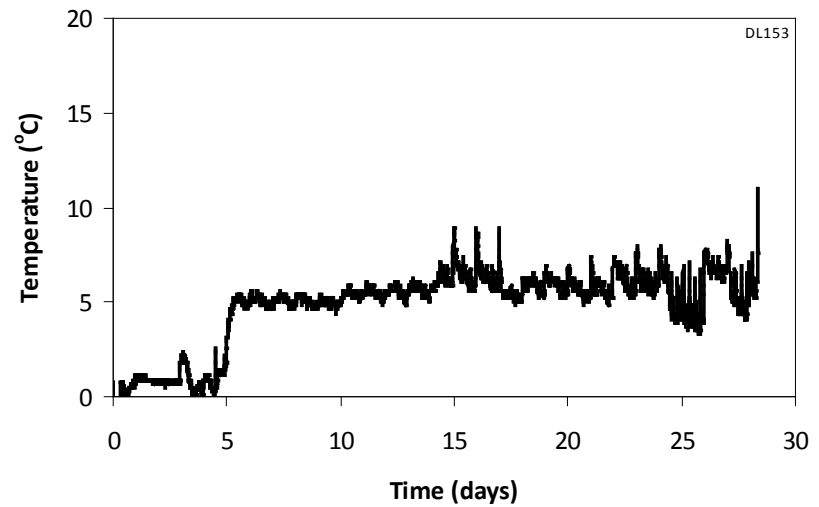
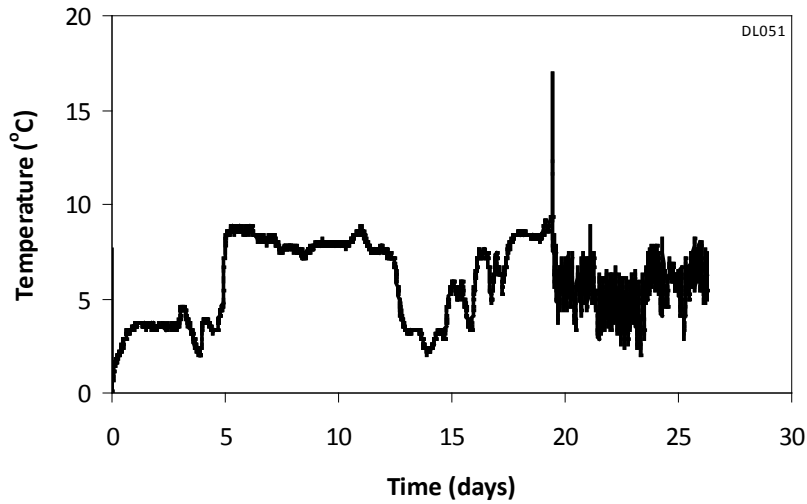


Field test time temperature profiles

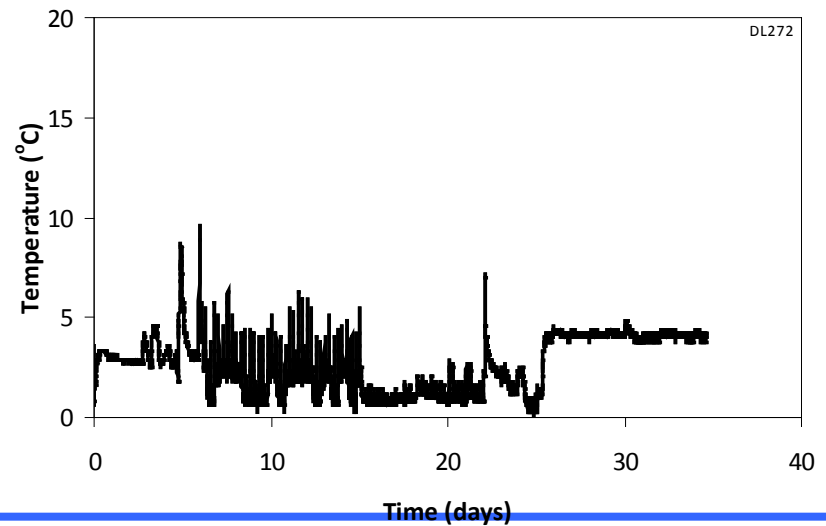
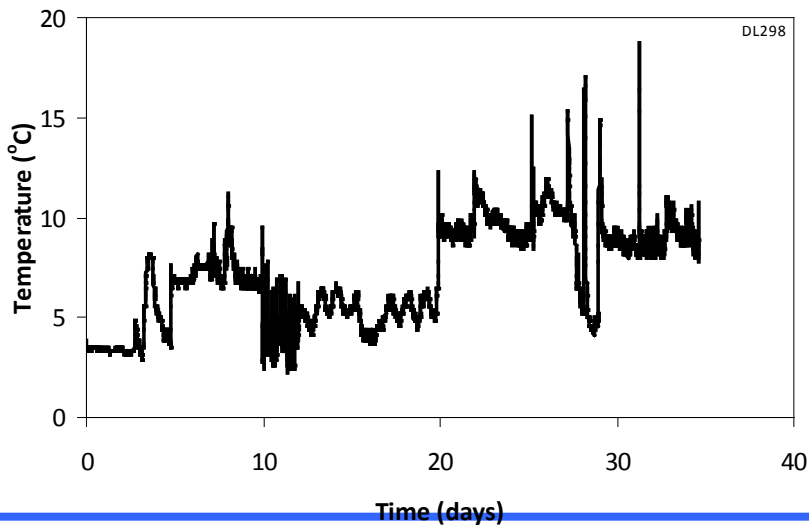
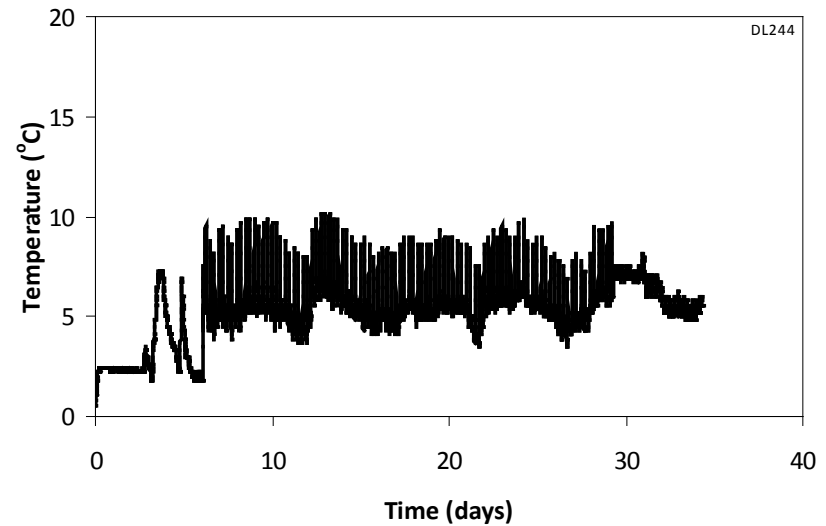
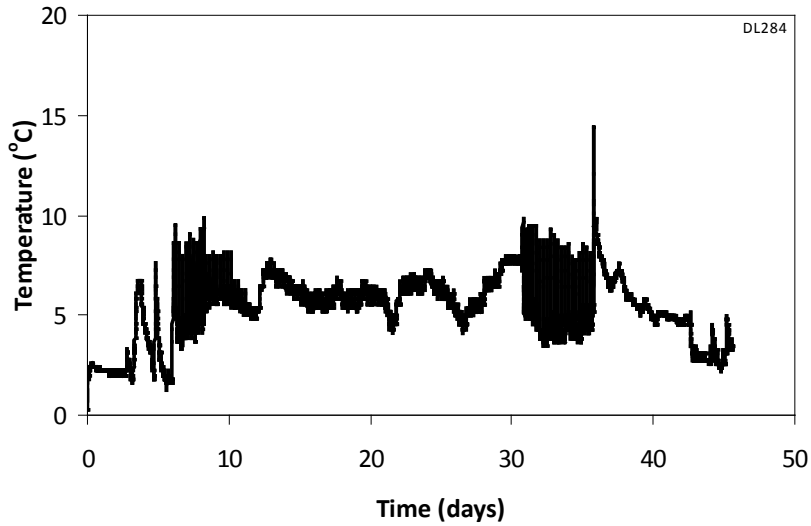
Complete Cold Chain-Retrieved profile



Field test time temperature profiles

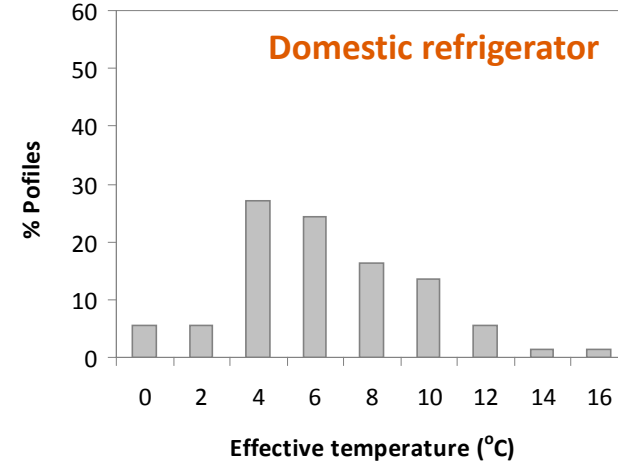
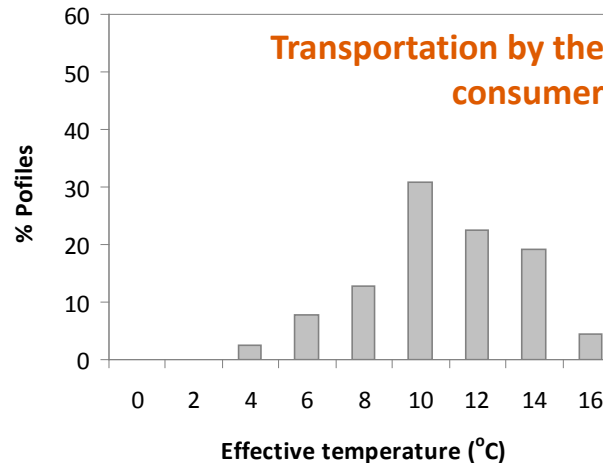
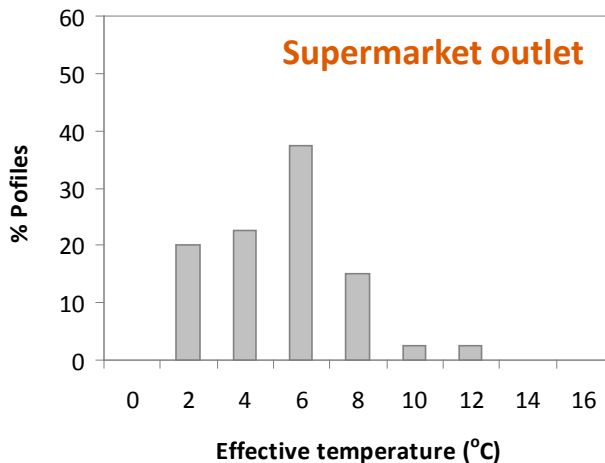
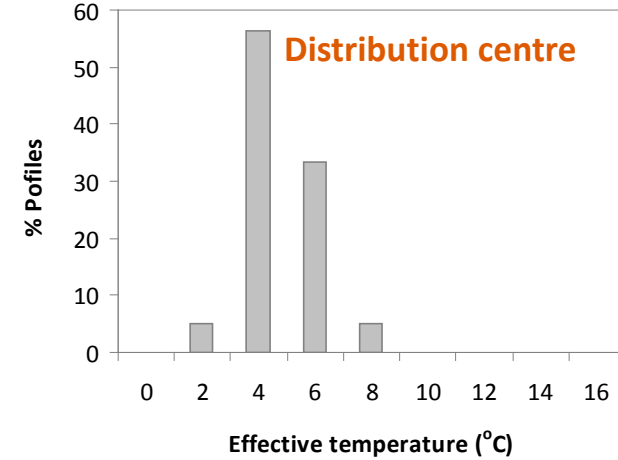
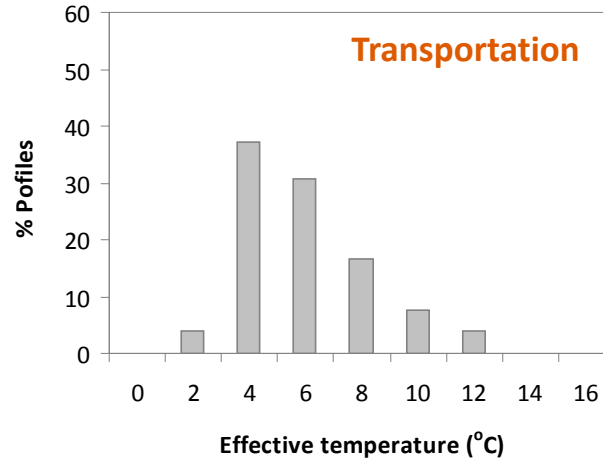
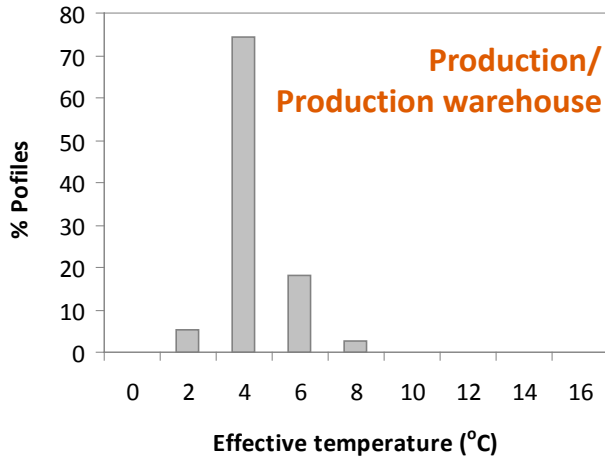


Field test time temperature profiles



Field test time temperature retrieved profiles

Temperature distributions



Field test-Validation experiment

Validation Experiments
Cold chain simulation

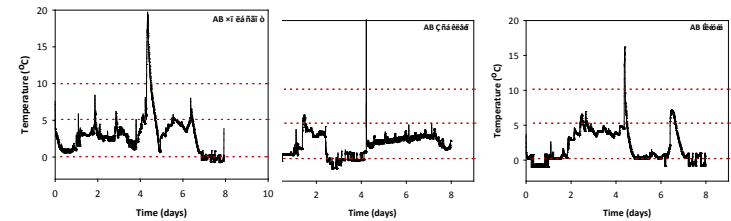
Selection of time-temperature profiles

- Reproduced in time-temperature controlled cabinets
- Cooked ham samples stored at the simulated t-T profile

Sampling at predetermined times

- Simulated to correspond to different cold chain stages
- Quality parameters**
- Total viable counts
 - Lactic acid bacteria counts
 - Sensory evaluation

Taking into account
Retrieved t-T profiles from the conducted field tests



Remaining shelf life determination
at different stages of the cold chain



Field test-Validation experiment

Kinetic model on cooked ham

Cooked ham Slices

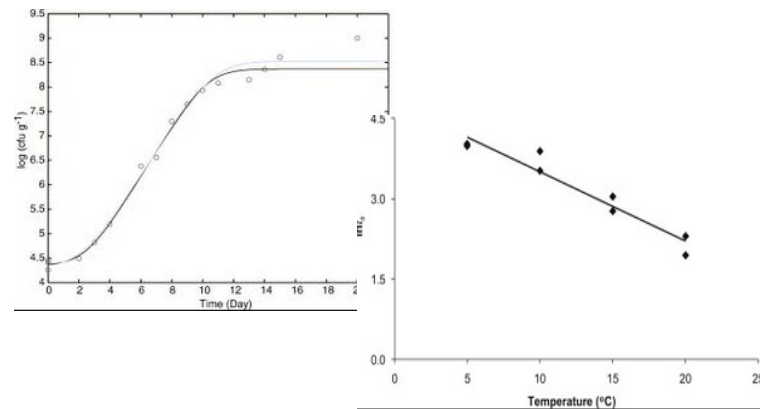
Vacuum packed



Storage at 4 constant temperatures (0, 5, 10, 15°C)

Parameters

- Total viable counts
- Lactic acid bacteria counts
- Sensory evaluation

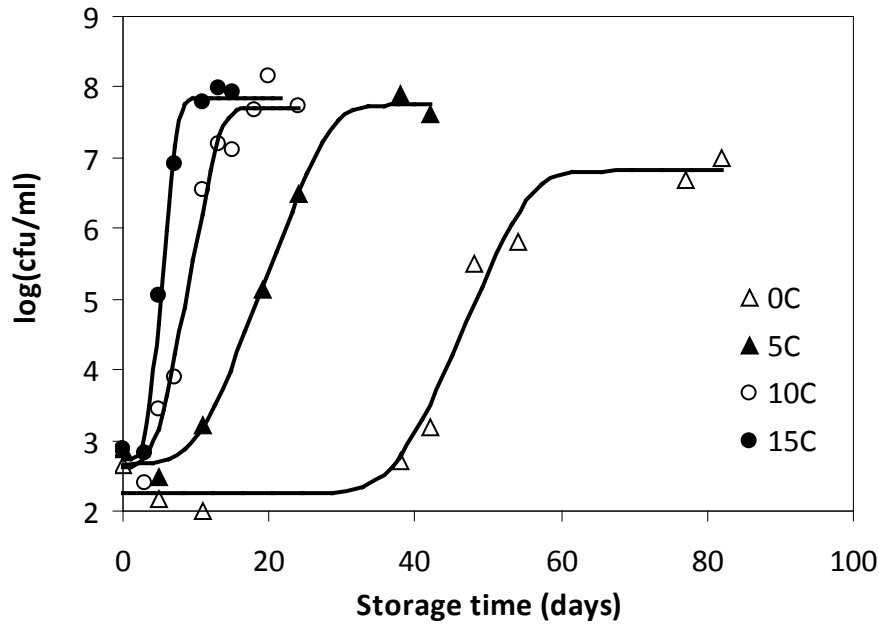


- Kinetic modeling
- Shelf life determination

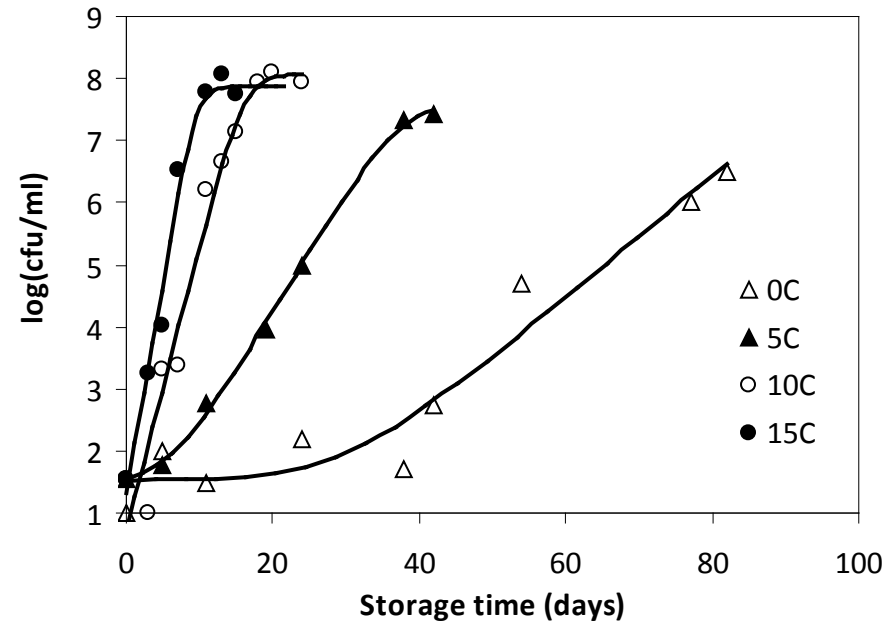


Field test-Validation experiment

Storage test of cooked ham at isothermal storage conditions



Total microbial count



Lactic acid bacteria



Kinetic models development

Primary model

Baranyi model, determination of growth kinetic parameters:

- ☑ Growth rate
- ☑ Lag phase
- ☑ Initial microbial load

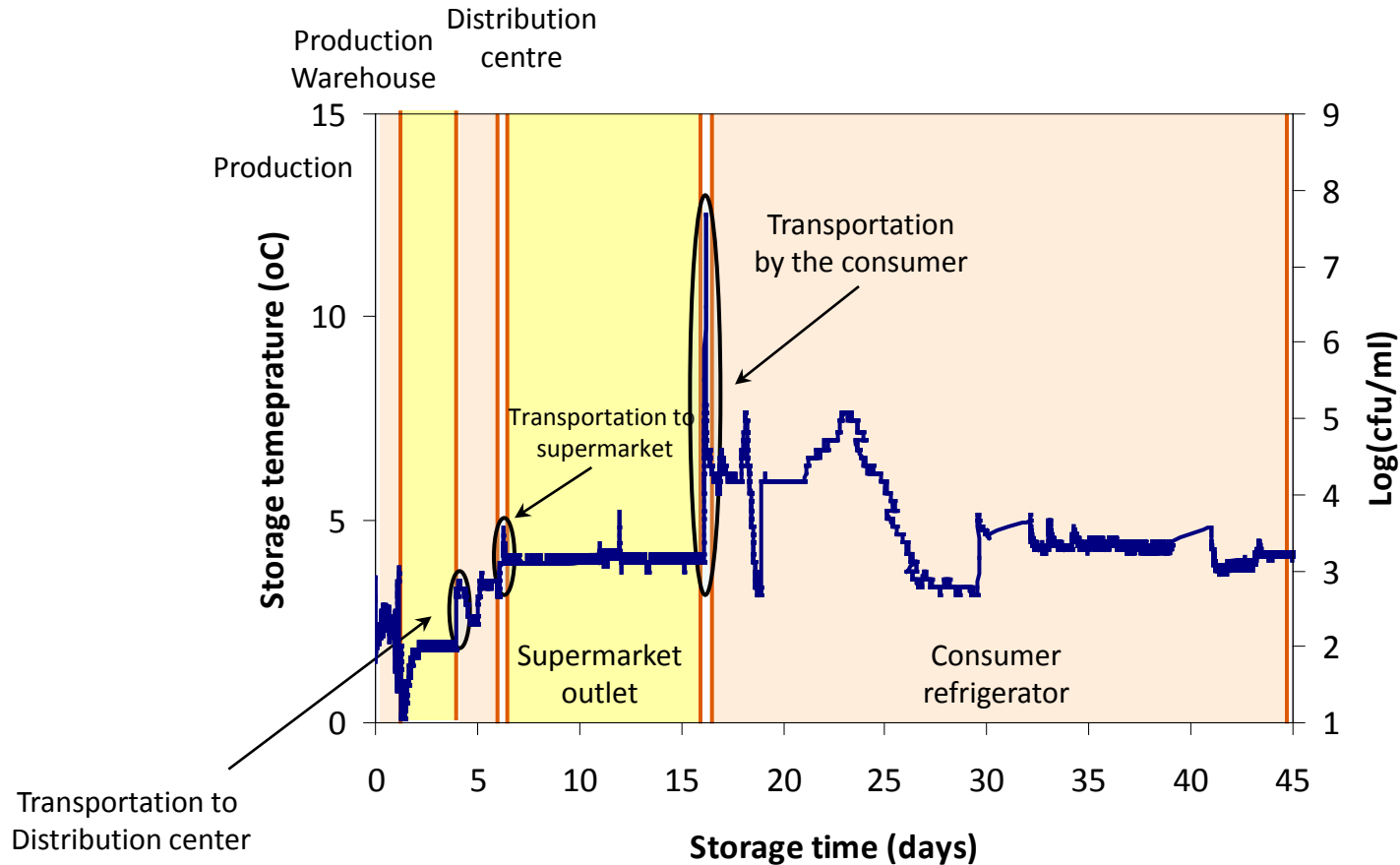
Secondary model

Arrhenius equation, determination of Arrhenius kinetic parameters:

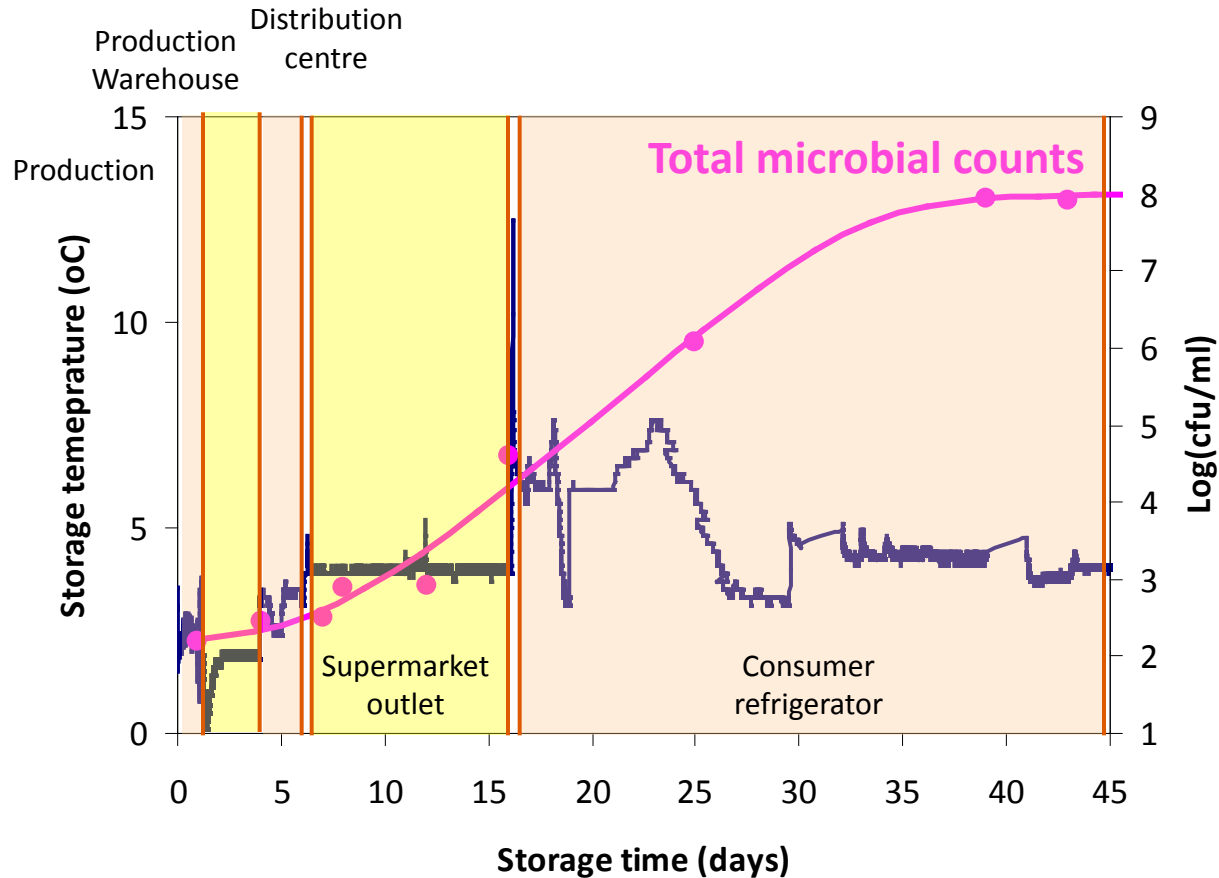
- ☑ Reference growth rate at reference storage temperature
- ☑ Activation energy value (E_a)



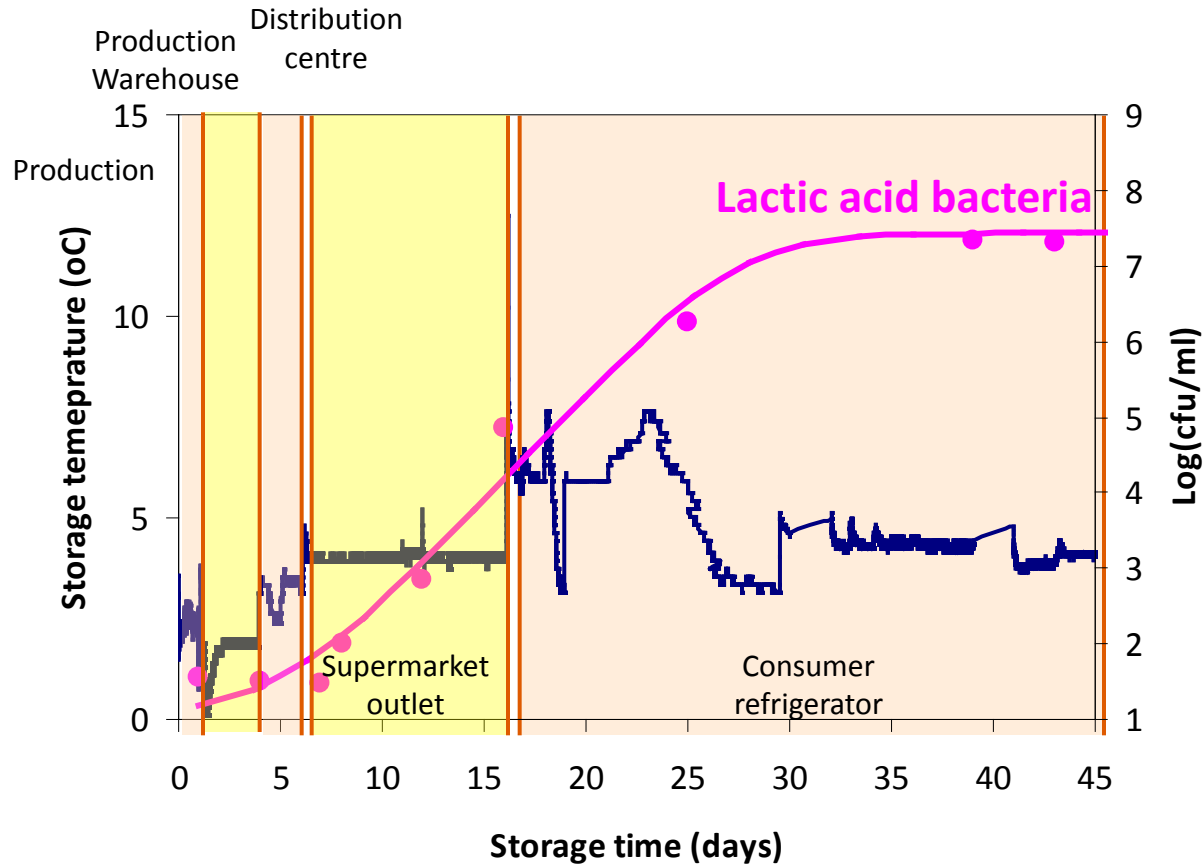
Simulated time-temperature scenario



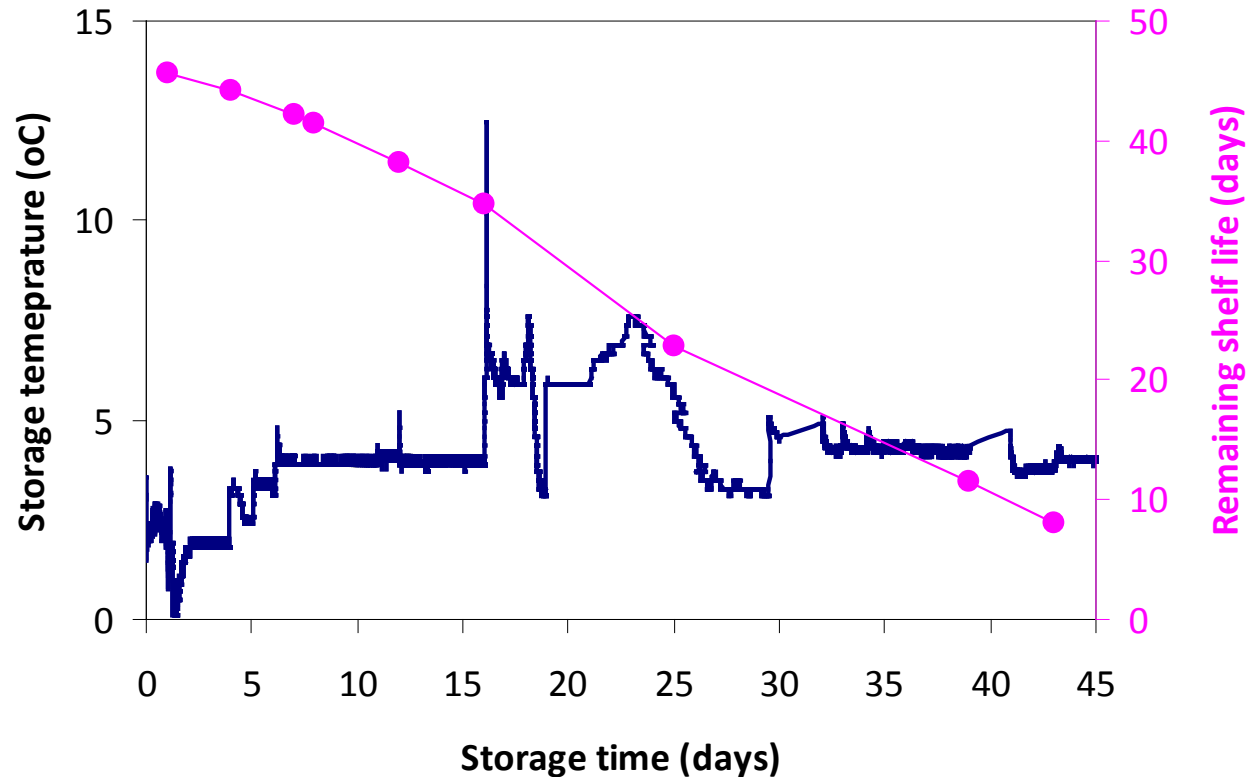
Simulated time-temperature scenario



Simulated time-temperature scenario



Remaining shelf life at different stages of the simulated cold chain



Contribute your own data to the Cold Chain Database-Join forces!

- ✓ Organize & Manage your cold chain data
- ✓ Meta data analysis
- ✓ Get privileged access to the Database
- ✓ Visualize your data through **Cold Chain Database tools**
- ✓ Get privileged access to the **Cold Chain Predictor Software**



www.frisbee-project.eu/coldchaindb
frisbee@chemeng.ntua.gr


The First European Cold Chain Database has now been released!

<http://www.frisbee-project.eu/coldchaindb.html>

Find out how you can contribute your cold chain data & Gain privileged access to the Database



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THANK
YOU

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