Drying and Food Preservation

The preservation of foods by drying is the time-honored and most common method used by humans and the food processing industry. Dehydration (or drying) is defined as 'the application of heat under controlled conditions to remove the majority of the water normally present in a food by evaporation' (or in the case of freeze drying by sublimation). This definition excludes other unit operations which remove water from foods (for example mechanical separations and membrane concentration , evaporation and baking as these normally remove much less water than dehydration.

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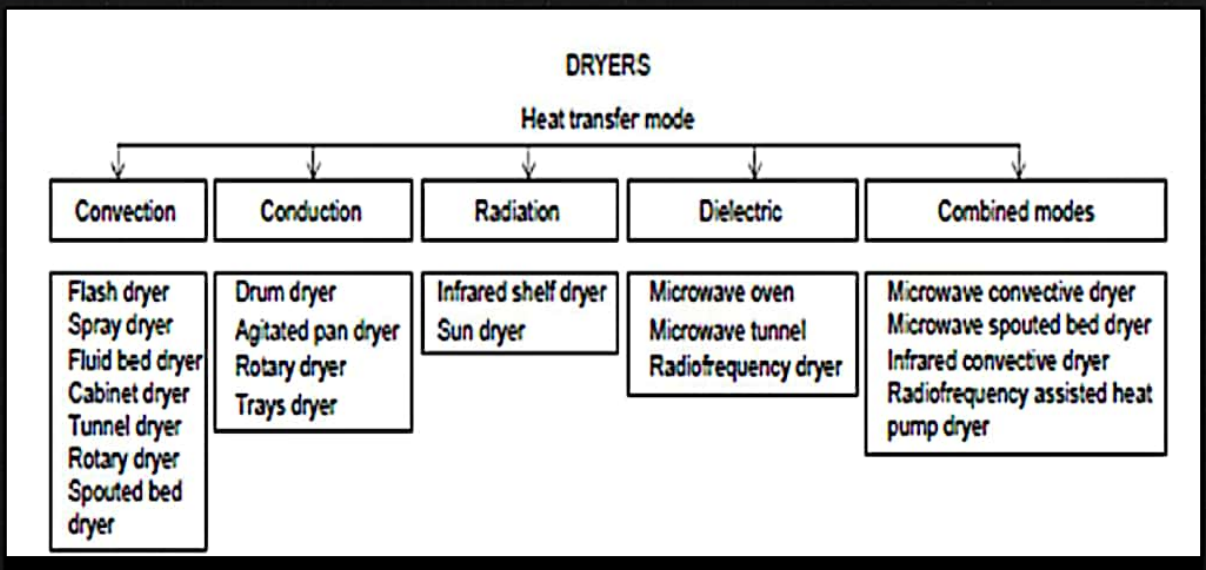
Drying methods



Classification of dryers according to heat mode transfer

Sun Drying

Sun drying tomatoes

Disadvantages:

-Contaminations from the environment

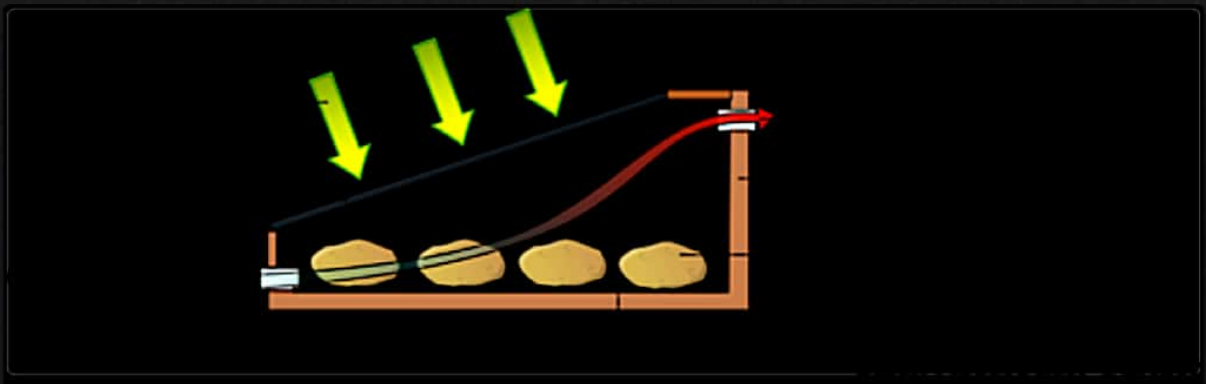
-Product losses and contaminations by insects and birds

-Floor space requirements

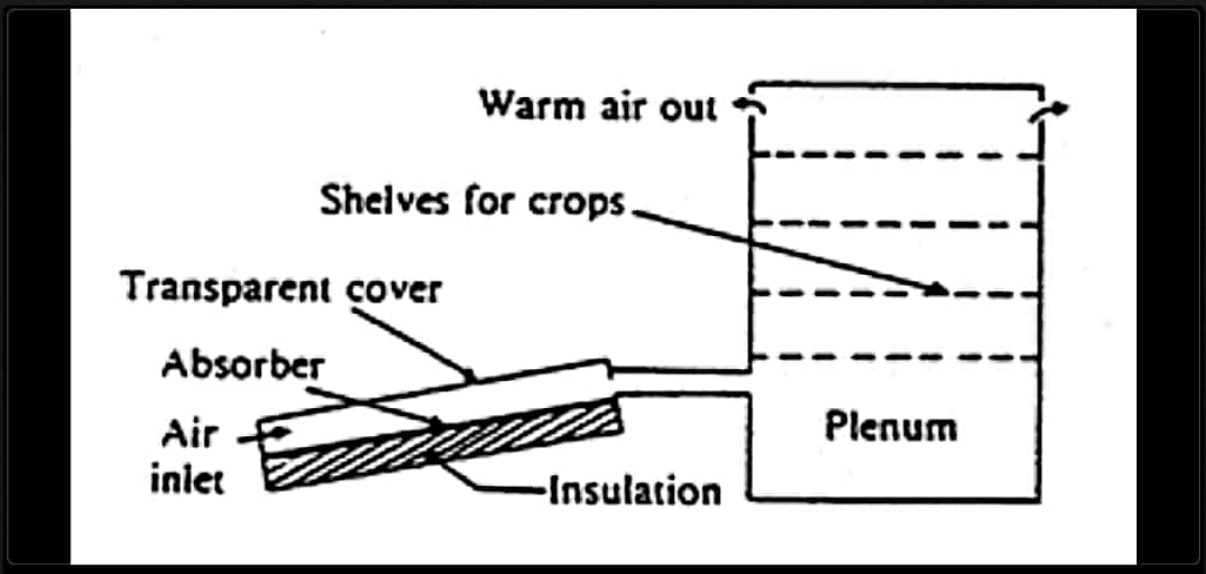
-Difficulty in controlling the process

-Inconsistent sensory quality

Solar Drying



Direct solar dryer



Indirect Solar Dryer

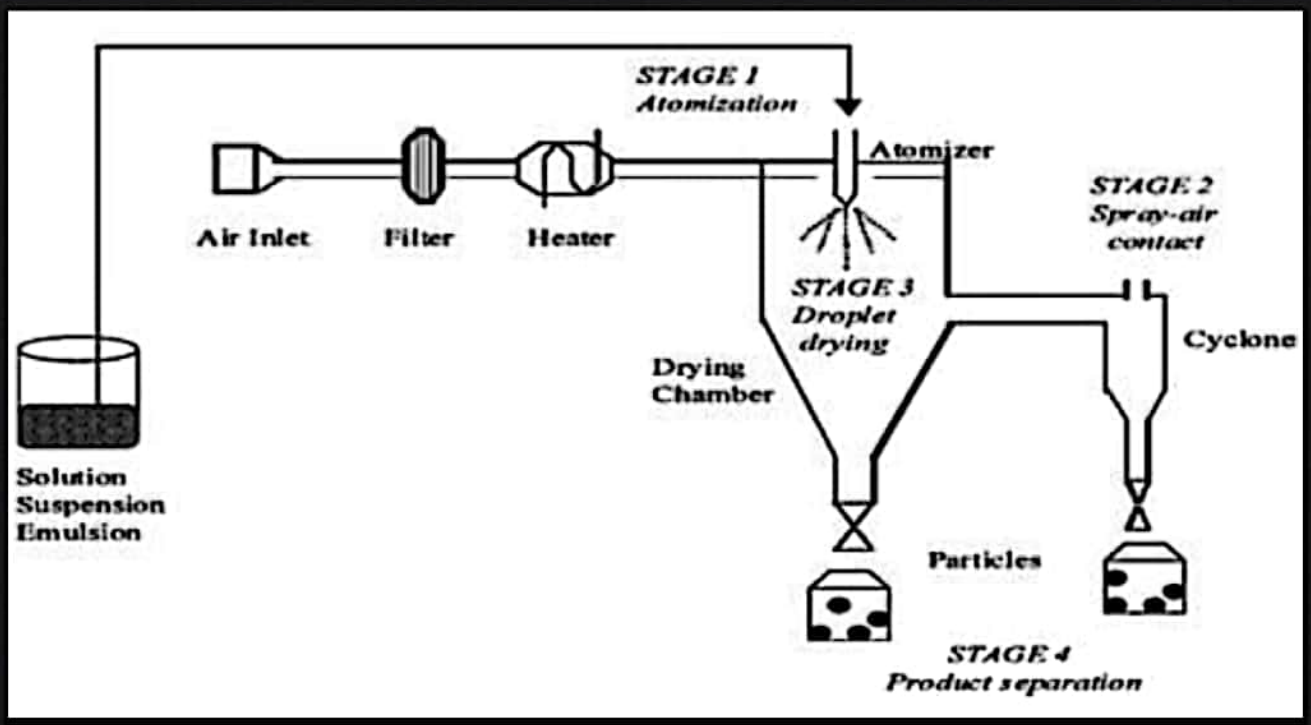
-Direct solar dryer

Direct solar dryers expose the substance to be dehydrated to direct sunlight.

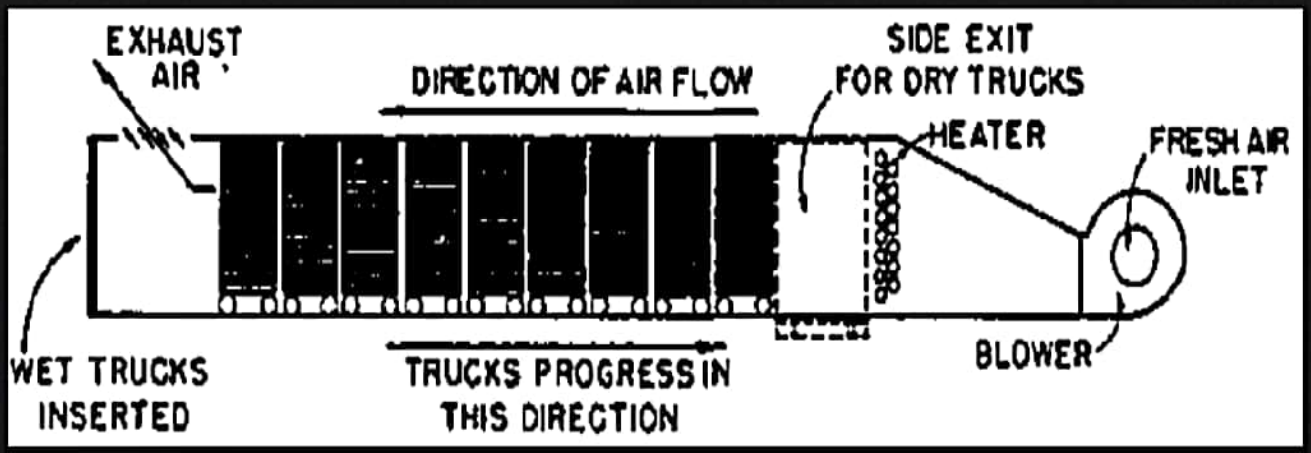
-Indirect solar dryer

Indirect driers are constructed so the sun shines upon a solar collector (a shallow box, the insides painted black, topped with a pane of glass) heating air which then moves upward through a stack of four to six trays loaded with produce.

Hot-air dryers



Spray dryer



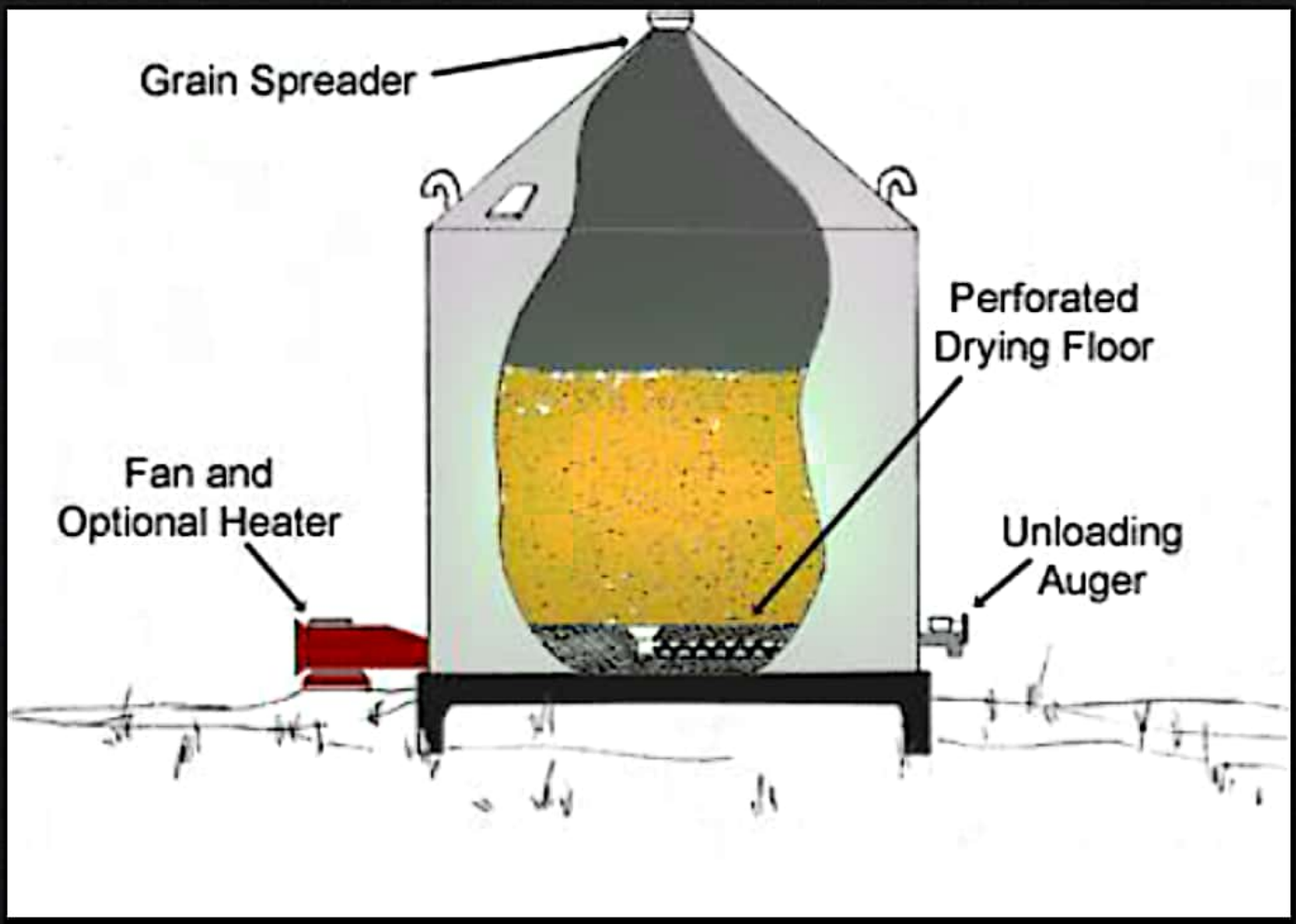
Tunnel dryer

-Spray dryer

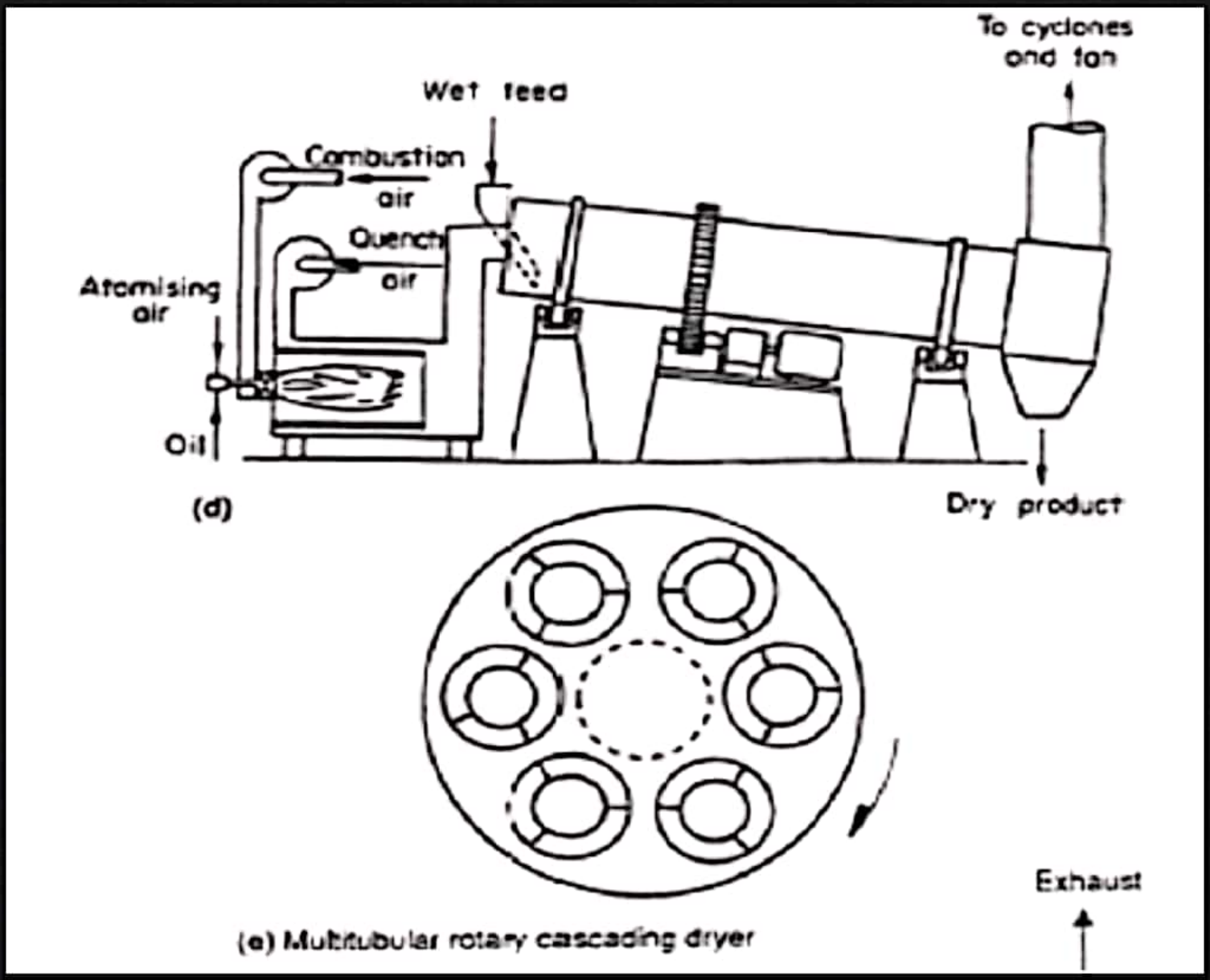
A fine dispersion of pre-concentrated food (40–60% moisture) is first 'atomized' to form fine droplets and then sprayed into a co- or counter-current flow of heated air at 150–300°C in a large drying chamber.

-Tunnel dryer

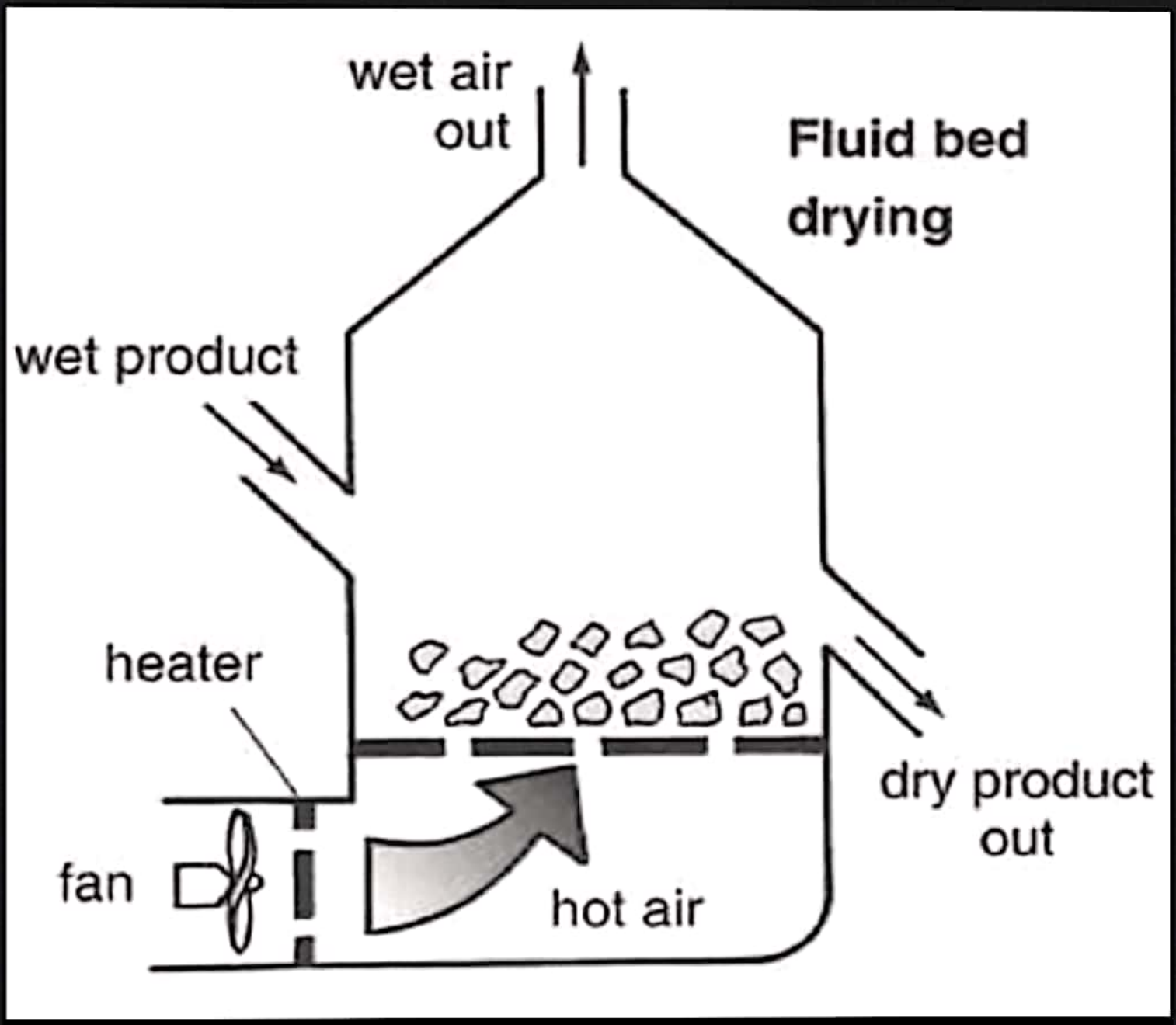
Layers of food are dried on trays, which are stacked on trucks programmed to move semi continuously through an insulated tunnel. Able to dry large quantities of food in a relatively short time However, the method has now been largely superseded by conveyor drying and fluidized bed drying as a result of their higher energy efficiency, reduced labor costs and better product quality.



Bin dryer



Rotary dryer



Fluidised-bed dryer

-Bin dryer

Bin dryers are large, cylindrical or rectangular containers fitted with a mesh base. Hot air passes up through a bed of food at relatively low velocities

-Rotary dryer

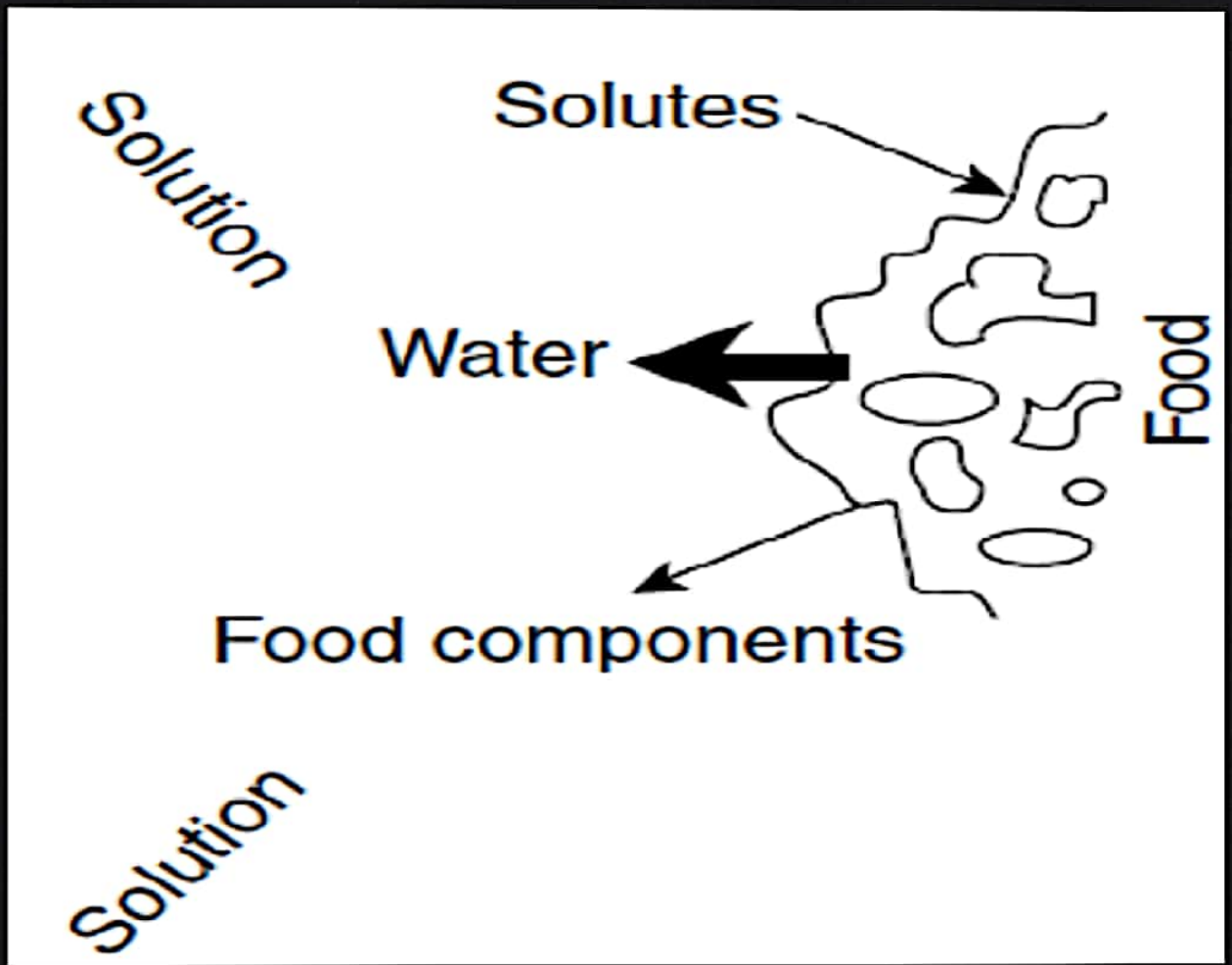
The food stuff is contained in a horizontal cylinder through which it travels. Heated either by air flow through the cylinder or by conduction of heat from the cylinder walls.

-Fluidised-bed dryer

Warm air is blown upwards directly underneath the food, causing it to flow and remain separated. This procedure is suitable for small items.

Osmotic Dehydration

This dehydration process generally does not produce a product of low moisture content that can be considered shelf stable. Need further processing (generally by air, freeze-, or vacuum-drying methods) to obtain a shelf-stable product, or the dehydration process could be used as a pretreatment for canning, freezing, and minimal processing. Osmotic dehydration is the process of water removal by immersion of water-containing cellular solid in a concentrated aqueous solution.

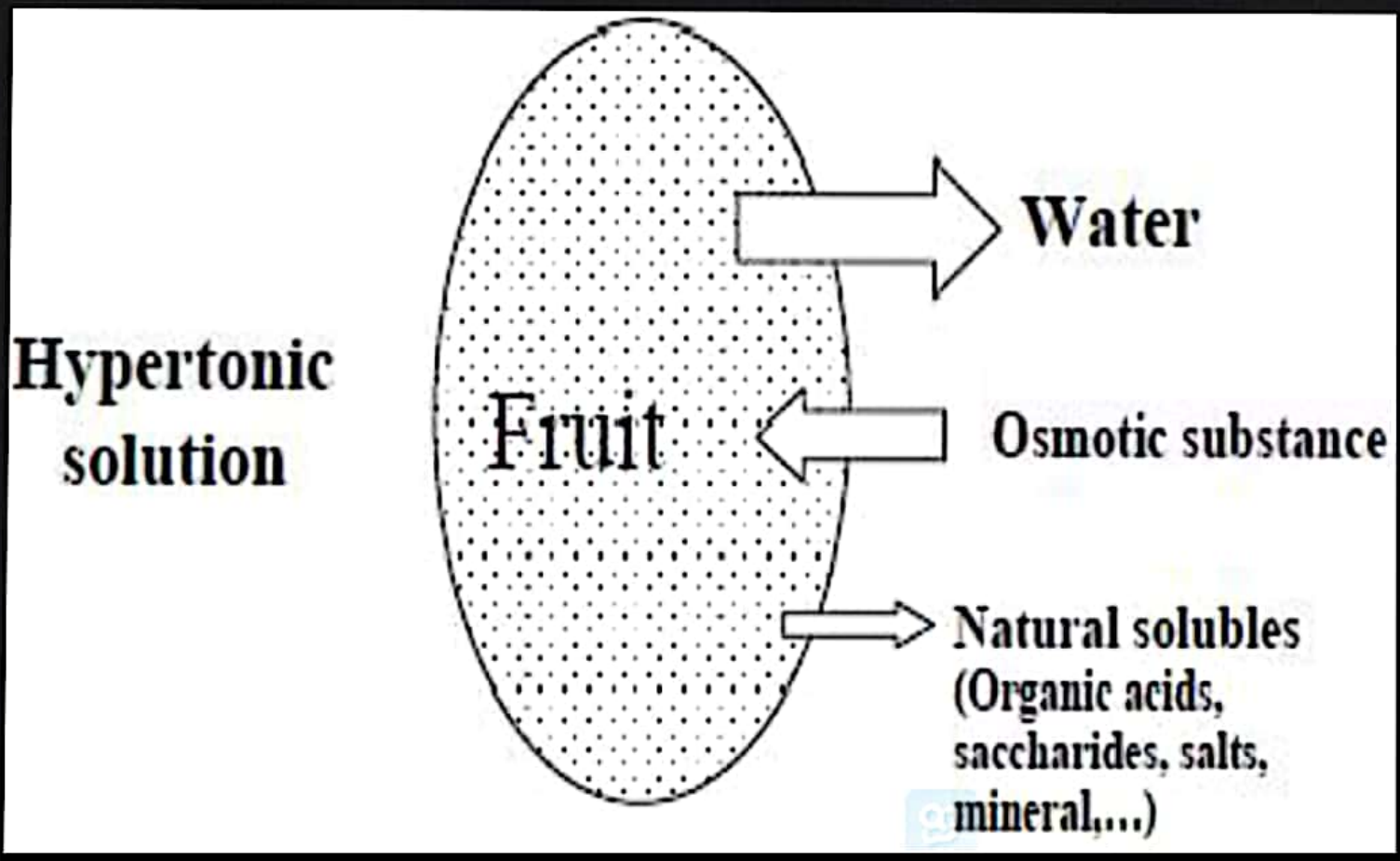


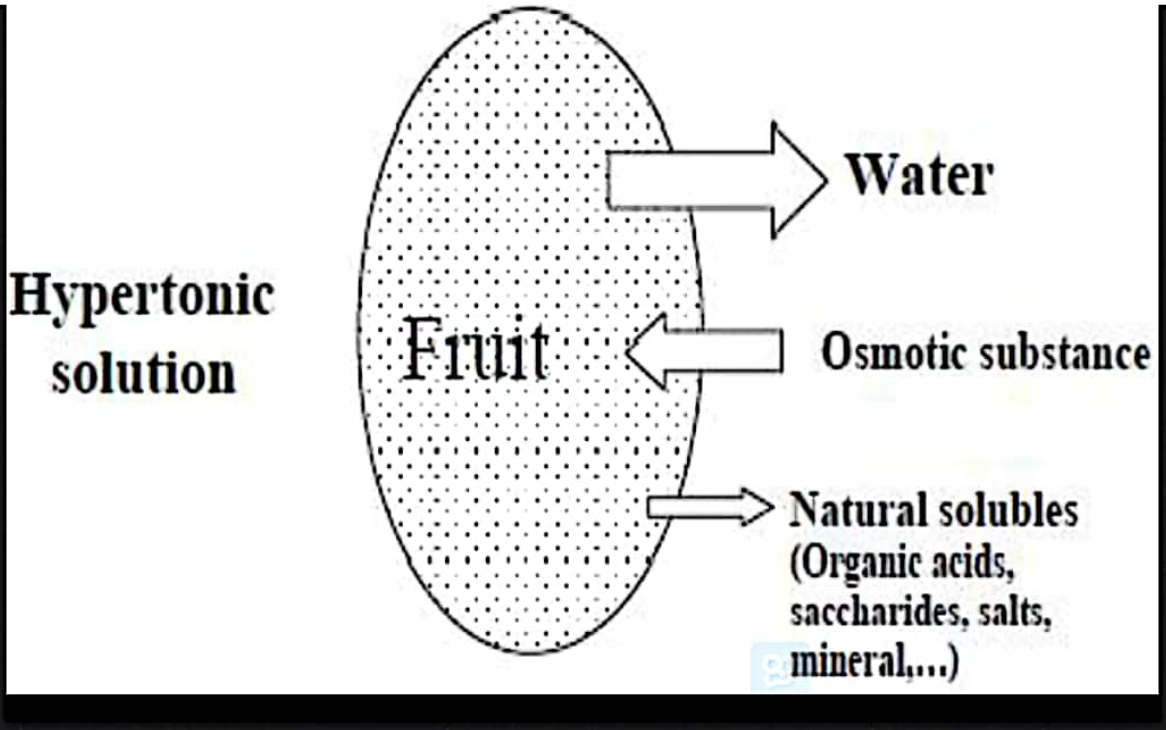
Water and solutes transfer in osmotic process

The driving force for water removal is the concentration gradient between the solution and the intracellular fluid. The removal of water during osmotic process is mainly by diffusion and capillary flow, whereas solute uptake or leaching is only by diffusion.

The osmotic dehydration process:

- dynamic period (mass transfer rates increased or decreased until equilibrium is reached).
- equilibrium period (equilibrium is the end point of osmotic process, i.e., net rate of mass transport is zero).





Problems in Applying the Osmotic Dehydration Process in the Food Industry

Product Sensory Quality

•Salty products when uses salt.

•Sweet products when uses sugar.

•Loss of acidity.

•Controlling solute diffusion and optimised process may be useful to overcome this problem

Syrup Management for long application and reuse of syrup.

- syrup recycling
- solute addition
- syrup composition and concentration
- reuse of syrup
- syrup disposal

Smoking

One of the most ancient food preservation processes, and in some communities one of the most important. The use of wood smoke to preserve foods is nearly as old as open-air drying. The heat associated with the generation of smoke also causes a drying effect. Smoking has been mainly used with meat and fish.

The main purposes of smoking are:
-It imparts desirable flavours and colours to the foods.
-Some of the compounds formed during smoking have a preservative effect (bactericidal and antioxidant) due to the presence of a number of compounds.

In many cases, smoking is considered as a pre-treatment rather than a drying process.
-Smoke is effective in preventing lipid oxidation in meat and fish products.
-Smoke contains phenolic compounds, acids, and carbonyls, and the smoky flavour is primarily due to the volatile phenolic compounds.
-Wood smoke is extremely complex and more than 400 volatiles have been identified.

-Wood smoke contains nitrogen oxides which are responsible for the characteristic colour of smoked foods, whereas polycyclic aromatic hydrocarbon components and phenolic compounds contribute to its unique taste. These three chemicals are also most controversial from a health perspective.

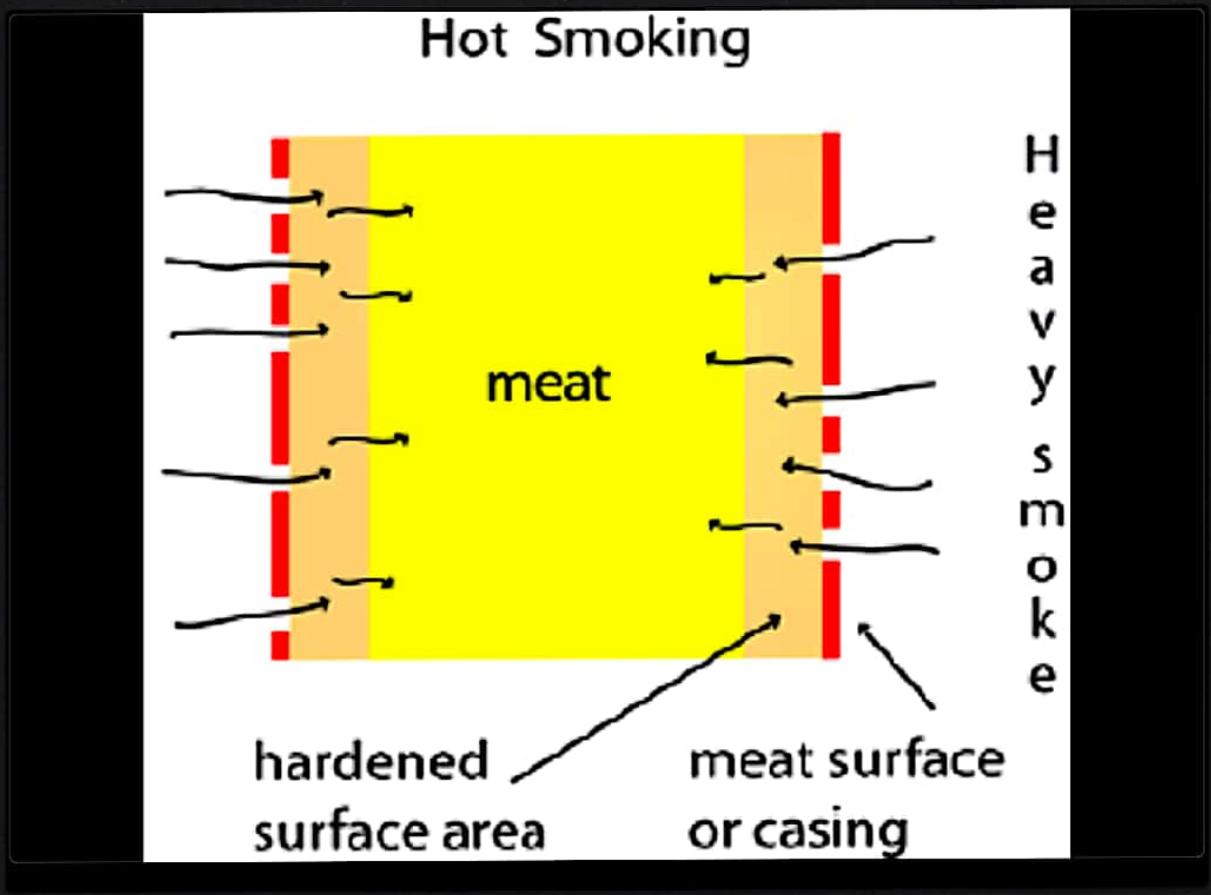
Hot and Cold Smoke

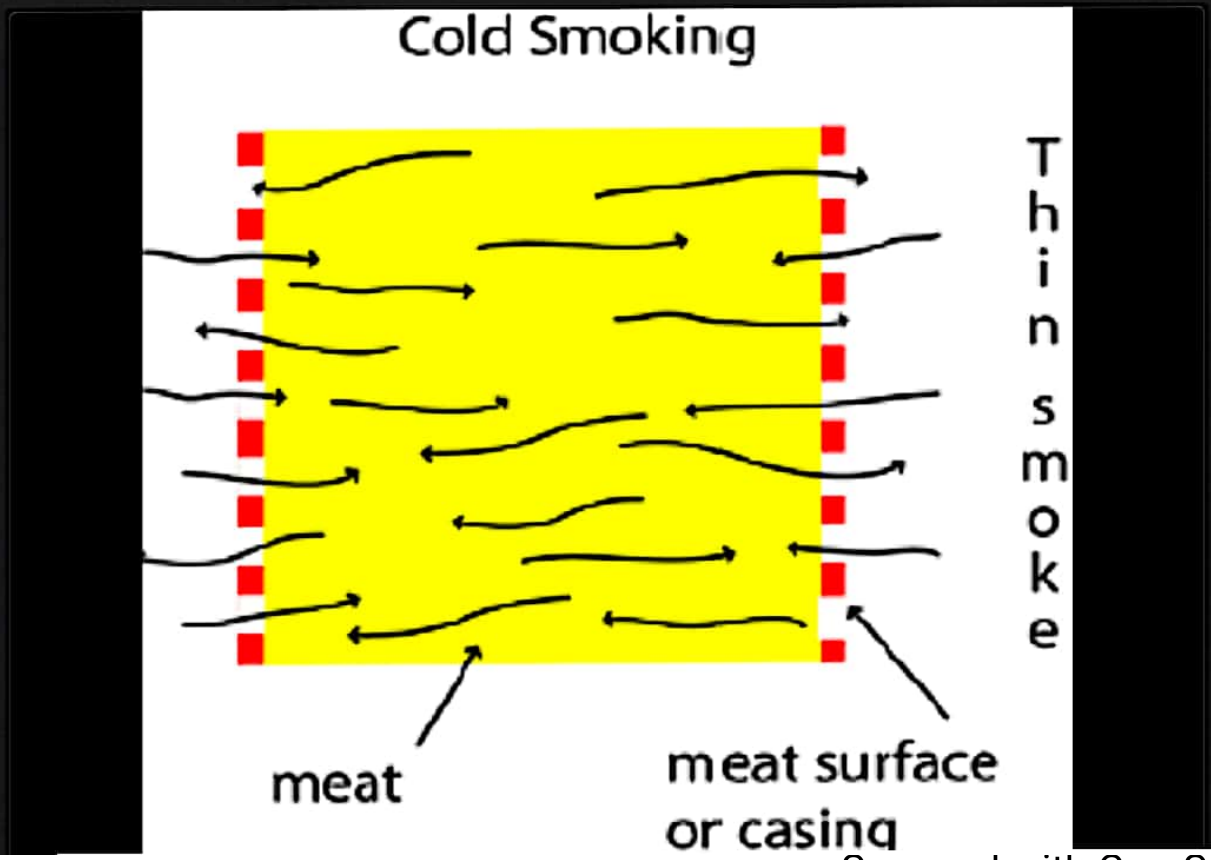
Hot smoking: cooks the product

- Heat and smoke is applied.
- Internal temperature <62.8oC for at least 30 min.
- At least 3.5% salt in water-phase of muscle.

Cold smoking: does not cook the product

- Smoke is applied.
- Internal temperature <35oC.
- At least 3.5% salt in water-phase of muscle.





Drying Pretreatments

To prevent increasing of microbial loads

To accelerate drying process

To improve quality of the food

-Blanching

-Sulfur Dioxide Treatment

-Salting or Curing

-Other Dipping Pretreatments

-Freezing Pretreatment

-Cooking

Microbial	Chemical	Physical	Nutritional
Pathogens	Browning	Rehydration	Vitamin loss
Spoiling	Oxidation	Solubility	Protein loss
Toxin	Color loss	Texture	Functionality loss
	Aroma development	Aroma loss	Fatty acid loss
	Removal of undesired components	Porosity	
		Shrinkage	
		Pores' characteristics	
		Crust formation	
		Structure	

Quality change during drying