LECTURE 5

PRACTICAL TECHNOLOGY

(Chapters 8-12)

PRACTICAL TECHNOLOGY

1 HEAT PRESERVATION AND PROCESSING

2 COLD PRESERVATION AND PROCESSING

3 FOOD DEHYDRATION AND CONCENTRATION

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

5 FERMENTATION PROCESS

1 HEAT PRESERVATION AND PROCESSING(Ch.8)

- Heat preservation of food refers to controlled processes that are performed commercially, such as blanching, pasteurizing, and canning.

1 HEAT PRESERVATION AND PROCESSING

Degrees of preservation:

Sterilization – Refers to complete destruction of microorganisms. This frequently requires a treatment of at least 121°C of wet heat for 15 min or its equivalent.

Commercially sterile – Degree of sterilization at which all pathogenic and toxin forming organisms have been destroyed as well as all other types of organisms which could grow in the product and produce spoilage under normal handling and storage conditions. They may contain a small number of heat resistant bacterial spores but these will not normally multiply in the food supply (most canned and bottled food products)

1 HEAT PRESERVATION AND PROCESSING

Pasteurization – Involves a comparatively low order of heat treatment, generally at temperature below the boiling point of water. These processes are specifically designed to destroy pathogenic microorganisms and to extend product shelf-life from a microbial and enzymatic point of view.

Blanching - A kind of pasteurization generally applied to fruits and vegetables primarily to inactivate natural food enzymes. This is common practice when such products are to be frozen. Depending on its severity, blanching also destroys some microorganisms.

1 HEAT PRESERVATION AND PROCESSING

However, heat sufficient to destroy microorganisms and food enzymes also affects other properties of foods negatively, therefore there is need for “optimisation”. For choosing optimal heat treatment parameters, the following points should be evaluated:

- Time-temperature combinations required to inactivate the most heat-resistant pathogen and spoilage organisms in a particular food(the most heat-resistant pathogen in canned foods is *Clostridium botulinum).*

0.78 minutes at 127C=10 minutes at 116C=36minutes at 110C

- Heat penetration characteristics in a particular food, including the can or the container if it is packaged.

1 HEAT PRESERVATION AND PROCESSING

2 Alternative Techniques involved:

1. Heating food in containers(Fig.8.8-12):

✓Still or agitating retorts

✓Hydrostatic cooker or coolers

✓Direct flame sterilization

✓In-package pasteurization

2. Heating food prior to packaging:

High Temperature Short Time (HTST) pasteurization followed by "asceptic packaging"(Hot pack or Hot fill)

2 COLD PRESERVATION AND PROCESSING(Ch.9)

- Cool storage generally refers to storage at temperatures above freezing, from about 16°C down to -2°C.
- Commercial and household refrigerators are usually operated at 4 -7°C.
- Most foods will not begin to freeze until about -2°C or lower.
- Frozen storage refers to storage at temperatures that maintain food in frozen condition.
- Good frozen storage generally requires temperatures of -18°C or below.

2 COLD PRESERVATION AND PROCESSING(Fig. 9.1)

60°C – 51,7°C	Many bacteria survive and some may grow
37°C	Body temp. ideal for bacterial growth
37°C – 15,6°C	Temp. in this zone allow rapid growth of bacteria and production of toxins by some bacteria
15,6°C – 4,4°C	Bacteria causing foodborne illness may grow
4,4°C – 0°C	Refrigerated temp. permit slow growth of bacteria
0°C – -17,8°C	Freezing temp. stop the growth of bacteria but allow many to survive.

2 COLD PRESERVATION AND PROCESSING

The principal requirements for effective refrigerated storage are:

- ✓Controlled low temperature
- ✓Air circulation
- ✓Humidity control
- ✓Modification of gas atmospheres

Storage requirements and properties of perishable foods

Commodity	Storage temp (°C)	RH%	Storage life	Water %
Bread	-18	-	Several week	32-37
Skim milk (dried)	4-5	-	Several months	-
Egg (shell)	-1	85-90	8-9 months	67
Fish fresh	0,5-4,5	90-95	5-20 days	62-85
Fish frozen	-18- (-23)	90-95	8-10 months	62-85
Beef, fresh	0,5-1,0	88-92	1-6 weeks	62-77
Meat frozen	-18- (-23)	90-95	9-12 months	-
Oil(vegetabe salad)	1,5	-	1 year	0
Tomatoes	12-25	85-90	2-5 weeks	94,7

2 COLD PRESERVATION AND PROCESSING

There are three basic freezing metods in commercial use(Fig. 9.4-10):

- Freezing in air
- Freezing by indirect contact with a refrigerant
- Freezing by direct immersion in a refrigerating medium: Immersion freezing is done with cryogenic liquids: (liquid nitrogen and liquid carbon dioxide -196°C and -79°C)

3 FOOD DEHYDRATION AND CONCENTRATION(Ch.10)

- Food dehydration refers to the nearly complete removal water from foods by dring under artifical and controlled conditions that cause minimum or ideally no other changes in the food properties (Dried milk and eggs, potato flakes, instant coffee etc.)
- Processes that remove only part of the water from foods (preparation of syrups, evaporated milk, condensed soups) are **not** considered "food dehydration" but are called "concentration"
- (Fig. 10.7-22)

3 FOOD DEHYDRATION AND CONCENTRATION

Reasons of dehydration:

✓Preservation

✓Retaining size and shape

✓Production of convenience items

In food dehydration, every effort should be made to speed heat and mass transfer rates. The following criteria have to be optimized for this aim:

3 FOOD DEHYDRATION AND CONCENTRATION

Surface area: Food to be dehydrated is subdivided into small pieces or thin layers to speed heat and mass transfer

Temperature: The greater the temperature difference between the heating medium and the food the greater will be the rate of heat tansfer into the food.

Air-velocity: Air in motion sweeps moisture away from the drying food's surface, preventing the creation of saturated atmosphere.

Humidity: When air is the drying medium, the drier the air, the more rapid is the rate of drying. Moist air is closer to saturation so absorbs less additional moisture.

3 FOOD DEHYDRATION AND CONCENTRATION

Atmospheric pressure and vacuum: At a pressure of 1 atm, water boils at 100°C. As the pressure is lowered, the boiling temperature decreases. Lower drying temperatures and shorter drying times are important in the case of heat-sensitive foods.

Time and temperature: With few exceptions, drying processes that employ high temperatures for short times do less damage to food than drying processes employing lower temperatures for longer times.

3 FOOD DEHYDRATION AND CONCENTRATION

- Concentration can be a form of dehydrating or a preliminary step in food drying but only for some foods.
- Concentration reduces weight and volume and results in immediate economic advantages.
- Nearly all liquid foods to be dehydrated are concentrated before they are dried because in the early stages of water removal , moisture can be more economically removed in highly efficient evaporators than in dehydration equipment.

3 FOOD DEHYDRATION AND CONCENTRATION

The more common concentrated foods include:

- Evaporated and sweetened condensed milk
- Fruit and vegetable juices and nectars
- Sugar syrups and flavored syrups
- Jams and jellies
- Tomato paste
- Fruit purees

3 FOOD DEHYDRATION AND CONCENTRATION

Methods of concentration:

- ✓Solar concentration
- ✓Open kettles
- ✓Flash evaporators
- ✓Thin-film evaporators
- ✓Vacuum evaporators
- ✓Freeze concentration
- ✓Ultrafiltration and reverse-osmosis devices

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS(Ch. 11)

- Food irradiation is used primarily as a preservation method.
- Microwave energy, on the other hand, is being employed especially to produce rapid and unique heating effects, one application of which can be food preservation.
- Ohmic heating is the newest and least used of the three technologies. Ohmic heating can preserve foods by the application of heat and has the ability to very rapidly heat foods with minimal destruction.

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

In 1983 the FDA (Food And Drug Administration) approved irradiation as means of controlling microorganisms on spices.

In 1985 FDA widened the allowed uses of irradiation to additional foodssuch as strawberry, poultry, ground beef, and pork.

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Irradiation is used for three purposes:

- Control insects in food such as pices, fruits and vegetables (as an alternative to chemical fumigation)
- Inhibit sprouting or other self-generating mechanisms of deterioration
- Destroy vegetative cells of microorganisms

✓Increase in safety and shelf-life

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Ultraviolet light – especially within the wavelength range of 200-280 nm, is employed to inactivate microorganisms on the surface of foods. It has low degree of penetration. Treatment of equipment surfaces, water and air used in food plants are additional applications.

X-rays - have greater penetrating power than UV light. But they cannot easily be focused leading to low efficiency of use with current equipment. Applications have been experimental rather than commercial.

Alfa, beta and gamma rays are also used

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Dose determining factors:

- ✓Safety and wholesomeness of treated food
- ✓Resistance of food to organoleptic quality damage
- ✓Resistance of microorganisms
- ✓Resistance of food enzymes
- ✓Cost

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Microwave energy in food applications is used for its heating properties.

When microwaves pass into foods, water molecules and other polar molecules tend to align themselves with the electric field. The electric field reverses 915 or 2450 million times per second generating intermolecular friction, which quickly causes the food to heat.

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Microwave food applications:

- Baking
- Concentrating
- Cooking
- Curing
- Drying
- Blanching
- Finish-drying
- Freeze-drying
- Heating
- Pasteurizing
- Precooking
- Puffing and foaming
- Solvent removal
- Sterilizing
- Tempering
- Thawing

4 IRRADIATION, MICROWAVE AND OHMIC PROCESSING OF FOODS

Ohmic heating:

Considerable heat is generated when an alternating electric current is passed through a conducting solution such as a salt brine.

Products in a conducting solution are continuously passed between these electrodes, each of which raises the temperature.

The solid pieces and the liquid are heated nearly simultaneously.

5 FERMENTATION PROCESS(Ch. 12)

Fermentations occur when microorganisms break down food macro-components (i.e. Carbohydrates like sugars) into new products (i.e. alcohol, CO_2, lactic acid). It encourages the multiplication of microorganisms and the production of their products of metabolic activities in foods.

But only selected microorganisms are encouraged, since while their metabolic activities and end products are highly desirable, there are others which produce undesirable and toxic metabolites.

5 FERMENTATION PROCESS

Some industrial fermentations in food industries:

Lactic acid bacteria:

Cucumbers – dill pickles, sour pickles

Olives – green olives, ripe olives

Vegetable and milk – tarhana

Meats – sausages such as salami

Milk – yoghurt, cheese

Lactic acid bacteria with other microorganisms:

Dairy products with mould –Cheeses(I.e. roquefort, camambert)

Dairy products with yeast – kefir

Vegetable products with mould – soya sauce

Acetic acid bacteria: Wine, cider, malt, honey, vinegar

Yeasts: Beer, wine, brandy, whiskey, bread etc.

5 FERMENTATION PROCESS

The term fermentation refers to breakdown of carbohydrate and carbohydrate-like materials under either aerobic or anaerobic conditions. In wine, beer and bread fermentations, the yeasts ferment glucose :

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH+2CO_2$$

Lactose ⟶ lactic acid *Streptococcus lactis*

Under anaerobic conditions - true fermentation.

Ethyl alcohol ⟶ acetic acid *Acetobacter aceti*

Under aerobic conditions – oxidation rather than fermentation

5 FERMENTATION PROCESS

In addition to providing variety to the diet , fermentation also aids in preservation of foods since end products of acids and alcohols are inhibitory to the common pathogenic microorganisms

Factors for controlling fermentation:

- ✓Acid
- ✓Alcohol
- ✓Use of starters
- ✓Temperature
- ✓Level of oxygen
- ✓Amount of Salt