Cooling and freezing technology

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Cooling and freezing

Cooling - a method of food preservation consisting in lowering the temperature, but without exceeding the cryoscopic temperature. For sensitive products, it is the only method of preserving in their natural state (fruit, vegetables, eggs - despite being cooled, they remain living organisms).

Cooling temperatures: +4 ± -2°C (higher Temp - plant products, lower Temp - animal products).

Cooling methods

ice cooling - simple. effective, widely used

The raw material is poured with ice, which melts and takes away heat from it (often additional air cooling in the cooling room). Heat transfer between the product surface and ice, ice water and air.

Cooling and freezing

Due to the fact that the heat capacity and conductivity of ice and water >> than that of air, the influence of air is small.

Heat transfer: product - water convection (very effective)

Heat transfer: product - ice main conduction

The product is poured with ice in layers - the flowing water is cooled and heated.

B. important proper fragmentation of the ice, drainage of water from the bottom of the tank.

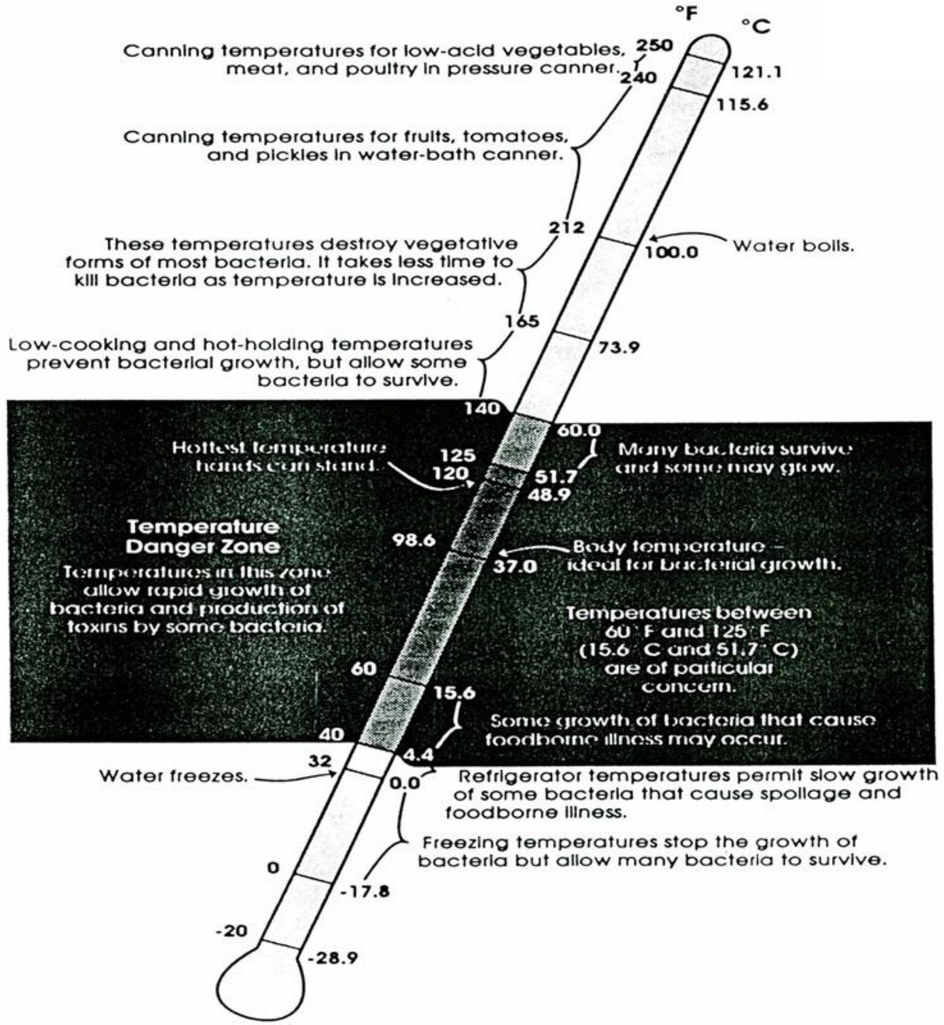

Figure 9.1. Some relationships between temperature and microbial growth in foods. Source: *Preventing Foodborne Illness: A Guide to Safe Food Handling. USDA Food Safety and Inspection Service, Washington, DC, 1990.*

Cooling of food

Theoretical amount of ice required to cool the raw material:

where $Q_0 = G \cdot c \cdot (t_p - t_k)$

r = heat of fusion of ice = 335 kJ / kg

e.g. cooling fish ⇒ 50 ÷ 75% ice weight required in relation to the weight of cooled fish.

In practice, determine the amount of ice experimentally

In order to eliminate direct contact between the raw material - ice, water, sheath cooling is also used (so-called non-contact cooling).

Ice used to cool food artificially produced from sanitary water.

Ice forms used in refrigeration:

a) block ice (e.g. truncated pyramids with the side of the base = 20 cm)

b) sheet ice

c) tubular ice

d) scale ice

e) ice with salt (prohibited in Polish transport) - corrosion

f) eutectic ice (cold accumulators) - also known as corrosion

g)dry ice (-78.5°C) - advantages: low T and no condensation

h)aseptic ice - addition of antiseptic and / or antibacterial substances (especially to fish and sea products)

air cooling

- used for most food products except fish, poultry and liquids

- b. a significant heat transfer coefficient, which b. depends on the air temperature, its speed and humidity

When cooling with air, it is recommended to:

- fast process - forced air circulation

- use low air temperature

- keep the air relative humidity as high as possible

The above condition quick cooling and little drying, eg: currently recommended cooling of meat II stages

Cooling of food

Advantages of two-stage cooling:

reducing the required production space

reducing the weight loss of meat

preservation of the color of the meat

good sanitary condition

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Freezing of food

a method of securing food for long-term storage consisting in lowering the temperature below the cryoscopic point (usually the temperature after freezing = -18 ÷ -30°C)

where it is possible to protect the product for a certain period of time by cooling it, do not freeze it

Freezing equipment

- Air

a) fairing

- periodic operation tunnels
- belt tunnels
- belt and spiral tunnels
- automatic tunnels for products in cardboard boxes

b) fluidization

- gutter
- band

Freezing of food

II. Contact plates (horizontal and vertical plates)

III. Immersion in non-boiling liquids

IV. Immersion in boiling liquids (LN_2, LCO_2, LAIR, LF)

Freezing of food

Freezing food:

-stops the action of microorganisms
- slows down chemical and biochemical (including enzymatic) processes
- thanks to the freezing of water, physical and physicochemical changes take place, which cause changes in the quality of the product

Physical phenomena caused by freezing:

- formation of ice crystals,
-traumatic excitation of cells and tissues,
-changes in volumetric and thermal properties
↓ (- 6%); ↑ V (- 6%); C (o - 2%),
- the amount of heat evaporated during freezing Y
-heat freezing
- heat of other phase transformations (e.g. solidification of fats)

Freezing of food

Nominal freezing time - the time from the moment the surface of the product reaches 0^0C until the temperature in the thermal medium is 5^0C lower than the temperature of the initial formation of the ice formation.

Effective Freezing Time -The time taken to bring the temperature of the product down from its initial temperature to the specified end temperature in the thermal medium.

Freezing rate the quotient of the minimum distance of the thermal center from the product surface to the nominal fracture time the average rate of the ice formation advancing deeper into the product.

- high freezing speed 5 ÷ 20 cm / h quick freezing
- average freezing speed 1 ÷ 5 cm / h intensive freezing
- slow freezing rate 0.1 ÷ 1 cm / h slow freezing

For most products, it is recommended that the freezing rate be at least 4 cm/h.

Freezing of food

Physicochemical phenomena caused by freezing

- ↑ concentration of colloids (their destabilization)
- ↑ salt concentration, partial precipitation of some (phosphates), protein denaturation

Biochemical phenomena caused by freezing

Fruits and vegetables

- loss of firmness, leakage (vacuoles)
- damage to the cellular system, intensification of enzymatic transformations

Often used blanching before freezing

Meat

After the death of the animal $\Rightarrow$, metabolic processes continue in the muscles

ATP decay $\Rightarrow$ shortening of sarcomeres $\Rightarrow$ rigor mortis $\Rightarrow$ especially intense when T ↓ below 15^0C, pH has not dropped below 6.5. Effect $\Rightarrow$ very strong muscle contraction and the meat becomes hard - the so-called cooling shortening.

Freezing of food

To prevent cold shortening:

- after slaughter, mature the meat at T not <15^{0}C for 10 ÷ 15 h, when ATP decomposition is not yet intense in order to ↓ pH below 6 to inhibit ATP decomposition
- freeze quickly immediately after slaughter, and then ↑ T until glycolysis causes ↓ pH and despite the decomposition of ATP, ice crystals do not allow shrinkage
- use ES accelerate glycolysis, rapid decrease in pH below 6 and rapid decomposition of ATP, which is the main source of energy for muscle contraction.

Thawing stiffness occurs in thawed meat, in which ATP has not been broken down beforehand muscle contraction during thawing, damaged tissue structure due to freezing significant thaw leakage.

Freezing of food

Prevention of defrosting stiffness

freeze after rigor mortis (especially for short-term meat)

ATP breaks down slowly even at -20C long-term storage of meat slow breakdown of ATP and no defrosting stiffness

Keep the meat at -3C (ATP decomposition) before complete thawing, e.g. lambs for 3 days

The above phenomena are particularly important for beef and mutton (poultry and fish - not significant).

Freezing of food

Cold chain

The product after production or the raw material after collection should be immediately chilled or frozen in an optimal way for it, and then stay in the most unchanged conditions until it is ready for consumption.

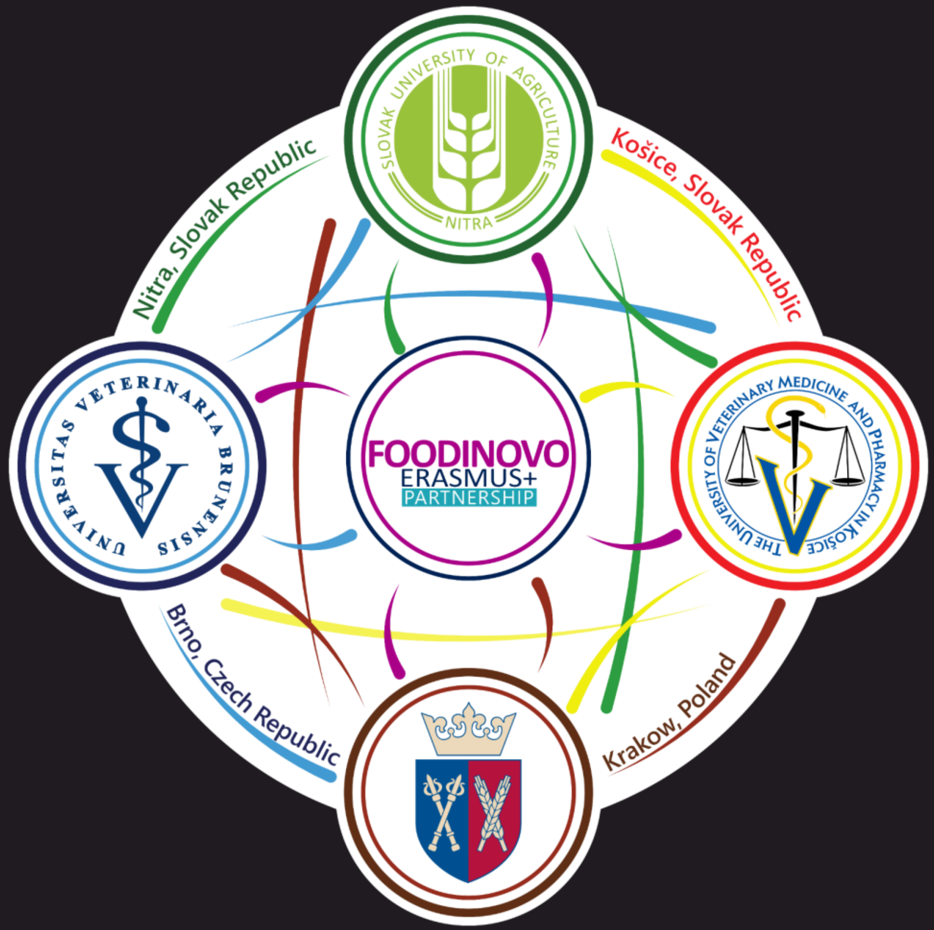
Links in the cold chain $\Rightarrow$ production and storage cold stores, distribution, retail outlets, domestic freezers and refrigerators.

Refrigerated transport connects the individual links in the cold chain.

A characteristic feature of the cold chain - its continuity

All the links in the cold chain - equally important. An interruption is a loss of quality.

Thank you for your attention



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