UMP OPEN COURSEWARE

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

## Chapter 1:

# Food Dehydration

Expected outcome:

a) Able to apply the principles of dehydration in food
b) Able to and analyze dehydration in food

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# Content

- Introduction
- Dehydration and quality
- Water and air – psychrometry
- Drying equipment

# Introduction

- Dehydration /drying – removal of water from a product
- Purpose
  - Improve shelf life
  - Controlling water activity,
  - Inactivate microorganisms and enzymes
  - Minimize chemical reaction
  - Control texture properties
  - Standardize composition
  - Easy to handle

# Dehydration and quality

- Changes food products in several ways
  - High temperatures can cause chemical reactions
  - Affects physical appearance

→Rehydration after drying may not restore original product.

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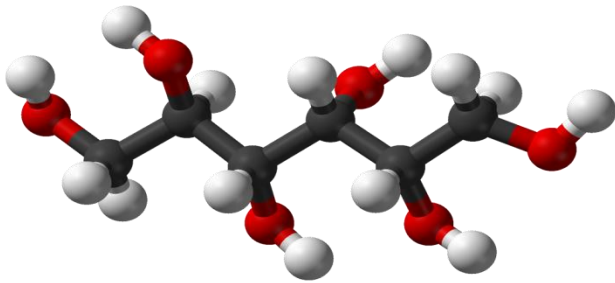
# Dehydration and quality

- Water activity ($a_w$)
  - Partial pressure of water vapour ($p_w$) above the food surface divided the pure component vapor pressure of water ($p'_w$) at the same temperature (Smith, 2003).

$$a_w = \frac{p_w}{p'_w}$$

  - A measure of availability of water activity in range of 0 to 1
  - Other methods to control water activity by adding humectants.



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# Dehydration and quality

- Microbial stability
  - Limits of microbial growth determined by $a_w$
  - Less favorable the factors, the higher $a_w$ required for growth
- Chemical stability
  - Enzymic reactions low in low $a_w$
- Physical stability
  - Softening/hardening of texture – texture softens at high moisture, hardens at low moisture


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# $A_w$ at high moisture content

- Ideal solution, Raoult's law ; $A_w = x_w$
- Non ideal solution; $A_w = \gamma x_w$

$$x_w = \frac{\frac{x_w'}{M_w}}{\frac{x_w'}{M_w} + \frac{x_s'}{M_s}}$$

$$A_w = x_w \in^{-k(1-x_w)^2}$$

In multi component system with 2 solutes;

$$A_w = (A_{w1})(A_{w2})$$

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# Example

i. Determine the water activity of a 70% sucrose solution

ii. Determine the water activity of fruit jams containing 70% soluble solids, 5% insoluble solids, and water. The soluble solids are 50% glucose and 50% sucrose.

Values of the Constant k for Various Solutes in Norrish's Equation for Water Activity of Solutions.

| | |
|---|---|
| Sucrose | 2,7 |
| Glucose | 0,7 |
| Fructose | 0.7 |
| Invert sugars | 0,7 |
| Sorbitol | 0.85 |
| Glycerol | 0.38 |
| Propylene glycol | −0.12 |
| Nacl | $15.8(x_2 < 0.02)$ |
| | $7.9(x_2 > 0.02)$ |
| Citric acid | 6.17 |
| d-Tartaric acid | 4.68 |
| Malic acid | 1.82 |
| Lactic acid | −1.59 |

*Sources:* Norrish, R. S., *J. Food Technol. 1:25, 1996*;

# Water and air

- Movement of water vapor from food to surrounding air
  - the moisture content and composition of the food
  - the temperature and humidity of the air.
- At constant temperature the moisture content of food changes until it comes into equilibrium with water in the surrounding air. ==>EMC
  - This relative humidity of the storage atmosphere is called equilibrium RH (ERH).
- Capacity of air to remove moisture from a food depends on the temperature and the amount of water vapor on the air.
- Psychrometry – study of the interrelationships of the temperature and humidity of air

Carrier

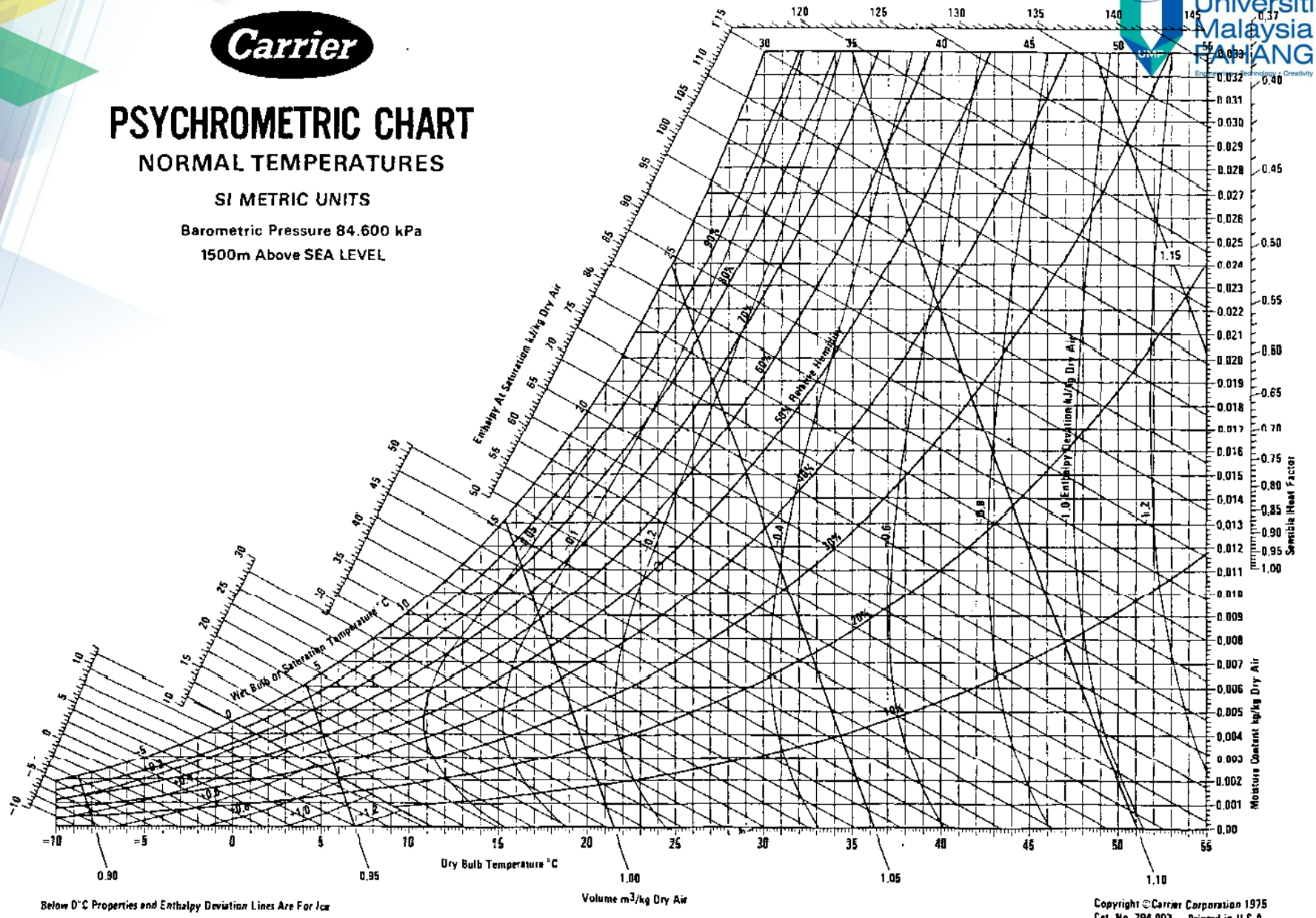
# PSYCHROMETRIC CHART

## NORMAL TEMPERATURES

### SI METRIC UNITS

Barometric Pressure 84.600 kPa

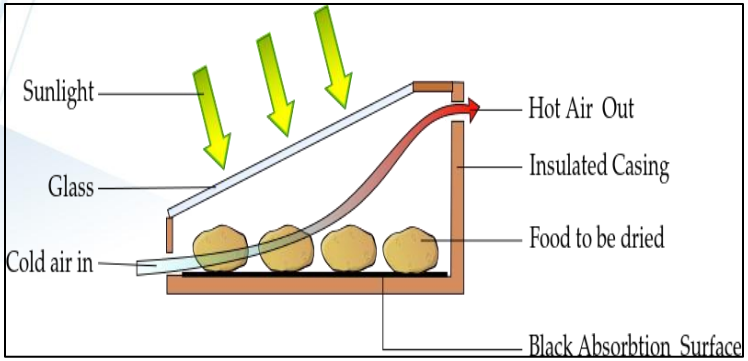
1500m Above SEA LEVEL



# Drying equipment

- Hot air driers
  - Tray drier
  - Solar dryer
  - Conveyer/belt drier
  - Spray drier
  - Rotary drier
- Heated-surface driers
  - Drum drier
  - Vacuum shelf drier

# Example of dryer equipments

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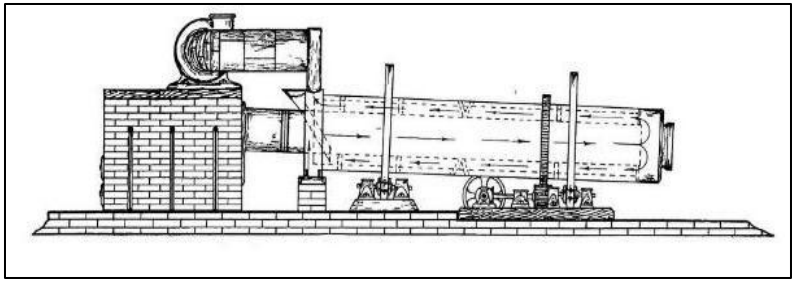

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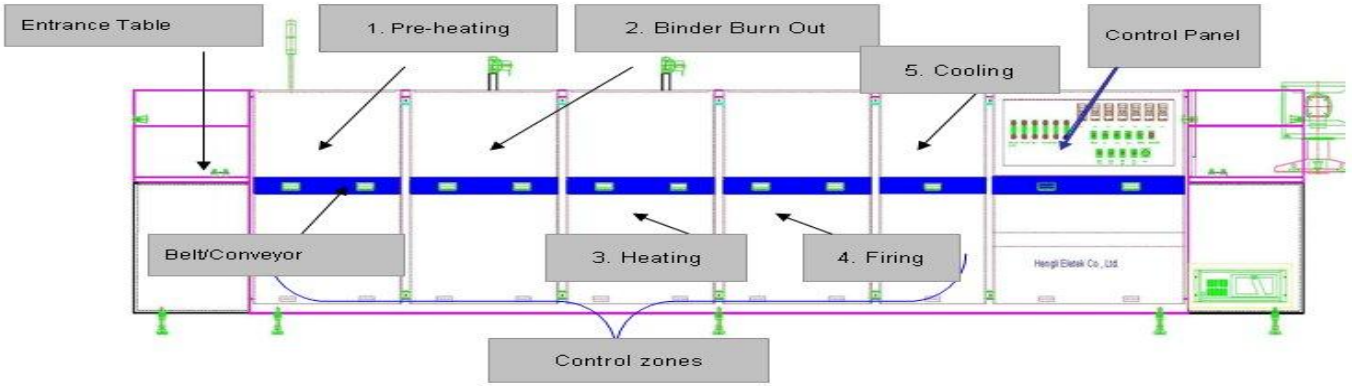


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