FOOD PRESERVATION BY LOW TEMPERATURE

Freezing:

Frozen food is held at colder temperatures than refrigeration. As opposed to refrigerator short-term storage, freezing is a long-term storage form that preserve food for several months or a year.

Freezing is by using low temperature less than (zero) C°, Usually the temperature which use to freezing is (-17.8) C°. Freezing makes free waters component turns to ice crystals which it will be unavailable for microorganisms, thus they are dormant and there is no multiplication of pathogens microbial.

Types of freezing:

1. ***Slow freezing:*** The foods in this method are freeze by using the temperature between (-5) to (-29) C°, it takes between 3 to 72 hours, this period depend on the temperature of the foods, size, and the distribution method in the freezer. Slow freezing leads to Creates big ice crystals , more damage to the food & Loss high amount of drip during thawing . The food doesn't retains its shape & texture with this method after thawing. When the foods freeze will transfer to frozen storage.

2. ***Quick freezing:*** In this method the temperature which use is (-40) C° or less, the period of freezing is less than 30 minutes, This method is better than The first method (slow freezing) because of the following reasons :
    a. The small size of ice crystal which forms in the intracellular and in the extracellular, So that will reduce the effective on the cell composition.
    b. The amount of drip which lose is less than in slow freezing during thawing.
    c. The frozen foods in this method will appear similar to the unfrozen (fresh) foods.

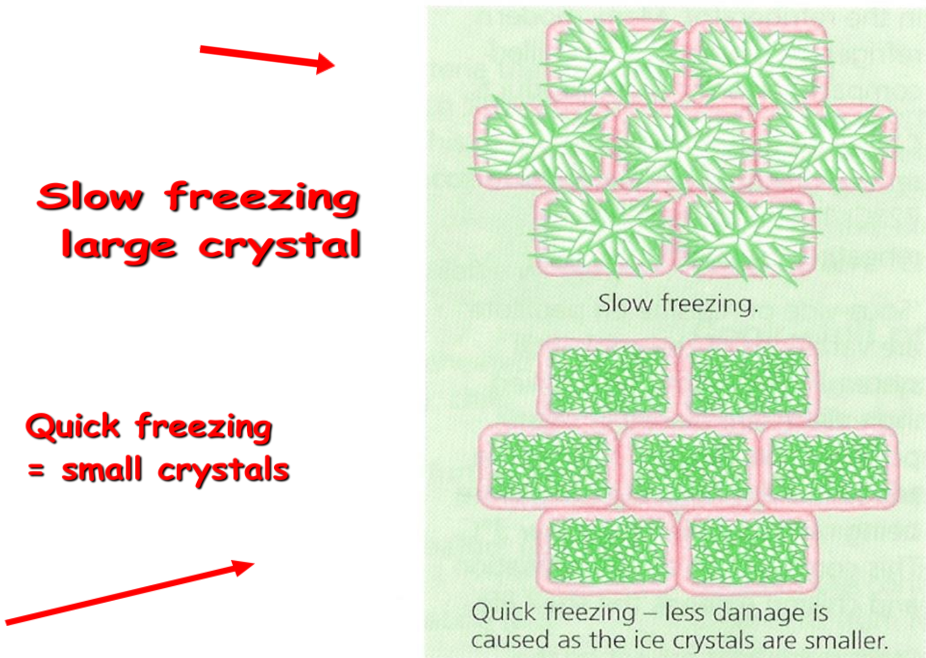

Fig. 6.31 *Cellular damage is caused by large ice crystals*

Freezing methods

1. Air freezing
2. Indirec contact Freezing
3. Immersion freezing
4. Freezing by cryogenic liquids.

Steps of freezing:

1. Harvest & transport.
2. Washing, sorting & grading: grading according to the size, color.
3. Preparation Peeling and cutting.
4. Blanching: Blanching is a process which involves dipping vegetables first into hot water~80c° for few minutes, then in to cold water for a few seconds. This deactivates the enzymes and reduces the number of bacteria present on the surface of the food.

   Blanching lead to:

   a. Inhibition of enzymes.
   b. Killing of some microorganisms.
   c. Maintain the natural color of the vegetable.

 

5. Sulfuring: Small pieces of fruit immersed in sodium meta bisulfate ($Na_2S_2O_5$) for 1 minute that inhibit the enzymes.
6. Cooling the blanched food.
7. Packing: In nylon bags, (some time salt solution or sugar solution added), and labeled.
8. Freezing and storage.

Problems Associated with Freezing

Most of the problems associated with freezing are:

• **Physical damage** due to formation of ice crystals

- **Changes in texture and flavor** caused by increase solute concentration that occurs progressively as liquid water is removed in the form of ice. Both of these effects are minimized by quick freezing methods. Increases in solute concentration can cause changes in pH, denaturation of proteins, all of which may lead to deterioration of food quality.
- **Freezer burn** is the dehydration that may accompany the freezing process.

The surface of food may show white patches and become tough. This occurs due to sublimation of ice. Solid ice will become gas, by passing the liquid phase, The differential of vapor pressure between the food and the atmosphere will lead to turn of ice crystal to gas by sublimation.

- **Oxidation:** May lead to the development of off-flavor fats, as the double bonds of unsaturated fats are oxidized. Fruits and vegetables may brown due to enzymatic oxidative browning if enzymes are not denatured before freezing. Vitamin C (ascorbic acid) may be oxidized.

CALCULATING THE TOTAL PRODUCT LOAD

TO CALCULATE SENSIBLE HEAT Above-freezing temperatures:-

Most products are at a higher temperature than the storage temperature when they are first placed in the refrigerated space. Many food products have a high percentage of water content. Their reaction to a loss of heat is quite different above the freezing point than it is below the freezing point. Above the freezing point, the water continues to exist as liquid. Below the freezing point, it changes to ice.

The *specific heat* of a product is defined, as the amount of heat (Btu) required raising the temperature of 1 lb of the substance 1°F. Note that the specific heat of a product differs depending on whether the temperature is above freezing or below freezing. The freezing point, which in most cases is below 32°F, also varies among products. The heat to be removed from a stored product to lower its temperature to a point above freezing can be calculated as follows:

$Q = W \times C \times (T1 - T2)$

where:

Q = the quantity of heat (Btu) to be removed
W = the weight of the product (lb)
C = the specific heat of the product above freezing
T1 = the initial temperature (OF)
T2 = the final temperature, at or above the freezing point (OF).

For example, assume that you want to calculate the heat that must be removed in order to cool 1,000 lb of veal from 42°F to 29°F. The highest freezing point of veal is 29° F. The specific heat, taken from table is 0.76 Btu/ lb/ºF. Proceed as follows:

Q = 1,000 lb x 0.76 x (42°F -29°F)
= 1 ,000 x 0.76 x 13 = 9,880 Btu

Btu Below-freezing temperatures:

Once the water content of a product has been frozen, sensible cooling occurs again, just as it did when the product was above freezing. Now the ice in the product causes the specific heat to change. For example, the specific heat of veal *above* freezing is 0.76. Its specific heat *below* freezing is 0.41.

The heat to be removed from a stored product to lower its temperature to a point *below* freezing can be calculated as follows:

$Q = W \times C1 \times (T2 - T3)$

where:

Q = the quantity of heat (Btu) to be removed
W = the weight of the product (lb)
C1 = the specific heat of the product below freezing
T2 = the freezing temperature (OF)
T 3 = the final temperature, below the freezing point (OF).

For example, to calculate the heat that must be removed from the same 1,000 lb of veal in order to cool it from its freezing point (29°F) to 0°F, you would proceed as follows:
Q = 1,000lb x 0.41 x (29°F-0°F)
= 1,000 x 0.41 x 29 = 11,890 Btu

CALCULATING THE LATENT HEAT OF FREEZING

Most refrigerated food products contain a high percentage of water. When calculating the amount of heat that must be removed in order to freeze a product, you need to know its water content.

The *latent heat of freezing* (also called the *latent heat of fusion)* is defined as the amount of heat (Btu) that must be removed in order to change 1 lb of a liquid to 1 lb of solid at the same temperature. You can find a product's latent heat of freezing by multiplying the latent heat of water (144 Btu/lb) times the percentage of water in the product. It also shows the latent heat of fusion for veal to be 100 Btu/lb, but you could have arrived at approximately the same figure by calculating as follows:
0.70 x 144 Btu/lb = 100 Btu/lb
To calculate the amount of heat that must be removed from a product in order to freeze it, then, simply proceed as follows:
Q = *W x hf*
where:
Q = the quantity of heat (Btu) to be removed
W = the weight of the product (lb)
hf = the product's latent heat of fusion (Btu/lb).
Therefore, the latent heat of freezing 1,000lb of veal at 29°F is:
Q = *W* x *hf*
= 1,000 lb x 100 Btu/lb = 100,000 Btu

CALCULATING THE TOTAL PRODUCT LOAD

The *total product load* is the sum of the individual calculations just completed. It includes the sensible heat above freezing, the latent heat of freezing, and the sensible heat below freezing. Using the previous calculations as an example, if 1,000 lb of veal is cooled from 42ºF to 0ºF, the total product load would be:
Sensible heat above freezing 9,880 Btu + Latent heat of freezing 100,000 Btu + Sensible heat below freezing 11 ,890 Btu = 121,770 Btu total.

Example: If you have 1000 kg of peas its temperature 10C & it wanted to freeze it to -18C, Calculate the amount of heat which must be remove from it before storing in the storage?

Note: A- The latent heat of peas is 60 Kcal/Kg

B- the specific heat of peas:

1- over -2C is 0.8 Kcal/Kg

2- under -2C is 0.42 Kcal/Kg

Solution:

1- To Calculate Sensible Heat Above-Freezing Temperatures

$Q = W \times C \times (T1 - T2)$

= 1000x0.8x[10-(-2)] » = 1000x0.8x[10+2] » = 1000x0.8x12

= 9600 Kcal

2- To Calculate Sensible Heat Below-Freezing Temperatures

$Q1 = W \times C1 \times (T2 - T3)$

= 1000x0.42x[-2-(-18)] » = 1000x0.42x[-2+18] » = 1000x0.42x16

= 6720 Kcal

3- To calculate (Latent heat) the amount of heat that must be removed from a product in order to freeze it.

$Q2 = W \times hf$

= 1000x60

= 60000 Kcal

To Calculating The Total Product Load

The Total Product Load Would Be:

Sensible heat above freezing + Sensible heat below freezing + Latent heat of freezing

$Q_{total} = Q + Q1 + Q2$

$= 9600 + 6720 + 60000$

$Q_{total} = 76320$ Kcal