FREEZE DRYING

ABOUT THE FREEZE DRYING

Freeze drying is the more important operation commercially and is used to dry expensive foods which have delicate aromas or textures (for example coffee, mushrooms, herbs and spices, fruit juices, meat, seafoods,vegetables and complete meals for military rations or expeditions) for which consumers are willing to pay higher prices for superior quality. In addition, microbial cultures for use in food processing are freeze dried for long-term storage prior to inoculum generation.In freeze drying and freeze concentration a similar preservative effect is achieved by reduction in water activity without heating the food, and as a result nutritional qualities and sensory characteristics are better retained.

THEORY

The first stage of freeze drying is to freeze the food in conventional freezing equipment. Small pieces of food are frozen rapidly to produce small ice crystals and to reduce damage to the cell structure of the food. In liquid foods, slow freezing is used to form an ice crystal lattice, which provides channels for the movement of water vapour. The next stage is to remove water during subsequent drying and hence dry the food.

If the water vapour pressure of a food is held below 4.58 Torr (610.5 Pa) and the water is frozen, when the food is heated the solid ice sublimes directly to vapour without melting. The water vapour is continuously removed from the food by keeping the pressure in the freeze drier cabinet below the vapour pressure at the surface of the ice, removing vapour with a vacuum pump and condensing it on refrigeration coils. As drying proceeds a sublimation front moves into the frozen food, leaving partly dried food behind it.

The heat needed to drive the sublimation front (the latent heat of sublimation) is either conducted through the food or produced in the food by microwaves .Water vapour travels out of the food through channels formed by the sublimed ice and is removed. Foods are dried in two stages: first by sublimation to approximately 15% moisture content and then by evaporative drying (desorption) of unfrozen water to 2% moisture content. Desorption is achieved by raising the temperature in the drier to near ambient temperature whilst retaining the low pressure.In some liquid foods (for example fruit juices and concentrated coffee extract), the formation of a glassy vitreous state on freezing causes difficulties in vapour transfer.Therefore the liquid is either frozen as a foam (vacuum puff freeze drying), or the juice is dried together with the pulp. Both methods produce channels through the food for the vapour to escape. In a third method, frozen juice is ground to produce granules, which both dry faster and allow better control over the particle size of the dried food.

The rate of drying depends mostly on the resistance of the food to heat transfer and to a lesser extent on the resistances to vapour flow (mass transfer) from the sublimation front.

DIFFERENCES BETWEEN CONVENTIONAL DRYING AND FREEZE DRYING

CONVENTIONAL DRYING

1.Successful for easily dried foods (vegetables and grains

2.Meat generally unsatisfactory Successful with cooked and raw meats

3.Temperature range 37–93°C

4.Atmospheric pressures

5.Evaporation of water from surface of food

6.Movement of solutes and sometimes case hardening

7.Stresses in solid foods cause structural damage and shrinkage

8.Slow, incomplete rehydration Rapid complete rehydration

9.Higher density than the original food

10.Odour and flavour frequently abnormal Odour and flavour usually normal

11.Reduced nutritional value Nutrients largely retained

FREEZE DRYING

1.Successful for most foods but limited to those that are difficult to dry by other methods

2.Meat generally unsatisfactory Successful with cooked and raw meats

3.Temperatures below freezing point

4.Reduced pressures (27–133 Pa)

5.Sublimation of water from ice front

6.Minimal solute movement

7.Minimal structural changes or shrinkage

8.Solid or porous dried particles often having a

9.Porous dried particles having a lower density than original food

10.Colour frequently darker Colour usually normal

11.Costs generally low Costs generally high, up to four times those of conventional drying