

Sub Name:FOOD PROCESSING AND PRESERVATION

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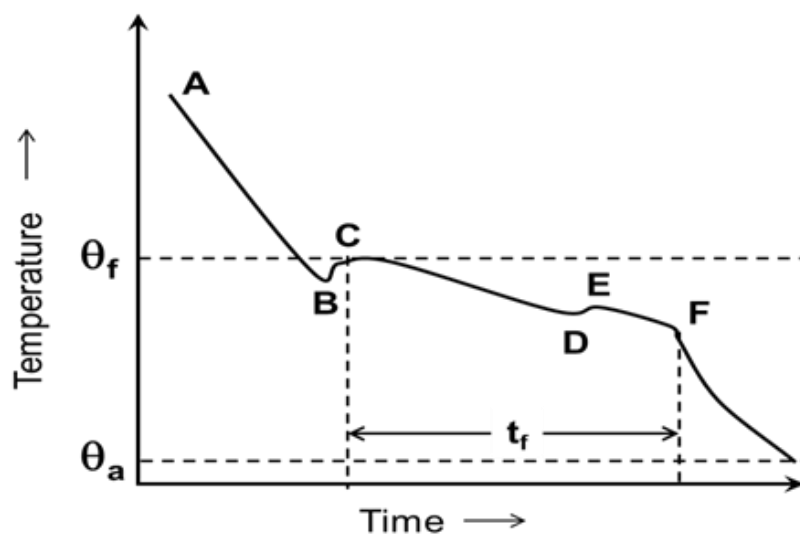
PRINCIPLE OF FREEZING

Introduction to Freezing

Freezing preservation is one of the most beneficial preservation methods. It involves, conversion of liquid content of food into ice crystals, which lowers down water activity and microbial growth is arrested due to cold shock. Pure water is frozen at 0C but since fruits and vegetables contain number of dissolved solids like sugars, acids, they freeze at below 0C.

Process of Freezing

During freezing the commodity cools down below their freezing point but dont freeze this phenomenon is called as super cooling. It is shown by AB phase of curve (Fig. 10.1). At super cooled storage nuclei formation (nucleation) which is the first and most important step in ice-crystal formation in in freezing process. Here the temperature of water will be lower than 0C but it will remain in liquid form. At this stage, further lowering of temperature result in the formation of ice crystals. The second step is called crystal growth stage. The release of heat of crystallization further enhances temperature (BC). Since food molecules contain substantial amount of solute hence, a progressive freezing occurs as depicted in Fig. 10.1. Various water molecules gathers around nuclei and due to subsequent addition, crystal growth occurs. Nucleation may be either due to chance orientation of molecule or due to induction of nuclei from outside, but in fruits & vegetable mostly chance nucleation occur. In next step, crystal growth around these nuclei occurs and as a result of ice-crystal formation, heat of crystallization is generated, which cause increase in temperature of commodity. This Tes is shown by BC lines. So, time taken by freezing curve from initial cooling to E point of curve is known as thermal arrest time. It determines how quick or slow freezing process is. After this point more ice crystal formation takes place and temperature lowers down.



Schematic diagram of freezing process

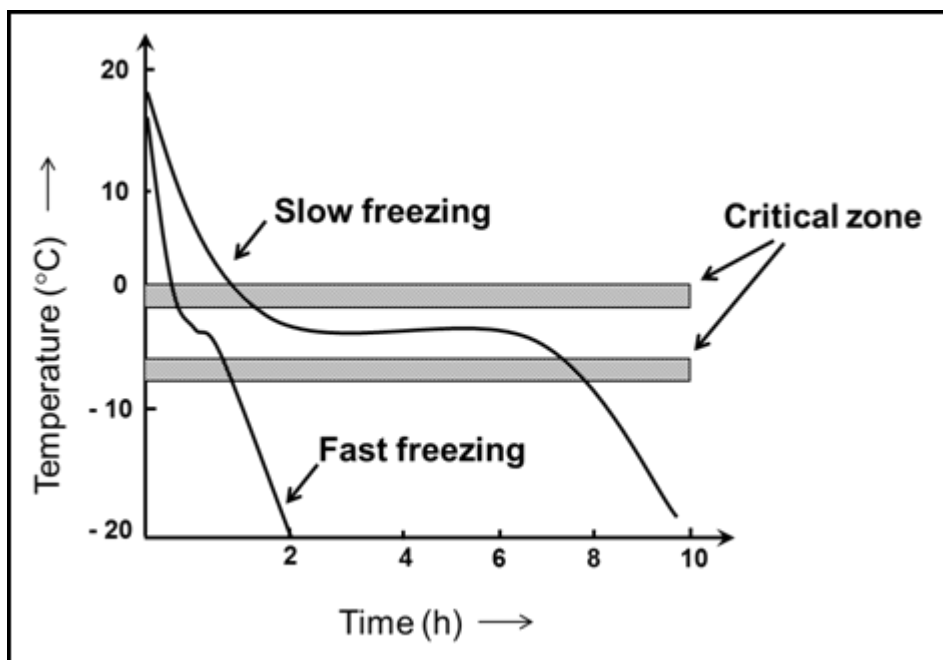
ADVANTAGES OF FREEZING

- No nutrient loss
- Retain freshness of commodity.
- Retain colour and flavor constituents.
- No microbial contamination.
- No respiration, hence longer shelf-life.

EFFECT OF FREEZING

Freezing process is divided into two broad categories viz. slow freezing and quick freezing.

- **Slow freezing: when thermal arrest time is more than 30 min.**
- **Quick freezing: Thermal arrest time is less than 30 min.**
- ✓ In slow freezing, less number of nuclei is formed and as a result of slow freezing more concentrated solution is left in inter-cellular spaces which causes osmotic effect and liquid comes out from cells. This affects turgidity of cell and they collapse and on thawing cannot regain their original shape. Also, crystals forms are larger in size and pierce the cell membrane, puncture it and damage the cells.
- ✓ Whereas in quick freezing large numbers of nuclei are formed, hence having large numbers of crystals of smaller size evenly distributed within the cell and in the intercellular space. Since process is very quick, hence no concentration effect occur and commodities retain their original shape.



Schematic diagram of temperature changes of food through the critical zone during freezing process

FREEZING METHODS

Mode of heat transfer in freezing food product is convection. Following points should be considered while selecting a freezing method:

- a) Product dimension
- b) Shape
- c) Specific heat
- d) Thickness of pieces
- e) Freezing rate
- f) Packaging
- g) Food product components.

1. Air freezing-This is an oldest method of freezing and utilizes cool air having a temperature of -18 to -40C as freezing method. Different types of air freezing are:

- a) Tunnel freezing
- b) Fluidized bed Freezing
- c) Air blast freezing

Air-blast freezers recirculate air over foods at between -30C and -50C at a velocity of 1.5-6.0 ms⁻¹. The high air velocity reduces the thickness of boundary air films. Air flow is either parallel or perpendicular to the food and is ducted to pass evenly over all food pieces.

Air freezing may result in

- Excessive drying
- Costly
- More efficient & more rapid heat transfer
- Less product dehydration & less frequent requirement of frosting.
- Short freezing time so less moisture loss.

2 .Plate freezing

Packaged or fresh commodities are placed over the surface of plate cooled by refrigerant in a cylindrical scraped surface heat exchangers. Double plates are specially used in retail storage. Plate freezing is a slow freezing process and packages must be of uniform thickness.

.3 Liquid immersion freezing

Certain liquids are used as refrigerant which are known as cryogenes. Example: Liquid Nitrogen, Liquid NO₂, Liquid Ammonia, etc.

.4. Cryogenic freezing

Freezers of this type use a change of state in the refrigerant (or cryogenic) to absorb heat from the freezing food. The heat provides the latent heat of vaporization or sublimation of the cryogen. The cryogen is in intimate contact with the food and rapidly removes heat from all surfaces to produce high heat transfer coefficients and rapid freezing. The two most common refrigerants are liquid nitrogen and solid carbon dioxide. The main advantages of cryogenic freezing are as follows:

- ✓ Short freezing time due to high heat transfer
- ✓ Reduction in flavor loss
- ✓ Reduction in drip loss
- ✓ Reduction in oxidative changes
- ✓ Improved texture of the product
- ✓ Suitable for freeze sensitive products

The main disadvantage of cryogenic freezing is relatively high cost of cryogenes.