



**COURSE TITLE: FOOD AND INDUSTRIAL MICROBIOLOGY**  
**COURSE NO. - DTM-321: CREDIT HRS-3 (2+1)**



**PHYSICAL METHODS - THERMAL PROCESSING**

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# Preservation of Food

Preservation is a method of giving some additional treatment to different food items to stop or slow down the food spoilages, maintain quality, edibility, nutritional value and improving shelf-life of products. Preservation usually restricts the growth of bacteria and fungi responsible for creating various kind of deterioration problems in foods.

For thousands of years, humans have used methods of preserving food, so that they can store food to eat later.

- Preservation of food prevents the food from being spoiled by the action of enzymes and microorganisms.
- Preservation of food increases the safe storage period of foodstuffs.
- It increases the availability of out of season foods (Fruits and Vegetables).
- It increases the availability of various foodstuffs even at distant and not easily approachable places.

# METHODS OF FOOD PRESERVATION

## TRADITIONAL METHODS

- Drying
- Cooling
- Freezing
- Boiling
- Heating
- Salting
- Sugaring
- Smoking
- Pickling
- Canning
- Burial



## INDUSTRIAL MODERN METHODS

- Pasteurization
- Vacuum packing
- Artificial food additives
- Irradiation
- Pulsed electric field electroporation
- Modified atmosphere
- Non thermal plasma
- High-pressure food preservation
- Bio preservation
- Hurdle technology



## **THERMAL**

- Ohmic heating
- Microwave heating
- Radiofrequency heating
- Infrared heating
- Inductive heating

## **NON-THERMAL**

- High pressure processing
- Pulsed electrified field
- Ultrasound
- High intensity light
- Pulsed X-rays
- Gamma radiation
- MAP
- Membrane technology

**Recently Developed Thermal and non Thermal Methods**

# Drying

Drying (dehydrating) food is one of the oldest method of food preservation.

Dehydration is the process of removing water or moisture from a food product. Removing moisture in Dehydrated foods are ideal for packing, transportation and storage because they weigh much less than their non-dried form of food and do not require refrigeration. Drying food is also a way of preserving seasonal foods for later use.

How dehydration preserves foods



Foods can be spoiled by food microorganisms or through enzymatic reactions within the food.

Bacteria, yeast and molds require sufficient amount of moisture in food for their growth and thus causing spoilage problem. Reducing the moisture content of food restricts the growth of spoilage-causing microorganisms and slower down enzymatic reactions within the food. The combine effect of this helps to prevent spoilage in dried food.



## Dehydration / Sun drying is a Good Method of Food Preservation

- Not Required Electricity.
- Less Time Consuming.
- Makes Winter Meals Easier.
- Requires Less Storage Space.
- Easy to handle.



### Solar Drying

- It is differentiated from sun drying by the use of instruments / equipment to collect the sun's radiation in order to use radiative energy for drying applications.
- The use of solar drier traps the freely available sun energy ensuring good product quality



## Technology Outlook

- Heat
- Steam
- Radiation
- Chemical
- Filtration
- Others

# Thermal Preservation / Processing of Foods

- Refers to controlled processes that are performed commercially

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- Blanching
- Pasteurizing
- Commercial Sterilization



Increasing  
severity of  
the process

- Inactivate disease and spoilage causing microorganisms

- Inactivate enzymes in food that can cause spoilage

# Blanching



Hot water blanching



Steam blancher

The factors which influence blanching time are:

- type of fruit or vegetable
- size of the pieces of food
- blanching temperature
- method of heating.

Blanching is a process used prior to freezing, canning or drying in which fruits or vegetables are heated for **inactivating natural / endogenous enzymes, improving texture, maintaining color, flavor, nutritional value and removing entrapped air**. So, blanching serves a variety of functions -- the main function is to destroy enzymatic activity in vegetables and some fruits before main thermal processing. **Peroxidase and catalase** are the most heat resistant enzymes and the activity of these enzymes indicates the effectiveness of a blanching treatment. If both are inactivated then it is assumed that other enzymes must be inactivated. It is not a method of preservation but it is a pre-treatment normally given in between the preparation of the raw material and processing treatment (sterilization, dehydration and freezing). Blanching is also combined with peeling and / or cleaning of food to achieve savings in energy, space requirement and equipment costs.

# Pasteurization

The pasteurization of milk is achieved by heating as follows:

145°F (63°C) for 30 minutes (low temperature long time [LTLT])

1610F (72°C) for 15 seconds (primary high temperature short time [HTST] method)

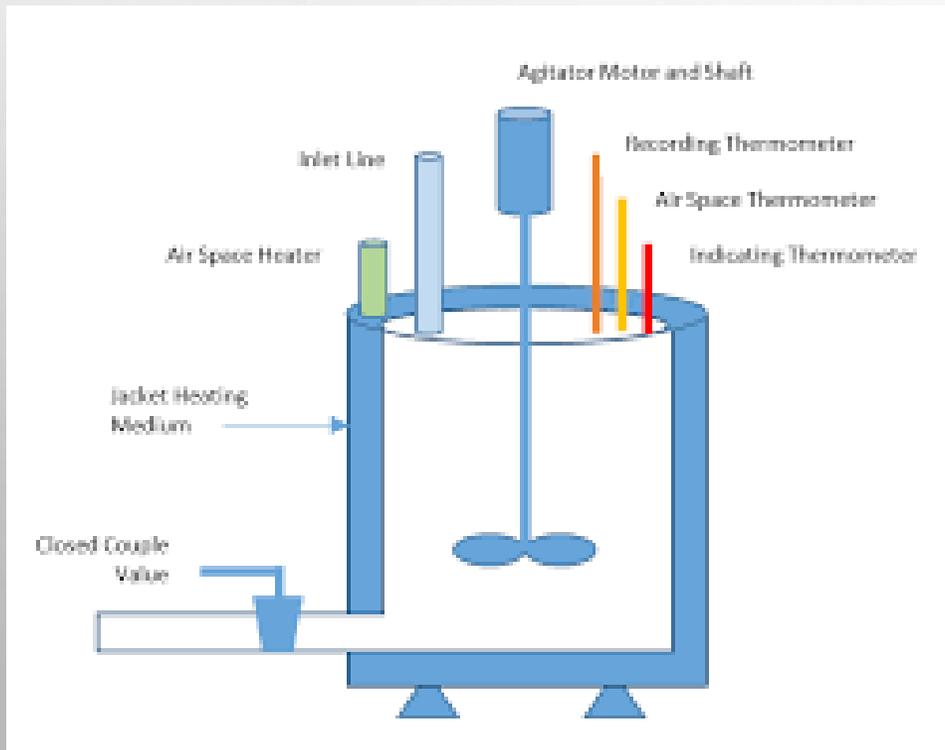
191°F(89°C) for 1.0 second

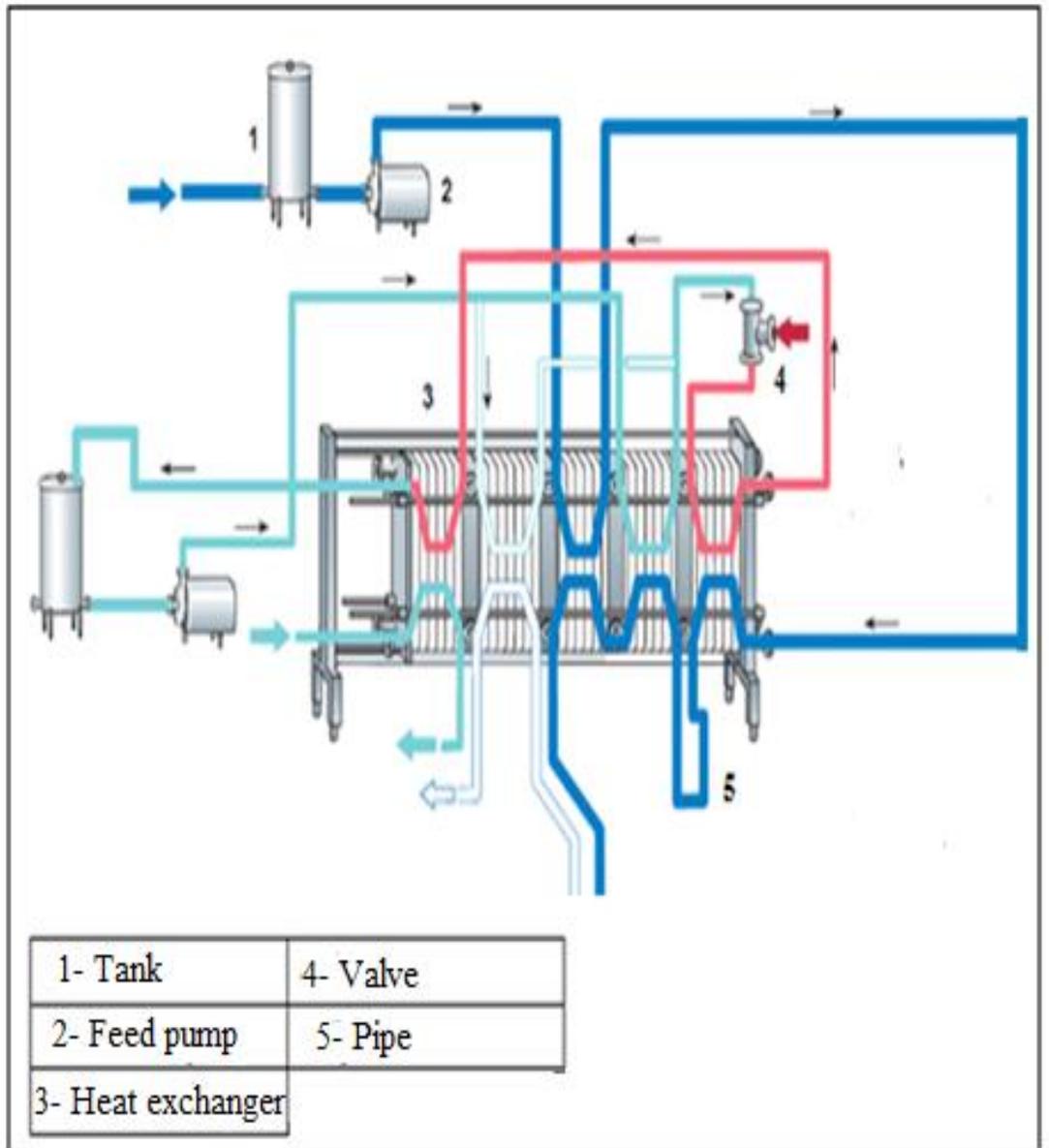
194°F (90°C) for 0.5 second

201°F(94°C) for 0.1 second

212°F (100°C) for 0.01 second

These treatments are sufficient to destroy the most heat resistant of the non spore-forming pathogenic organisms—*Mycobacterium tuberculosis* and *Coxiella burnetii*.



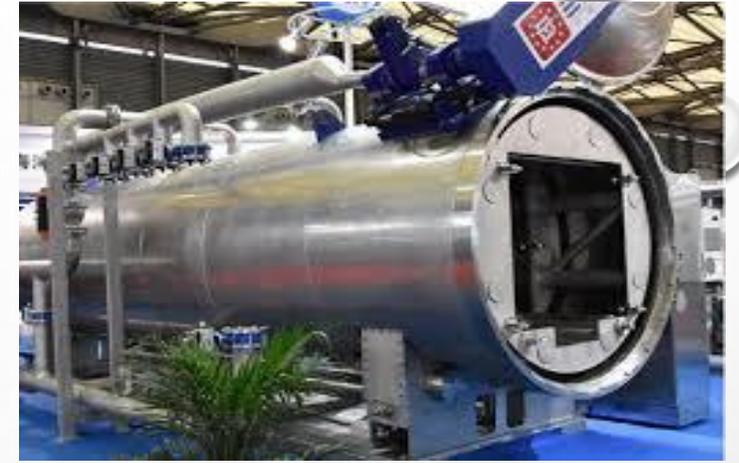


Milk pasteurization temperatures are sufficient to destroy all yeasts, molds, gram negative bacteria and many gram positives. The two groups that survive milk pasteurization are thermodurics and thermophiles.

Thermoduric organisms are those that can survive exposure to relatively high temperatures but do not necessarily grow at these temperatures. The non spore forming organisms that survive milk pasteurization generally belong to the genera *Streptococcus* and *Lactobacillus*.

Thermophilic organisms are those that not only survive relatively high temperatures but *require* high temperatures for their growth and metabolic activities. The genera *Bacillus* and *Clostridium* contain the thermophiles of greatest importance in foods.

# Sterilization



Sterilization is a process of heating food at  $121^{\circ}\text{C}$  for varying times under pressure to insure destruction of all viable microorganism. Thus results in improving shelf life of food items more than two years. Appropriate plating or enumerating technique / method may be used to check the sterilization effect. Foods having a pH of more than 4.6, such as meat and most vegetables must undergo severe heating conditions to destroy all pathogens. Severe conditions are applied primarily to ensure that *Clostridium botulinum* spores are destroyed during processing. Canned foods are called commercially sterile as no viable organisms can be detected by the usual cultural methods.

Dried microbial cells placed into test tubes and then heated in a water bath are considerably more heat resistant than moist cells of the same type. Because it is well established that protein denaturation occurs at a faster rate when heated in water than in air.

**Autoclave Sterilization:** is the process by which all living micro-organisms both pathogenic and non-pathogenic including spores are killed. Autoclaving is the process of moist heat sterilization in which micro-organisms are exposed to steam under saturated pressure. Steam autoclave (steam under pressure) Steam sterilization is the most inexpensive and effective method of sterilization. Steam under pressure permits permeation of moist heat to porous substances by condensation and results in destruction of all microbial life. This is the usual method of sterilizing surgical instruments, dressing, drapes, swabs, laps sponges and culture media.

Advantage -- Destroys micro-organisms more efficiently than dry heat and therefore a shorter exposure at a lower temperature is possible. Porous materials can be sterilized without damage. Equipment or components of rubber and certain plastics such as nylon and pvc.



Pressure Cooker Type



Horizontal Autoclave



Vertical Autoclave

## Ultra-high temperature processing (UHT)

Ultra-high temperature processing (UHT) / ultra-heat treatment / ultra-pasteurization is a method of food processing technology that sterilizes liquid food by heating it above  $135^{\circ}\text{C}$ , the temperature required to kill bacterial endospores for 2 to 5 seconds. UHT is most commonly used in processing of milk but the process is also used for manufacturing tetra packing of fruit juices, cream, soy milk, yogurt, wine, soups and honey.



The word Microwave means very short wave, which is the shortest wavelength region of the radio spectrum and a part of the electromagnetic spectrum.

- Microwave is an electromagnetic radiation of short wavelength.
- They can reflect by conducting surfaces just like optical waves since they travel in straight line.
- Microwave currents flow through a thin outer layer of an ordinary cable.

## Microwave Sterilization

Microwave sterilization of food is a thermal process and performed by passing non ionizing microwave radiation usually at a frequency of 2.125 GHz (a wavelength of 12.212 cm) through the food. Microwave radiation frequency used in food industry is in between common radio and infrared frequencies. Microwave heating takes place due to the polarization effect of electromagnetic radiation at frequencies between 300 MHz and 300 GHz. It delivers energy to the food package under pressure and controlled temperature to achieve inactivation of bacteria harmful for humans and also enhance shelf life of foods.



**Thermal Death Time** Thermal death time (TDT) is the time necessary to kill a given number of organisms at a specified temperature. By this method, the temperature is kept constant and the time necessary to kill all cells is determined.

**Thermal Death Point (TDP)** which is the temperature necessary to kill a given number of microorganisms in a fixed time usually 10 minutes.

**Decimal Reduction Time or D value** – Time required to kill 90% of the microorganisms or spores in a sample at a specified temperature – Time required in a process to drop population by one log cycle However, such a destruction is logarithmic not possible to completely destroy microbes in a sample.

**Z Value** – The increase in temperature required to reduce D to 1/10 its value or to reduce it by one log cycle.

**F value** – Time in minutes at a specific temperature needed to kill a population of cells or spores – Usually at 121°C

The background features a light gray gradient with several realistic water droplets of various sizes scattered in the corners. The droplets have highlights and shadows, giving them a three-dimensional appearance. In the center, the words "THANK YOU" are written in a bold, black, serif font, enclosed within a thin blue rectangular border.

**THANK YOU**