Session 1:
Fundamental Aspects

Heat and mass transfer during soaking process at low temperatures

Goli, T.; Lucas, T.; Bohuon, P.; Wack, A.L.

CIRAD/CEMAGREF
Montpellier - France

Fair CT 96 1118
Karlsruhe - june 23-24th 2000

Introduction

Immersion Chilling and Freezing (ICF)

ICF : soaking foodstuffs in aqueous refrigerating media.

Immersion media : Binary brine solution or ternary (ethanol, sugars)

Foodstuffs : fish, shrimps, poultry, fruits and vegetables

Introduction

Main advantages :

- shorter processing times
- energy savings
- quality improvement

Drawbacks :

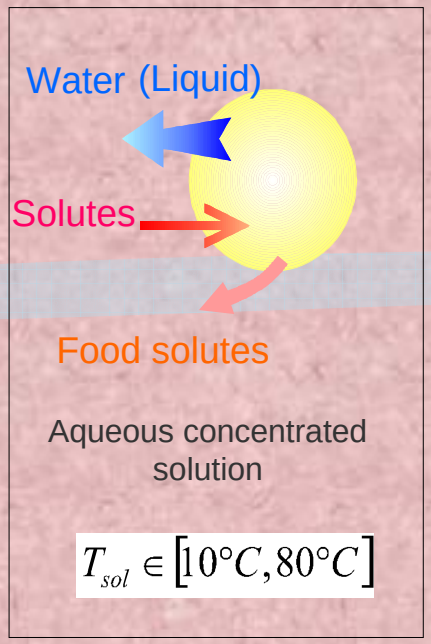
- uncontrolled solutes intake

Recent studies open the way to :

- reduce solutes intake
- get directly preprocessed frozen material

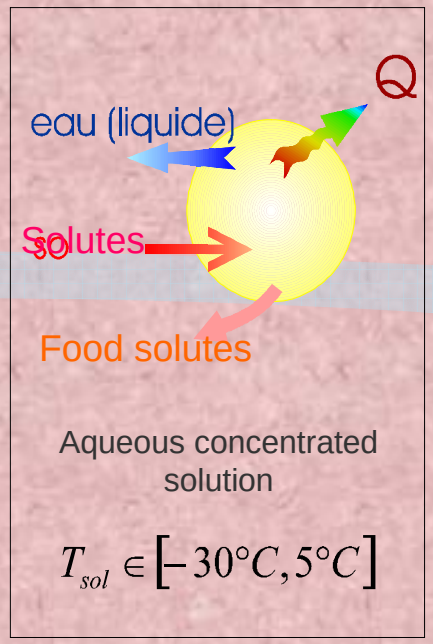
SOAKING TREATMENTS/ OT and ICF

« Osmotic treatments »



- Dehydration and formulmation,
- no phase change,
- « isothermal »
- osmotic phenomena, shrinkage

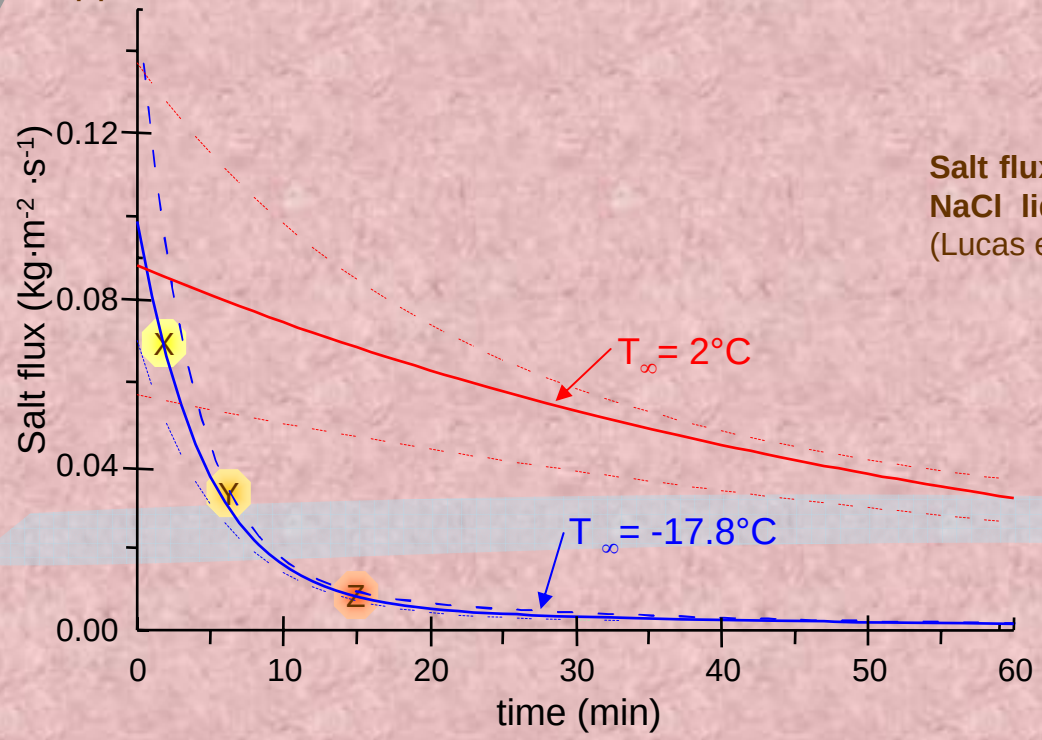
« Immmersion Chilling and freezing »



- Chilling, freezing, and formulation
- phase change
- non isothermal,
- shrinkage

ICF/ RESULTS

Apple tissues



Salt flux in apple cylinder (T_0=+5°C) soaked in NaCl liquids (4.55 mol/kg) at 2°Cand -17.8°C (Lucas et al., 1998).

X 87% ice in the outer layer
Y 87% ice at core
Z 90% ice at core

Theoritical approach

Mathematical modelling
+
glass bead bed

Coupling phenomena

- solute concentration profile
- ice weight fraction

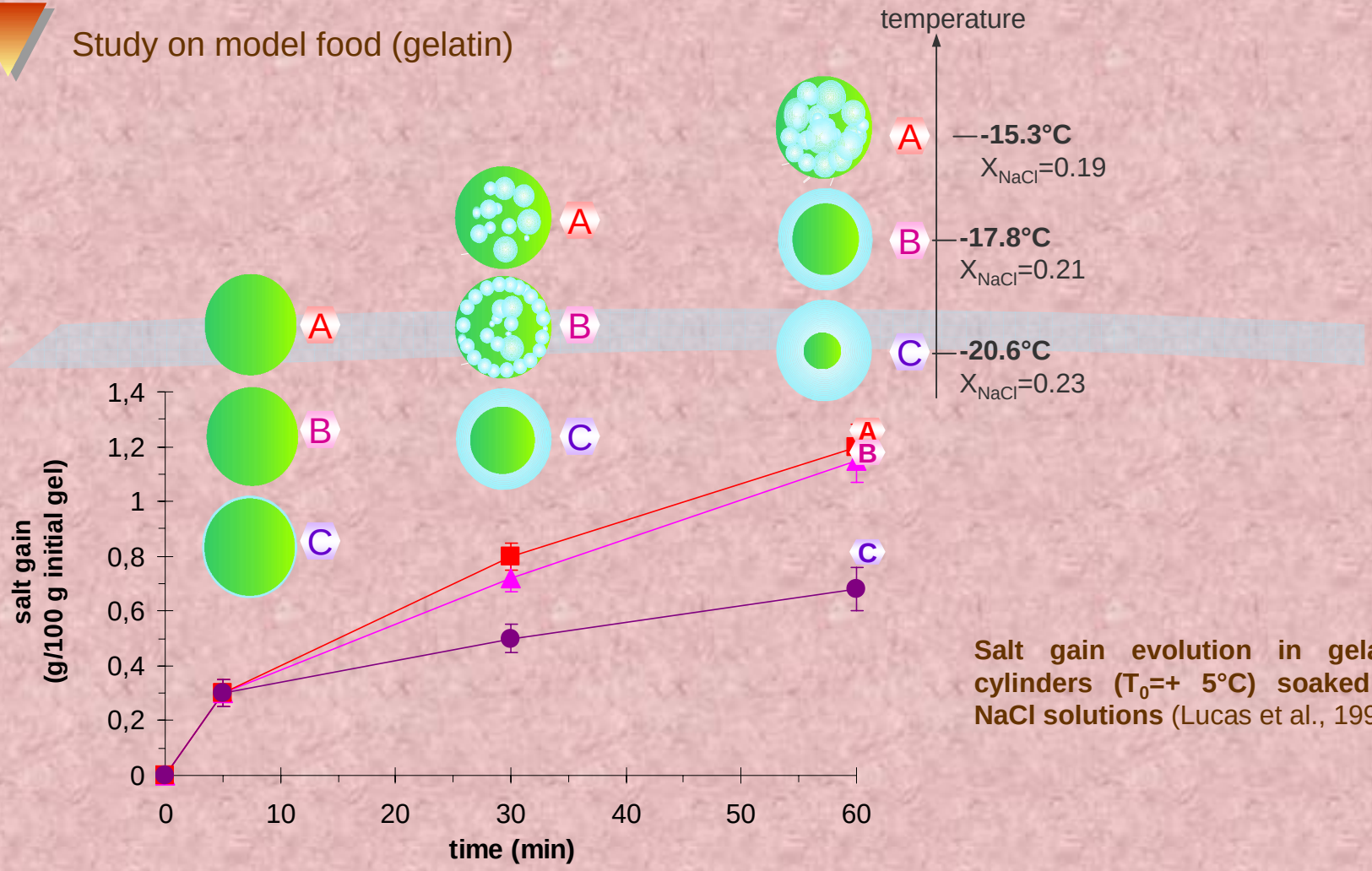
prédiction tools

- physical state of the outer layer (frozen or thawed)
- freezing front location and impregnation level of thawed area

Heat and mass transfer coupling

Question : links between heat (including phase change) and mass transfer ?

Study on model food (gelatin)

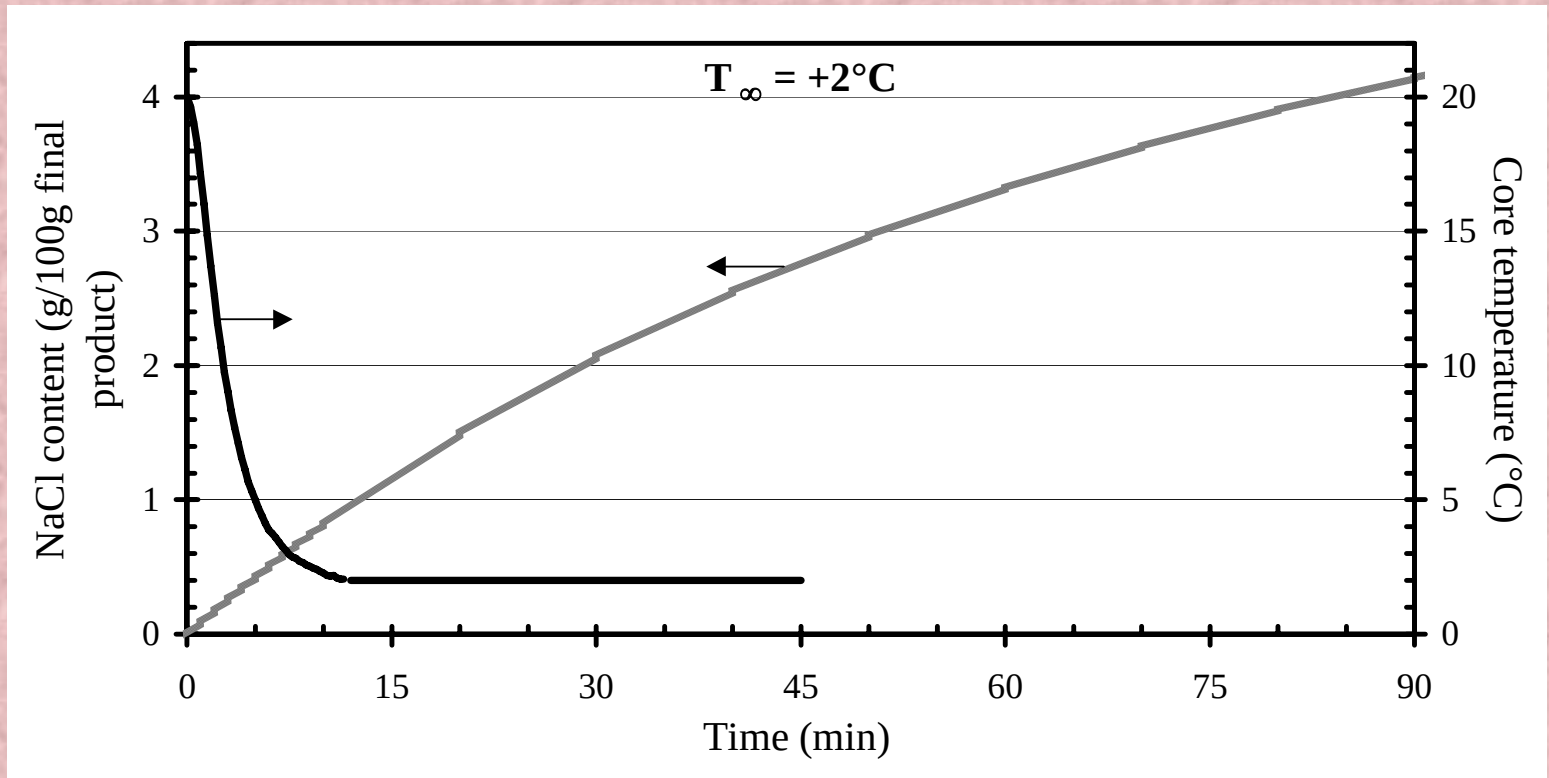


Salt gain evolution in gelatin cylinders (T_0=+ 5°C) soaked in NaCl solutions (Lucas et al., 1996).

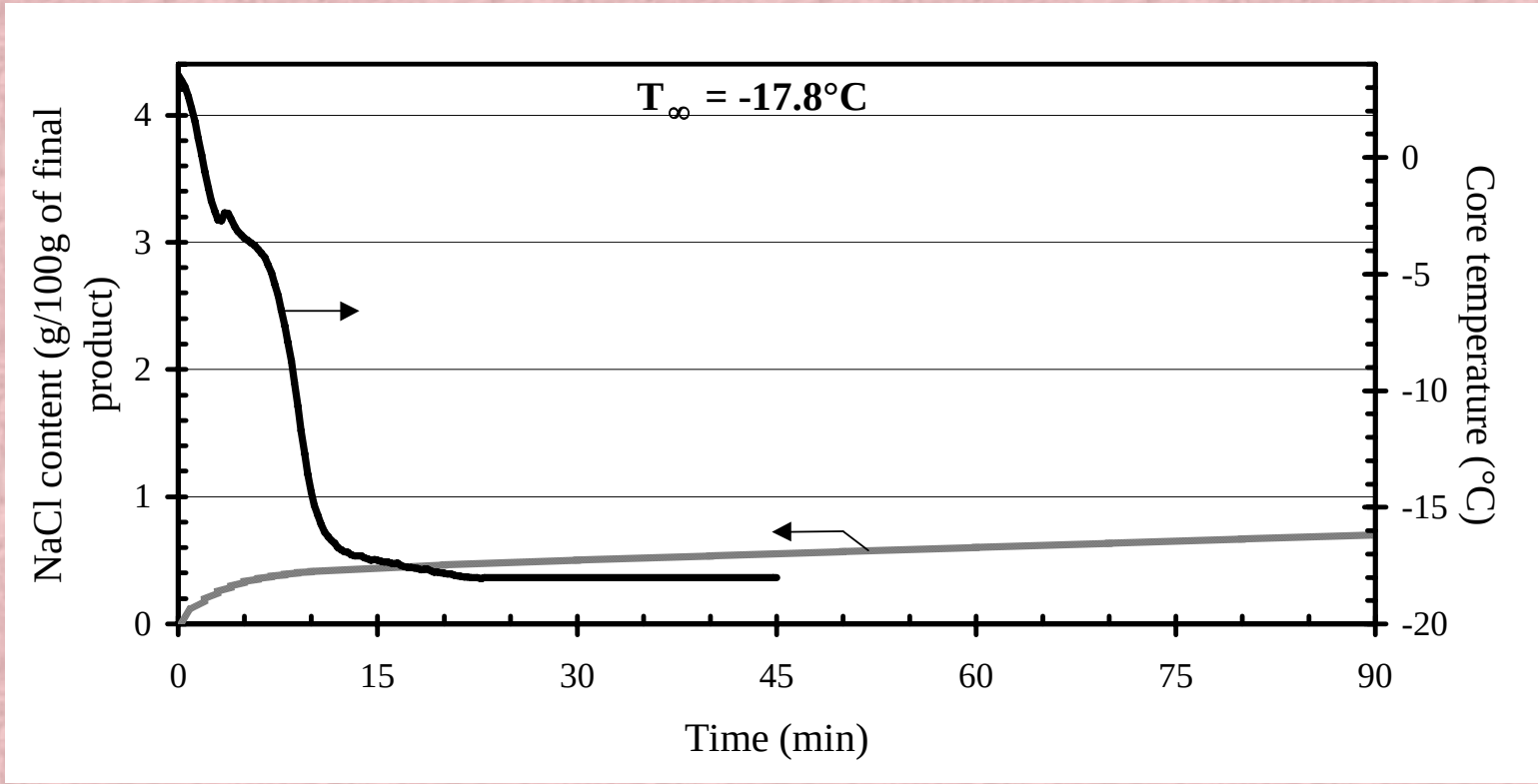
Table 1.
Comparison of different chilling and freezing techniques : heat transfer coefficient, h

Freezing techniques	h ($W.m^{-2}.K^{-1}$)
Air-blast freezer	
Tunnel	10-50
Fluidized bed	60
Plate freezer	100
Direct contact by immersion	
Freon	500
liquid nitrogen	100
aqueous solutions	100-950

Immersion at 2°C



Immersion at -17.8°C



Long term storage at -17.4°C