Muthayammal Engineering College (Autonomous) Rasipuram 637408

16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Fruits and Vegetables

Dr. N. Saravanan
Professor

Fruits and Vegetables

Fruits and vegetables are the most perishable commodities and are important ingredients in the human dietaries.

Fruits and vegetables are seasonal in nature and prices go down considerably during the glut period and production becomes uneconomical due to distress sale.

The costs involved in preventing the losses are always cheaper that the cost of production; hence, processing receives greater attention in recent years.

Fruits and Vegetables

The fruits and vegetable processing industry in India is highly unorganized.

The prominent proceeds items are fruit pulps and juice, fruit based ready–to-serve beverages, canned fruits and vegetables, jams, squashes, pickles, chutneys, dehydrated vegetables, etc.

More recently, products like frozen pulps and vegetables, frozen dried fruits and vegetables, fruit juice concentrates and vegetable curries in restorable pouches, canned mushroom and mushroom products have also been taken up for manufacture by the industry.

Fruits and Vegetables

Fruit and vegetables have many similarities with respect to their compositions, methods of cultivation and harvesting, storage properties and processing.

In fact, many vegetables may be considered fruit in the true botanical sense. Botanically, fruits are those portions of the plant which house seeds.

Therefore such items as tomatoes, cucumbers, eggplant, peppers, and others would be classified as fruits on this basis.

However, the important distinction between fruit and vegetables has come to be made on an usage basis.

Those plant items that are generally eaten with the main course of a meal are considered to be vegetables

Fruits and Vegetables

Classification

Category	Examples
Earth vegetables roots	sweet potatoes, carrots
modified stems tubers	potatoes
modified buds bulbs	onions, garlic
Herbage vegetables	
leaves	cabbage, spinach, lettuce
petioles (leaf stalk)	celery, rhubarb
flower buds	cauliflower, artichokes
sprouts, shoots (young stems)	asparagus, bamboo shoots
Fruit vegetables	
legumes	peas, green beans
cereals	sweet corn
vine fruits	squash, cucumber
berry fruits	tomato, egg plant
tree fruits	avocado, breadfruit

Fruits and Vegetables

Typical percentage composition of foods from plant origin Percentage Composition- Edible Portion

Food	Carbo-hydrate	Protein	Fat	Ash	Water
Earth vegetables					
potatoes, white	18.9	2.0	0.1	1.0	78
sweet potatoes	27.3	1.3	0.4	1.0	70
Vegetables					
carrots	9.1	1.1	0.2	1.0	88.6
radishes	4.2	1.1	0.1	0.9	93.7
asparagus	4.1	2.1	0.2	0.7	92.9
beans, snap, green	7.6	2.4	0.2	0.7	89.1
peas, fresh	17.0	6.7	0.4	0.9	75.0
lettuce	2.8	1.3	0.2	0.9	94.8
Fruit					
banana	24.0	1.3	0.4	0.8	73.5
orange	11.3	0.9	0.2	0.5	87.1
apple	15.0	0.3	0.4	0.3	84.0
strawberries	8.3	0.8	0.5	0.5	89.9

Fruits and Vegetables

Processing systems

1. Small-Scale Processing.
2. Intermediate-Scale Processing.
3. Large-Scale Processing.

Fruits and Vegetables

Processing systems

Small-Scale Processing.

This is done by small-scale farmers for personal subsistence or for sale in nearby markets.

In this system, processing requires little investment: however, it is time consuming and tedious.

Until recently, small-scale processing satisfied the needs of rural and urban populations.

However, with the rising rates of population and urbanisation growth and their more diversified food demands, there is need for more processed and diversified types of food.

Fruits and Vegetables

Intermediate-Scale Processing.

In this scale of processing, a group of small-scale processors pool their resources.

This can also be done by individuals. Processing is based on the technology used by small-scale processors with differences in the type and capacity of equipment used.

The raw materials are usually grown by the processors themselves or are purchased on contract from other farmers.

These operations are usually located on the production site of in order to assure raw materials availability and reduce cost of transport.

This system of processing can provide quantities of processed products to urban areas.

Fruits and Vegetables

Large-Scale Processing.

Processing in this system is highly mechanised and requires a substantial supply of raw materials for economical operation.

This system requires a large capital investment and high technical and managerial skills.

Because of the high demand for foods in recent years many large-scale factories were established in developing countries.

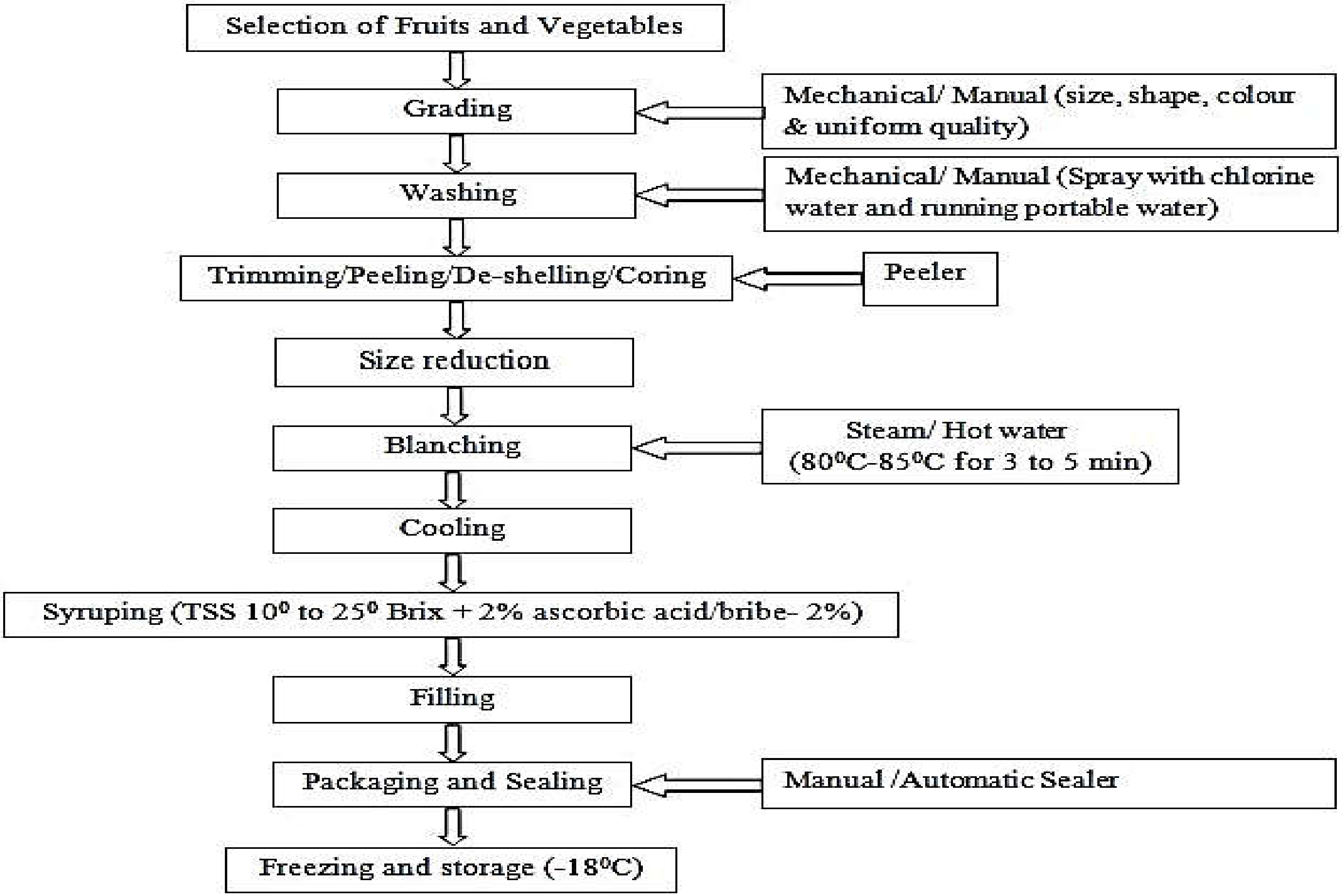
Fruits and Vegetables

Processing methods:

- Freezing
- Dehydration
- Canning

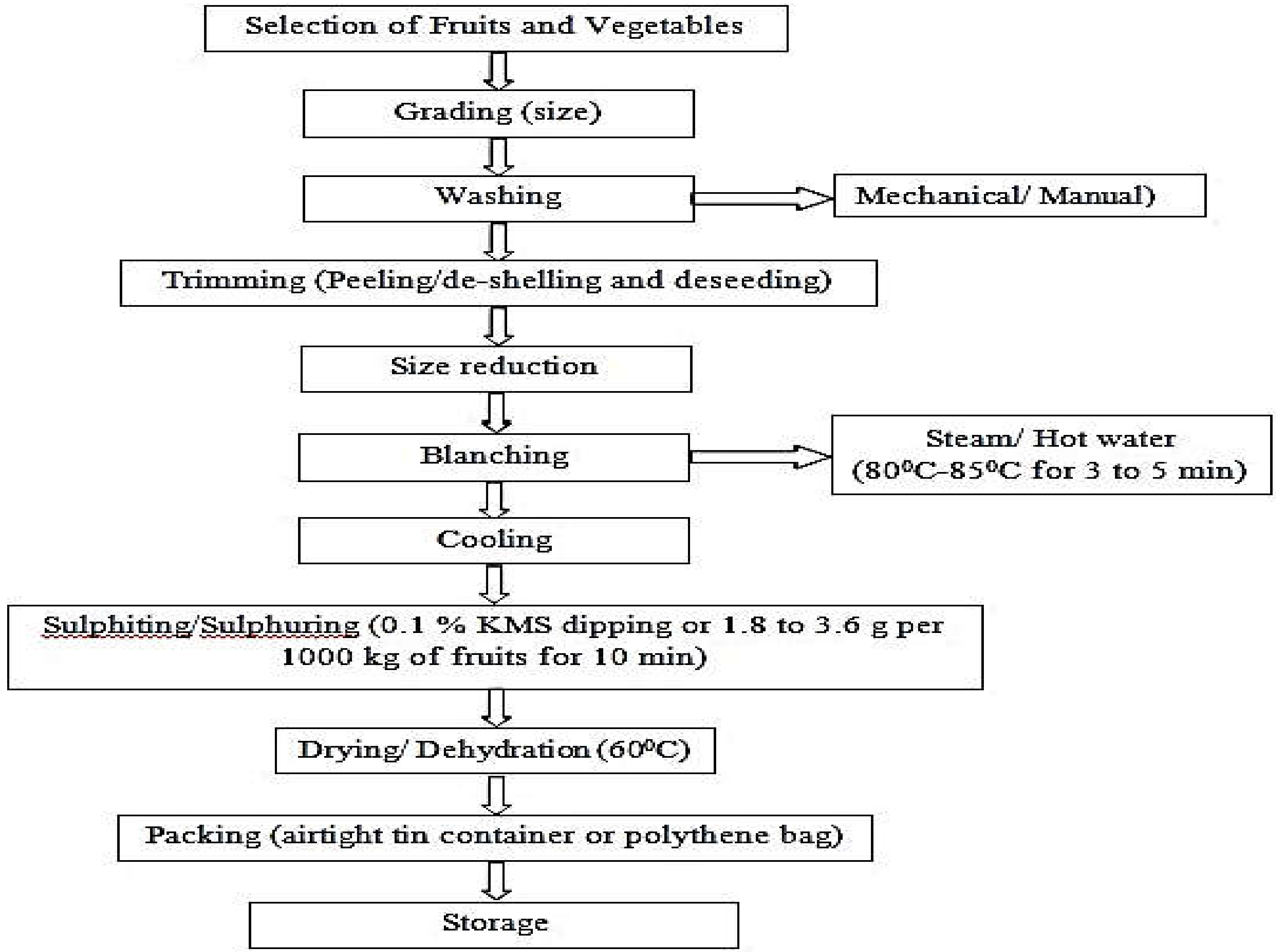
Fruits and Vegetables

Freezing

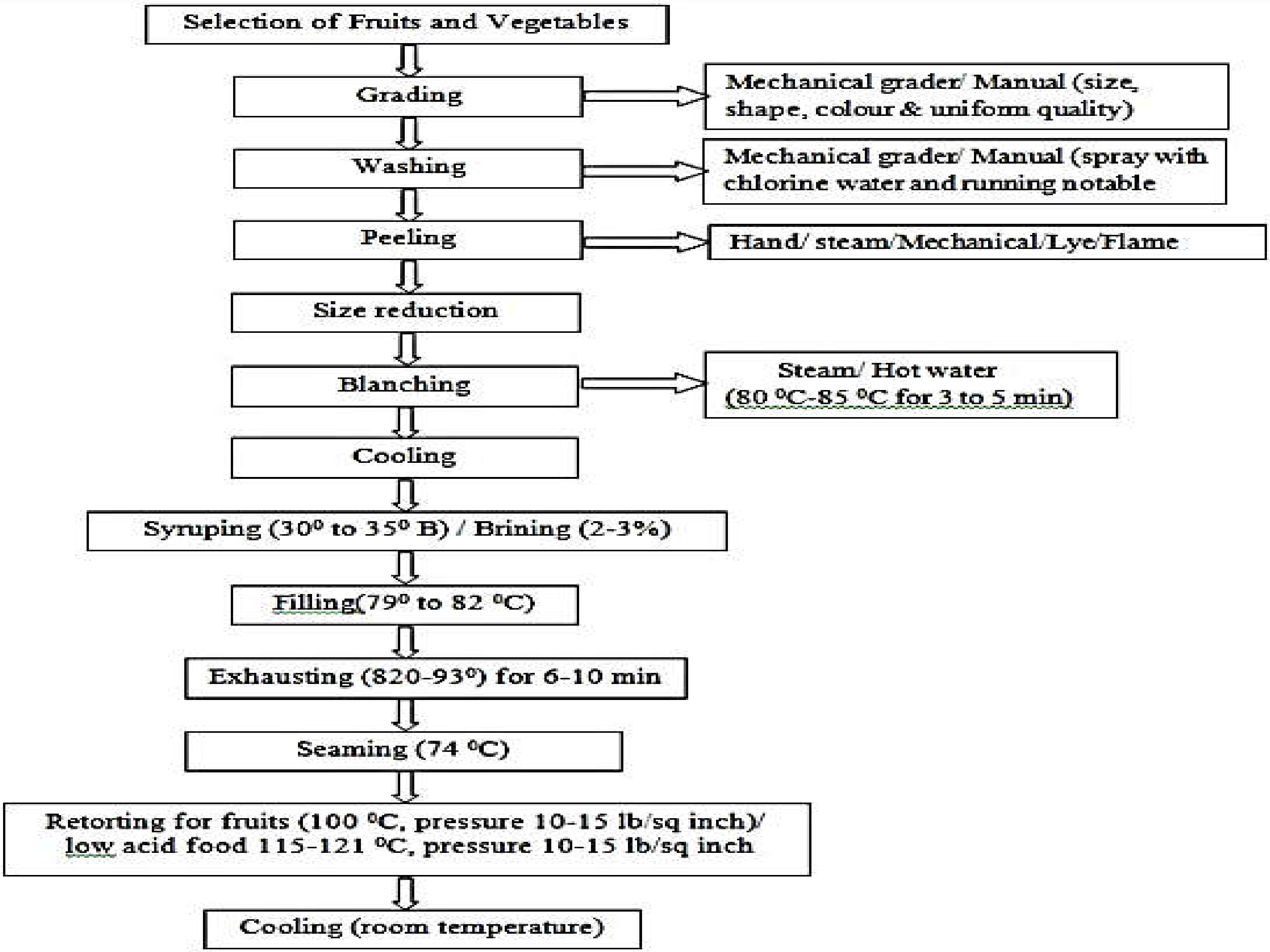


Fruits and Vegetables

Dehydration



Canning


Selection of Fruits and Vegetables
Grading
Mechanical grader/ Manual (size, shape, colour & uniform quality)
Washing
Mechanical grader/ Manual (spray with chlorine water and running notable
Peeling
Hand/ steam/Mechanical/Lye/Flame
Size reduction
Blanching
Steam/ Hot water (80 ºC-85 ºC for 3 to 5 min)
Cooling
Syruping (30º to 35º B) / Brining (2-3%)
Filling(79º to 82 ºC)
Exhausting (820-93º) for 6-10 min
Seaming (74 ºC)
Retorting for fruits (100 ºC, pressure 10-15 lb/sq inch)/ low acid food 115-121 ºC, pressure 10-15 lb/sq inch
Cooling (room temperature)

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Spices

Dr. N. Saravanan
Professor

Spices

- A spice is a seed, fruit, root, bark, or other plant substance primarily used for flavoring or coloring food.
- Spices are distinguished from herbs, which are the leaves, flowers, or stems of plants used for flavoring or as a garnish.
- Spices are sometimes used in medicine, religious rituals, cosmetics or perfume production.

Spices

- Indian spices are known for its flavours
- India is known as ‘Home of Spices and also Land of spices
- India- Largest producer, consumer and exporter of spices
- China - second largest producer
- >90% for domestic consumption
- 109 spices- all over world
- India- 52 spices
- India is producing 5.95 million tonnes of spices from an area of about 3.21 million hectares

Spices

- Share of spices in total agricultural export- 6%
- India's share of world spice trade- 45-50% by volume and 25-30% by value
- Major spice, producing states are Andhra Pradesh (19%), Gujarat (15%), Rajasthan (14.7%), Karnataka (8%), Madhya Pradesh (7.7%) and Tamil Nadu (7%)
- Chilli is the major spice crop occupying about 25% of area under cultivation and contributing 22% of total spice production in the country

Spices

Spices Production in India

Spices	Production (in Tonnes)
Pepper	26700
Cardamom (s)	4650
Cardamom (L)	935
Chilli	241000
Ginger	21550
Turmeric	79500
Seed Spices	120200
Other Spices	41720
Curry powders/Paste	17000
Mint Products	14750
Spice Oils & Oleoresins	7,265
Total	575270

Spices

Scope and importance

- India has diverse soil and climate & several agro ecological regions which provides the opportunity to grow a variety of spice crops.
- It is low volume and high value crop.
- spice crops play a unique role in India's economy by improving the income of the rural people
- Labor intensive so generate lot of employment opportunities for the rural population.
- The demand of Indian spice is very much in other countries . Hence we have very much scope to meet that demand by huge production.

Spices

- Spices can improve the palatability and the appeal of dull diets.
- Flavors stimulate salivation and promote digestion
- Improve health, by affecting the humors & moods
- Having antibacterial and preservative action Expickles
- The strong preservative quality of many spices made them ideal for embalming

Spices

Spices in Five Categories

- Major spices:-Black pepper, Cardamoms, Chilies, Ginger and Turmeric
- Seed spices:-coriander, celery, fennel, Cumin
- Tree spices:- clove, nutmeg, kokum
- Herbal spices:- thyme, marjoram
- Misc spices:- garlic, saffron, long pepper

Spices

Processing of Spices and Value addition

Problems associated with spice production

- High microbial loads and aflatoxin contamination
- Losses of valuable compounds due to endogenous enzyme activities
- Losses of valuable compounds due to conventional processing and storage

Spices

Microbial decontamination / Sterilization of spices

- Fumigation with ethylene oxide (ETO) treatment
- Irradiation
- Steam treatments
- High hydrostatic pressure

Spices

Fumigation with ethylene oxide (Eto)

- Ethylene Oxide (Eto) serves as a disinfectant, fumigant, sterilizing agent, and insecticide
- Ethylene Oxide (EtO-prevent human microbial contaminants such as Salmonella and E.coli in spices.
- EtO is extremely effective in eliminating pathogens as well as reducing bacterial loads, yeast and mold, coliforms and other pathogens.
- The main advantage of EtO is that its use on spice generally has no significant impact on the appearance or flavor of the spice

Spices

- Appearance and taste are essential for spices, thus EtO treatment can resolve the potential public health issues without negatively effecting the marketability of the spice
- Ethylene oxide is most commonly used and for practical and safety purposes, is normally diluted with carbon dioxide (80%)

Spices

Disadvantages of Eto

- Ethylene oxide (ETO) is banned in many countries (e.g., Japan, and some European countries) due to its reaction with spice components to form ethylene chlorohydrins and ethylene bromohydrin
- Ethylene chlorohydrin is a known carcinogen that persists in the spice for many months.
- Ethylene oxide also has been labeled as a carcinogen by the W.H.O

Spices

Irradiation of spices

- Gamma rays, electron beam and X-rays are effective methods for spice decontamination
- Doses of 3-10 kg are used for improving microbial safety of spice products
- Irradiation is allowed for the decontamination of dried aromatic herbs, spices and vegetable seasonings
- Irradiation of spices, which are usually pre-packaged to prevent secondary contamination, may cause the formation of low-molecular-weight volatile or non-volatile radiolysis products emanating from the packaging material

Spices

Steam treatments

- Usually high temperature steam is used to whole spices before grinding
- The moisture condensed on the surface of the particles needs to be removed after treatment to prevent unwanted mould growth.
- The treatment may affect the volatile profile, color, functionality, and physical state (caking may occur)

Spices

High hydrostatic pressure

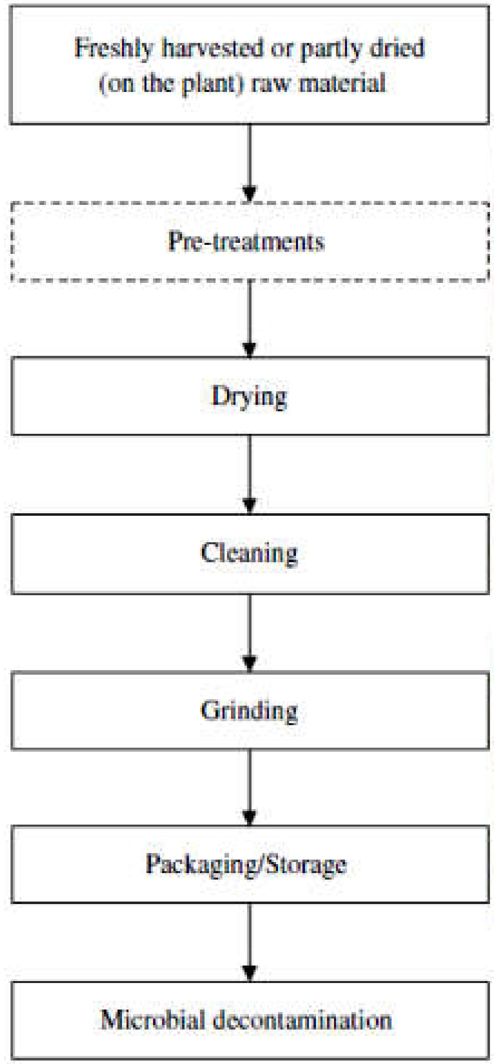
- High hydrostatic pressures ranging from 100 to 1000 Mpa is used for fruit and vegetable products
- The inactivation of microorganisms is strongly dependent on water activity
- Spice samples with water activities below 0.66 showed no reduction in the microbial count.

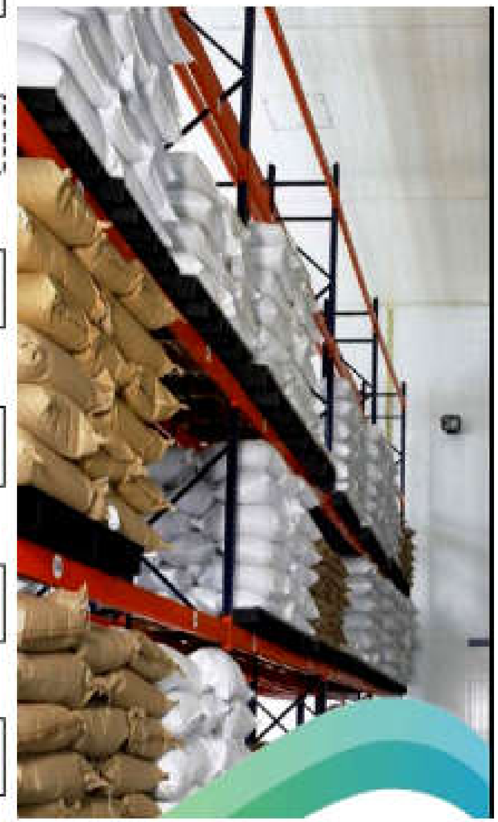
Spices

Milling of Spices or Grinding of Spices

- Spices are produced from a large variety of plant parts such as rhizomes, barks, leaves, fruits, seeds, etc
- Few spices can be incorporated directly into food products
- The degree of fineness of the processed spice is determined by its ultimate use (e.g., distillation, extraction, blended seasonings)

Spices





Conventional process for the production of spices (steps in dotted lines are optional).

Spices

Applications

- Straight spice powders (eg. Chilli powder, Turmeric powder, Coriander powder, Pepper powder, Cumin Powder, etc.,)
- Culinary Powders (eg. Samabr Powder, Rasam Powder etc)
- Masala blends (eg. Garama Masala, Chicken Masala, Meat masala etc)
- Seasonings and Tastemakers (eg. Snacks seasonings (Masala munch, Green chilli masala, sour cream onion, mint etc., and Pasta and noodles tastemakers etc.,)
- Soup mixes blends (Soup powders)

Spices

Advantages and Disadvantages of Traditional

Ground Spices

Advantages

- Slow flavor release in high temperature processing
- Easy to handle and weigh accurately
- No labeling declaration problems
- Presence of natural antioxidants in many herbs

Spices

Disadvantages

- Variable flavor strength and profile and ready adulteration with less valuable materials
- Unhygienic — Often contaminated by filth (microorganisms)
- Presence of lipase enzymes
- Flavor distribution poor and flavor loss and degradation on Storage
- Dusty and unpleasant to handle in bulk
- Discoloration due to tannins
- Dried herbs usually have unacceptable hay-like aroma
- Undesirable appearance characteristics in end products

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Oils and Fats

Dr. N. Saravanan
Professor

Oils and Fats

Fats and oils are water-insoluble compounds consisting of mainly triacylglycerols: three fatty acids esterified to a glycerol molecule.

Products are generally called “fats” when they are solid at room temperature and “oils” when they are liquid at room temperature

Edible fats and oils contribute to the flavor, texture, aroma, and mouth feel of foods, while providing nutritive value.

Oils and Fats

As such, they are scientifically called triacylglycerols but are commonly referred to in the food industry as triglycerides.

Although the terms 'oils' and 'fats' are often used interchangeably, they are usually used to distinguish triglycerides in the liquid state at ambient temperatures (oils) from those in the solid state (fats).

Oils and Fats

Origin:

They are commonly of :

- Vegetable origin (e.g. palm oil, rapeseed oil, soyabean oil, olive oil, cocoa butter, etc)
- Animal origin (e.g. pork lard, beef tallow, fish oils) as well as from animal milk fats.

Oils and Fats

The fatty acids found in most commonly consumed oils and fats are composed of long carbon and hydrogen chains, typically containing from 8 to 20 carbon atoms, mainly with even numbers of carbon atoms, although animal fats also contain significant levels of odd-chain fatty acids.

They have a methyl (CH3) group at one end and a carboxylic acid (COOH) at the other.

It is this carboxylic acid group that reacts with the hydroxyl groups on the glycerol molecule to form the ester linkages of the triacylglycerol molecule.

Oils and Fats

Fatty acids can be grouped into four main types:

- Saturated
- Monounsaturated
- Polyunsaturated
- Trans

Oils and Fats

Saturated fatty acids are straight chains of carbon atoms consisting of methylene (CH_2) groups between the end methyl and carboxylic acid groups.

The most common saturated fatty acids are lauric acid (C12), palmitic acid (C16) and stearic acid (C18).

Shorter chain saturated fatty acids are found in butterfat (e.g. C4, butyric acid) and coconut oil (e.g. C8, caprylic acid, and C10, capric acid).

Oils and Fats

Monounsaturated fatty acids contain a single carbon-carbon double bond in the carbon chain.

The most common monounsaturated fatty acid is oleic acid, containing 18 carbon atoms.

In oleic acid, the double bond is between carbon atoms 9 and 10 (counting from the COOH group)

Oils and Fats

Polyunsaturated fatty acids have more than one double bond in the carbon chain.

Common polyunsaturated fatty acids are linoleic acid (18 carbon atoms and 2 double bonds between carbon atoms 9/10 and 12/13) and linolenic acid (18 carbon atoms and 3 double bonds between carbon atoms 9/10, 12/13 and 15/16).

Oils and Fats

Trans fatty acids, are also unsaturated but, in this case, some or all of the double bonds.

These are most commonly found as a result of either hydrogenation of fats or by holding fats at a very high temperature (>200°C) for extended periods of time.

As such, they can gradually be produced and build up in used frying oils.

Oils and Fats

Oil	2006-7	2007-8	2008-9	2009-10*	2010-11†
Coconut	3.22	3.53	3.53	3.62	3.68
Cottonseed	5.13	5.22	4.78	4.65	4.98
Olive	2.83	2.78	2.78	3.05	3.01
Palm	37.33	41.08	43.99	45.86	47.97
Palm Kernel	4.44	4.88	5.17	5.50	5.65
Peanut	4.53	4.91	5.00	4.67	4.98
Rapeseed	17.13	18.43	20.49	22.35	22.65
Soybean	36.45	37.72	35.74	38.76	42.13
Sunflower	10.70	10.03	11.99	11.63	11.33
Total	121.75	128.57	133.48	140.08	146.37

Oils and Fats

General handling considerations:

Degradation of edible fats and oils cannot be stopped, but can be slowed by taking certain precautions during processing and storage. Where appropriate, care should be taken to avoid:

contamination: equipment surfaces should be cleaned and sanitized regularly to eliminate spoilage microorganisms and other adulterants, and to avoid build-up of oxidation products

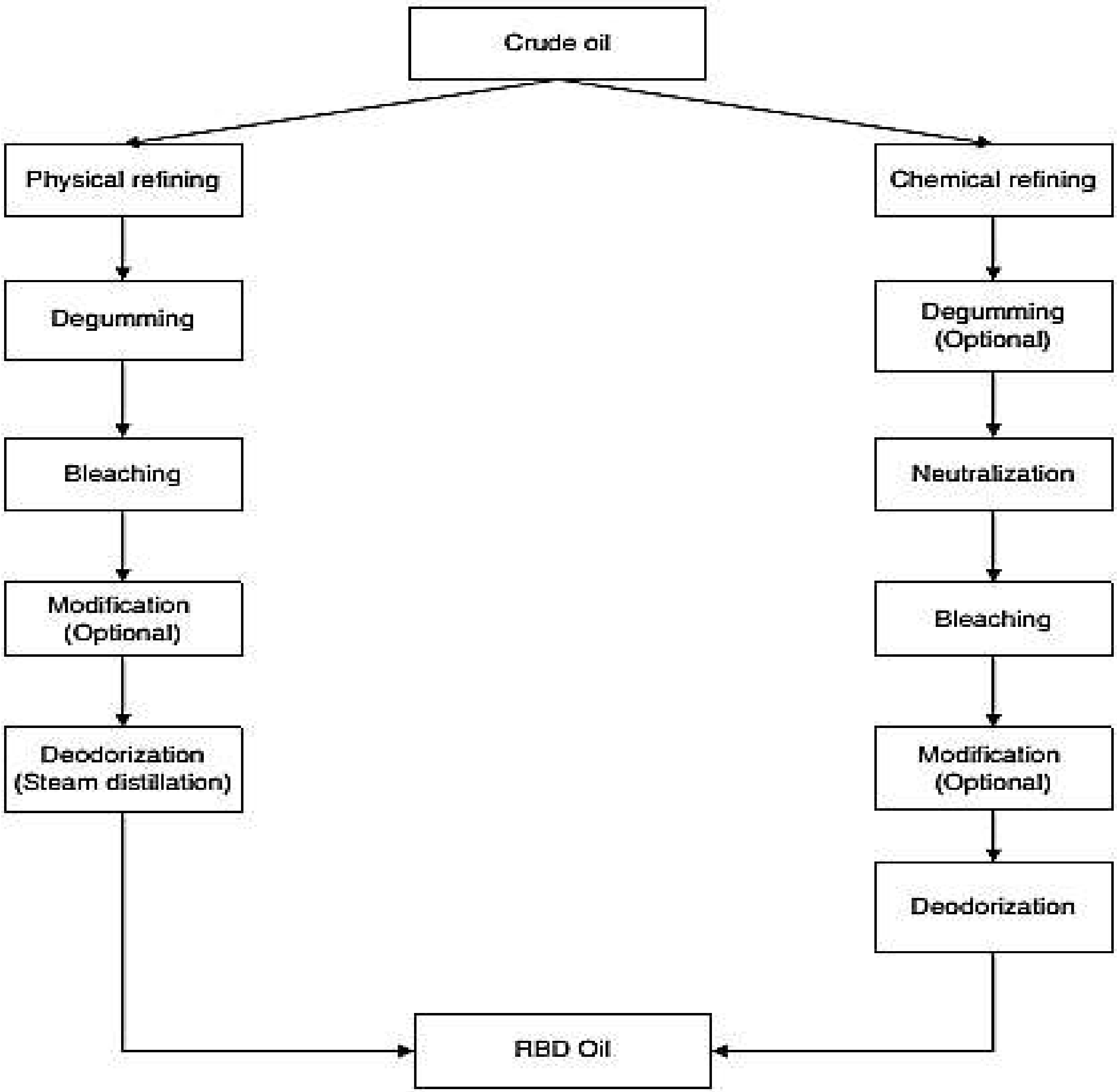
Oils and Fats

General handling considerations:

Oxygen: some processing steps require an inert atmosphere and may be conducted under vacuum or nitrogen atmosphere.

Trace metals: trace metals (e.g. copper) act as pro oxidants, and their levels may be minimized by the use of stainless steel equipment during processing

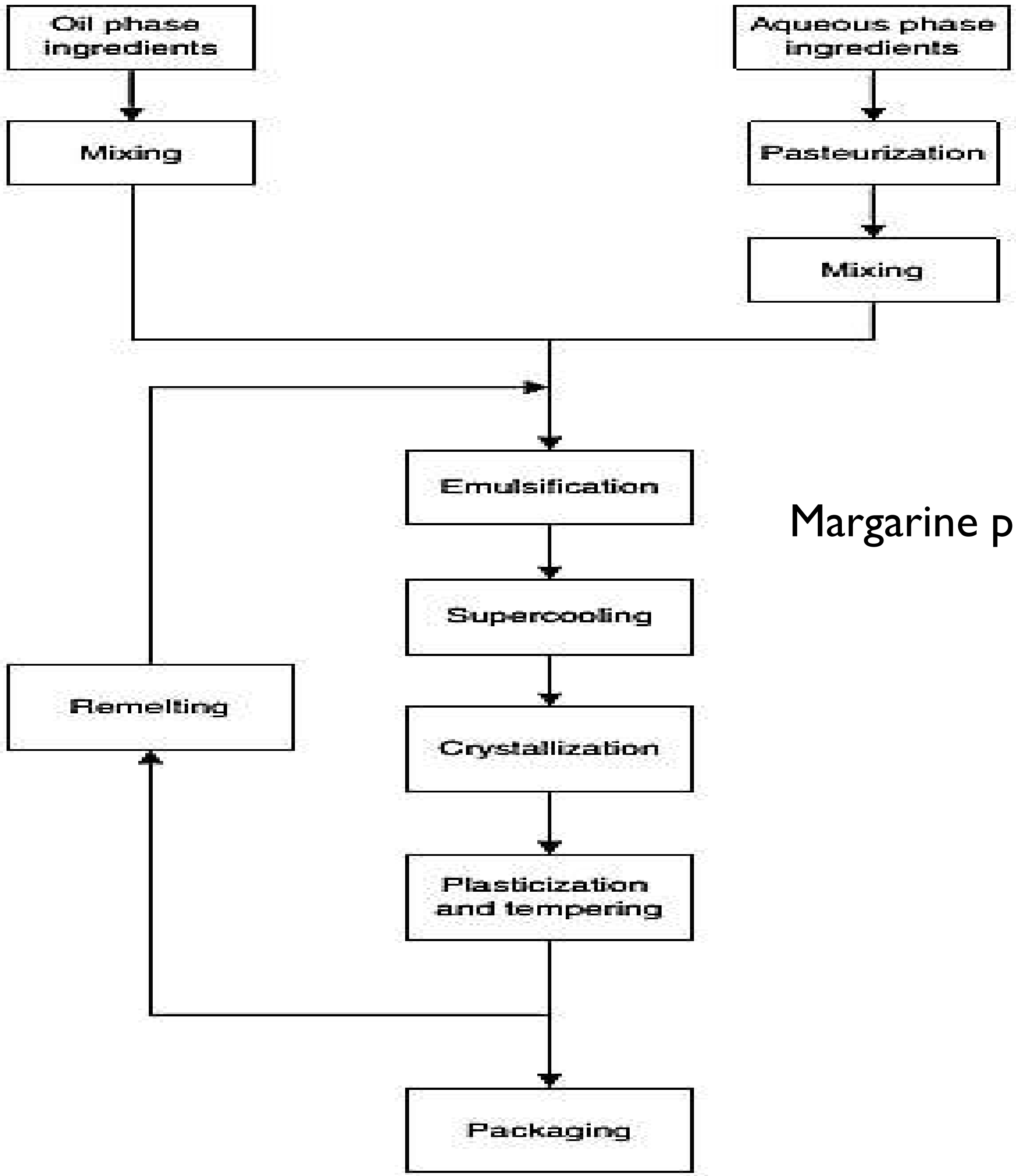
Light, heat, and water: because light and heat promote reactions that lead to oxidative rancidity (or, in the case of water, hydrolytic rancidity), oils should be stored in a cool, dry, dark location


Crude oil
Physical refining
Chemical refining
Degumming
Degumming
(Optional)
Bleaching
Neutralization
Modification
(Optional)
Bleaching
Deodorization
(Steam distillation)
Modification
(Optional)
Deodorization
RBD Oil

Oils and Fats

Components removed during refining process

Refining step	Targeted component(s) for removal	Other components removed
Degumming	Phosphatides	Filterable solids (e.g. waxes), trace metals
Neutralization	Free fatty acids	Phosphatides, soaps, trace metals, pigments
Bleaching	Pigments	Phosphatides, soaps, trace metals, waxes
Deodorization	Free fatty acids (physical refining)	Sterols, tocopherols, tocotrienols, carotenoids, pigments
	Secondary oxidation products (chemical refining)	



Margarine production

Oils and Fats

Animal fat processing methods:

The process of extraction of animal fats from raw material is termed melting or rendering.

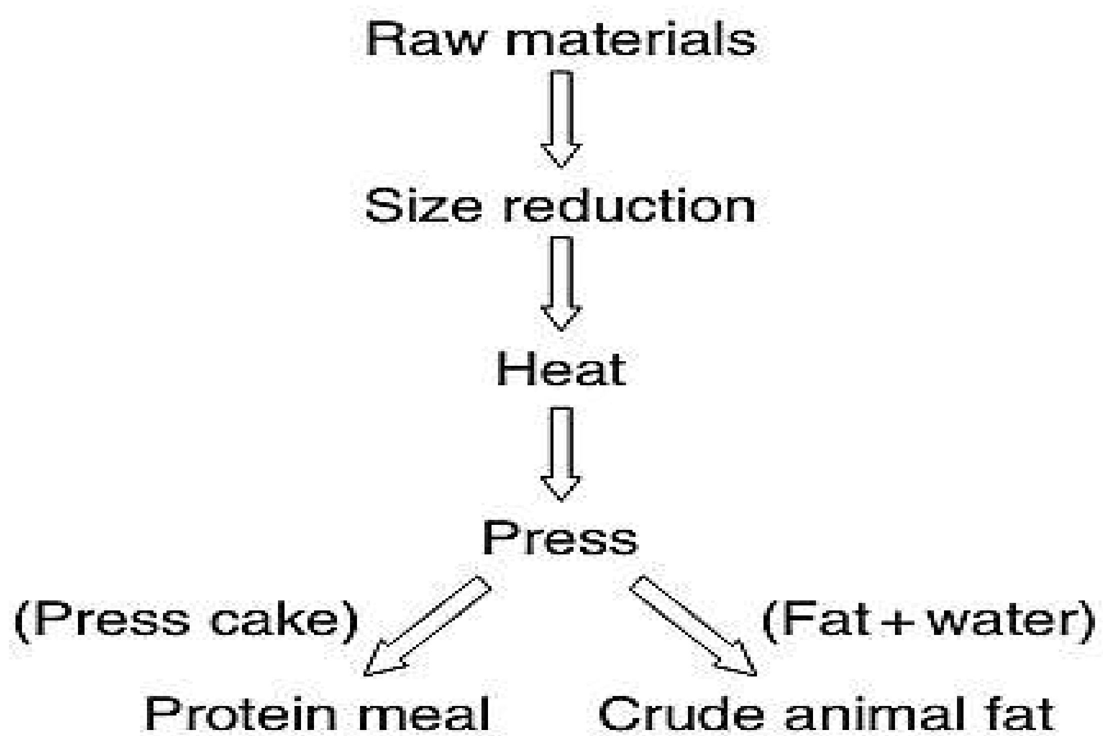
"Rendering" is an old word, which can mean different things to different people.

In its simplest form, rendering means "to render open" (or split)–by heat processing–raw material into a solid (proteins) and a liquid (fat, liquid at elevated temperatures).

Oils and Fats

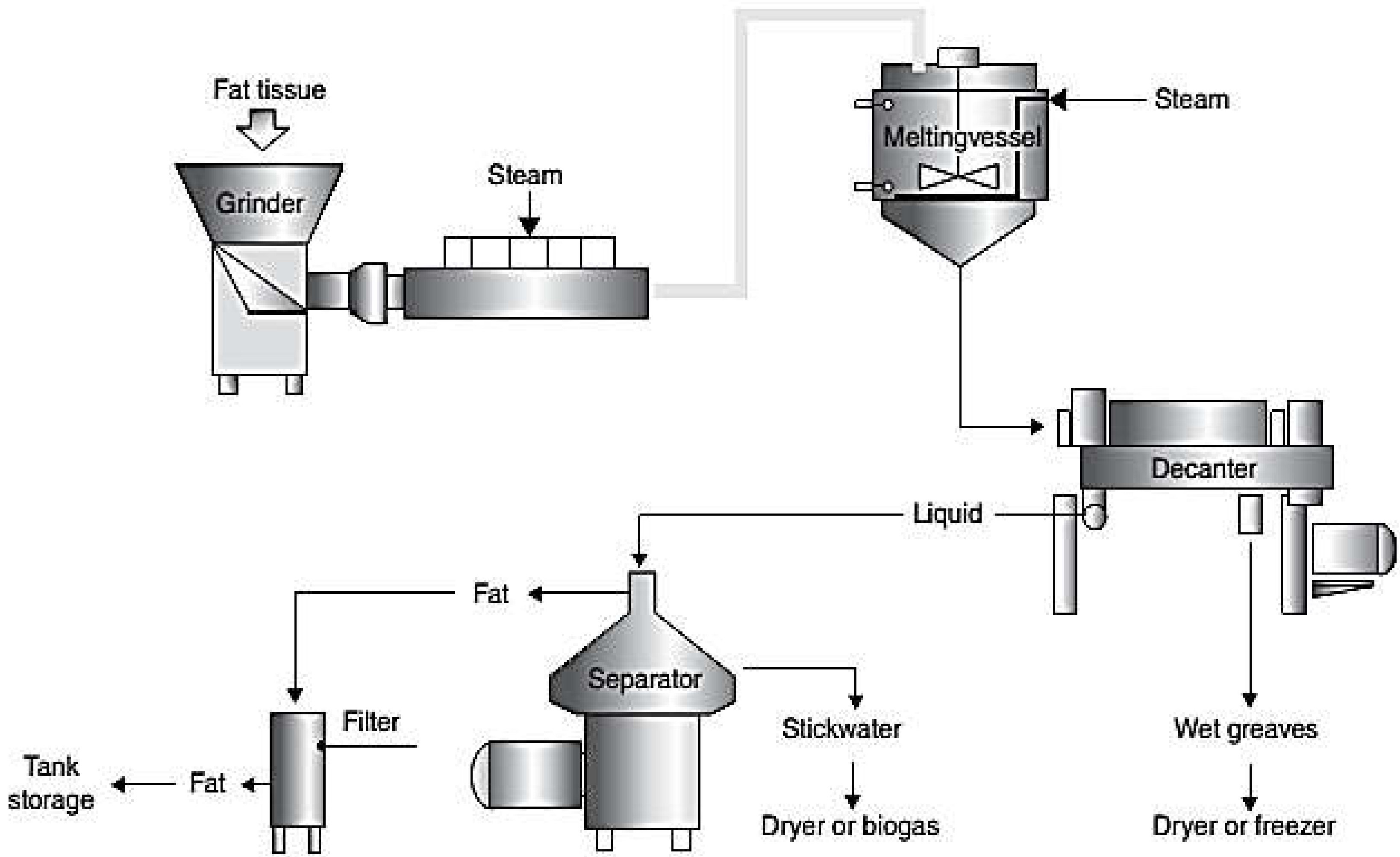
Most rendering processes refer to the processing of fat-rich or bone-rich raw materials.

A simplified generic process description for the processing of high-fat raw material



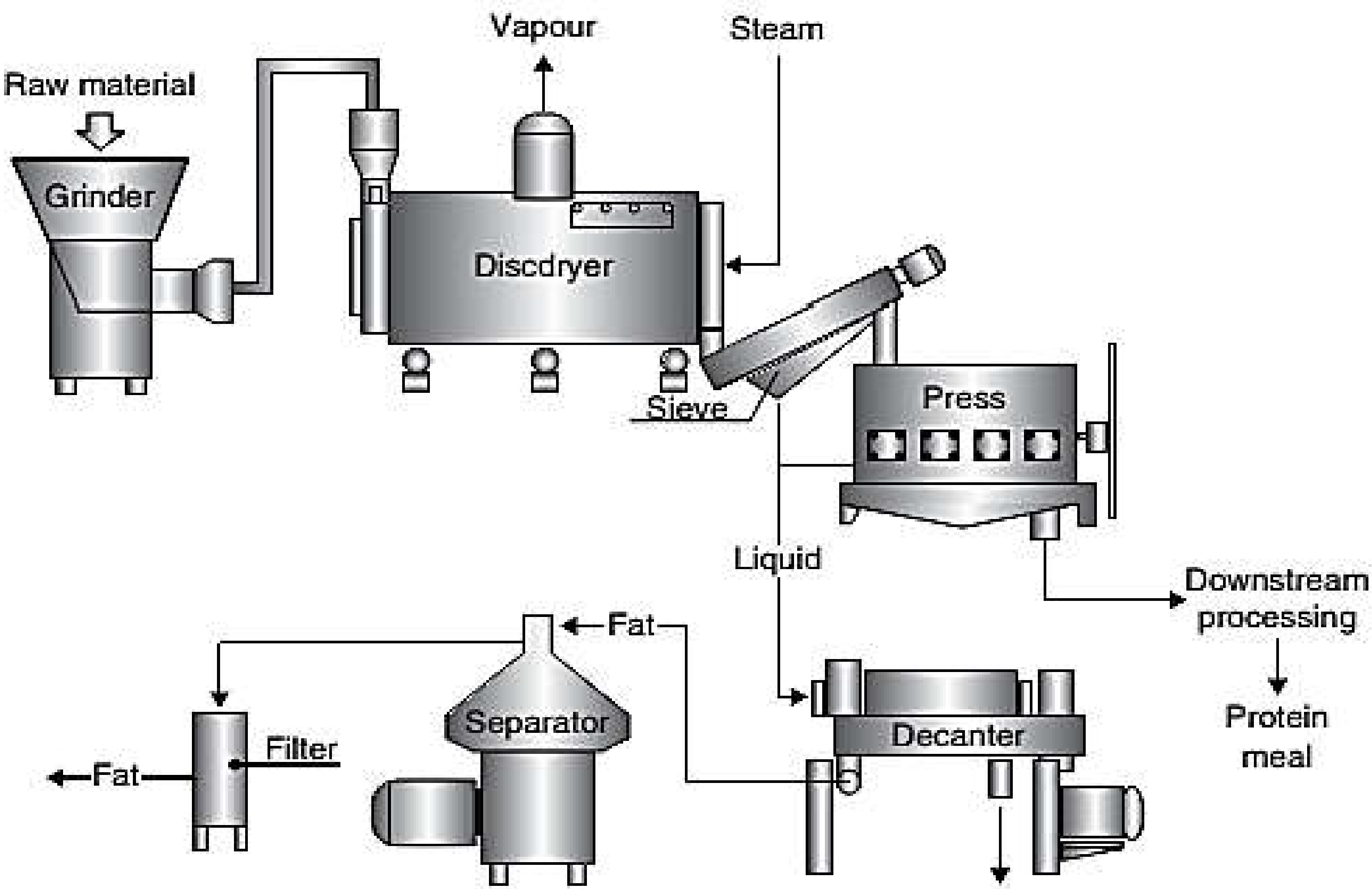
Oils and Fats

Wet rendering process:



Oils and Fats

Dry rendering process:



Oils and Fats

Applications:

Worldwide, annually 172 million tonnes of natural fats and oils of animal and vegetable origin are produced; 134 million tonnes of this production are consumed by humans (78%) while 7 million tonnes are consumed by animals.

Technical applications in the oleochemical industry are estimated at 14 million tonnes, and the biodiesel industry 17 million tonnes.

Oils and Fats

In recent years biodiesel utilization of natural fats and oils has grown steadily.

Fats and oils sourced from animals worldwide are estimated at 25 million tonnes.

In Europe, nearly 3 million tonnes of animal fats are produced annually.

The main outlets for animal fats are feed (26%), oleo and soaps (22%), energy (19%), biodiesel (15%), and pet food (13%)

Thank you

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16BTE01 / 16CHE03 –
FOOD TECHNOLOGY

Topic: Confectionery and chocolate products

Dr. N. Saravanan

Professor

Confectionery and chocolate products

Confectionery is the art of making confections, which are food items that are rich in sugar and carbohydrates.

Confectionery is an important food item of great popularity among wide range of population.

It has been enjoyed as a major food delicacy from ancient times.

The term confectionery is ambiguous and describes a spectrum of sweet goods.

Confectionery and chocolate products

It takes on different meaning depending on the country in which it is used, for example in the United Kingdom the term applies to any sweet product including cakes.

In the United States confectionery is candy and includes sugar confectionery and chocolate confectionery.

Globally, confectionery foods represent 50% by volume of foods produced and 60% by value.

Confectionery and chocolate products

Classification of Confectionery

Confectionery can be classified into four major groups.

They are as follows:

- Sugar confectionery
- Chocolate confectionery
- Flour confectionery
- Milk-based confectionery

Confectionery and chocolate products

Sugar confectionery

It includes products using mainly sugar such as boiled sweets, fondants, fudge, jellies, toffees, etc.

Chocolate confectionery

It includes mainly cocoa, chocolate and chocolate products.

Sugar confectionery coated with chocolate is also included in it.

Confectionery and chocolate products

Flour confectionery

It includes baked products such as cakes, biscuits, cream rolls, etc.

Traditional Indian cereal and legume flour based sweets such as *mysorepak*, *soanpapdi*, *badushah*, *jalebi*, etc. are also included in this category.

Milk-based confectionery

It includes mainly Indian traditional milk-based sweets such as *burfi*, *peda*, *rasogolla* etc.

Confectionery and chocolate products

Confectionery Production Principles

All confectionery products have a number of common requirements.

They must have an extended shelf life under ambient storage conditions and although this may be assisted by protective packaging their inherent properties must provide stability against microbial deterioration and stability of shape.

Confectionery and chocolate products

Toffee is a confection made by caramelizing sugar or molasses along with butter, and occasionally flour.

The mixture is heated until its temperature reaches the hard crack stage of 149 to 154 °C. While being prepared, toffee is sometimes mixed with nuts or raisins.

Confectionery and chocolate products

The basic ingredients used in the production of toffee are:

- Sugar (sucrose)
- Glucose syrup
- Milk Protein
- Fat
- Salt
- Water
- Other additives e.g. colour, flavour etc.

Confectionery and chocolate products

Structure of toffee

Toffee is an emulsion of fat in complex aqueous system. It is a mixture of sugars, water and protein which is resistant to crystallization. Toffees have number of textural characteristics:

- Hardness is a function of moisture content.
- Chewiness and toughness on eating are related to molecular weight of the carbohydrates
- Body is a function of quantity and state of the milk protein.

Confectionery and chocolate products

Processing

Toffees can be made using equipment ranging from an ordinary saucepan to a large continuous plant. The processes carried out are fundamentally similar.

a. Dissolving

Solid sugars are first dissolved in water or a mixture of water and glucose syrup.

b. Emulsifying

The fat and skim milk solids are added into the dissolved sugar or glucose syrup which makes the emulsion.

Confectionery and chocolate products

c. Cooking

The emulsion is then cooked to achieve the final water content. It is controlled by measuring the boiling point of 118-132°C for regular toffee and 146-154°C for hard toffee

d. Shaping the Toffee

The finished toffee has to be shaped in some way. Toffee is normally run into trays, cut into slabs or used as a component of other confectionery.

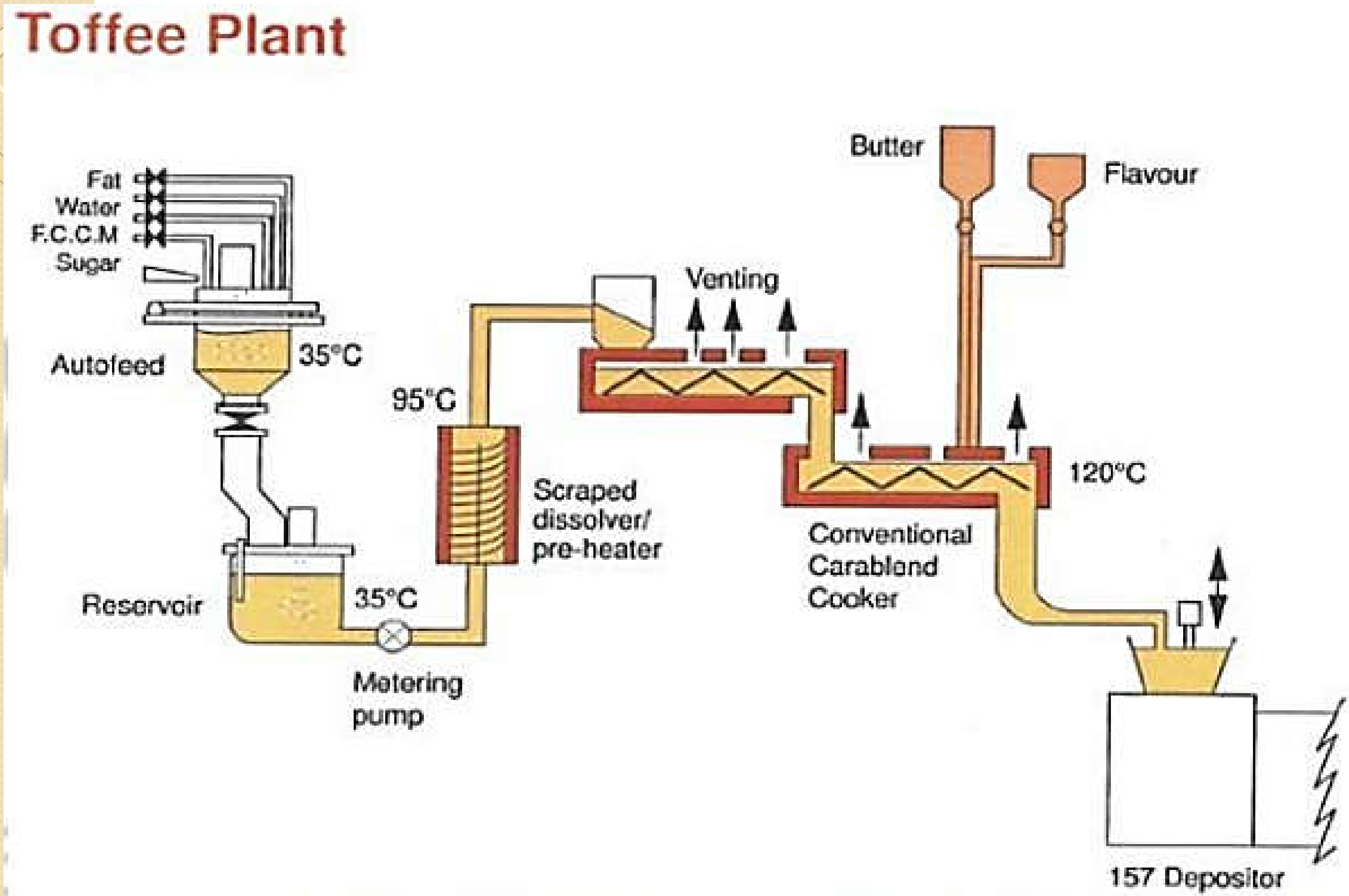
Confectionery and chocolate products

There are three processes used for shaping toffees for individual twist wrapping.

The processes are:

- The slab process,
- Cut and wrap processing
- Depositing

Confectionery and chocolate products



Confectionery and chocolate products

The cocoa bean or simply cocoa is the dried and fully fermented seed of Theobroma cacao, from which cocoa solids and cocoa butter can be extracted.

Cocoa beans are the basis of chocolate.

Confectionery and chocolate products

Confectionery and chocolate products

Confectionery and chocolate products

Cocoa bean production – 2017	
Country	**(tonnes)**
Ivory Coast	2,034,000
Ghana	883,652
Indonesia	659,776
Nigeria	328,263
Cameroon	295,028
Brazil	235,809
Ecuador	205,955
World	**5,201,108**

Confectionery and chocolate products

- To make 1 kg of chocolate, about 300 to 600 beans are processed, depending on the desired cocoa content.
- In a factory, the beans are roasted.
- Next, they are cracked and then deshelled by a "winnower".
- The resulting pieces of beans are called nibs.
- They are sometimes sold in small packages at specialty stores to be used in snacking, and chocolate dishes.

Confectionery and chocolate products

Since nibs are directly from the cocoa tree, they contain high amounts of theobromine.

Most nibs are ground, using various methods, into a thick, creamy paste, known as chocolate liquor or cocoa paste.

This "liquor" is then further processed into chocolate by mixing in cocoa butter and sugar, and then refined.

Confectionery and chocolate products

Alternatively, it can be separated into cocoa powder and cocoa butter using a hydraulic press.

This process produces around 50% cocoa butter and 50% cocoa powder. Standard cocoa powder has a fat content around 10–12%.

Cocoa butter is used in chocolate bar manufacture, other confectionery, soaps, and cosmetics.

Confectionery and chocolate products

The basic blends of ingredients for the various types of chocolate (in order of highest quantity of cocoa liquor first), are:

- Dark chocolate: sugar, cocoa butter, cocoa liquor, and (sometimes) vanilla
- Milk chocolate: sugar, cocoa butter, cocoa liquor, milk or milk powder, and vanilla
- White chocolate: sugar, cocoa butter, milk or milk powder, and vanilla

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Soft drinks and alcoholic beverages

Dr. N. Saravanan

Professor

Soft drinks and alcoholic beverages

A drink (or beverage) is a liquid intended for human consumption.

In addition to their basic function of satisfying thirst, drinks play important roles in human culture.

Common types of drinks include plain drinking water, milk, coffee, tea, hot chocolate, juice and soft drinks.

Soft drinks and alcoholic beverages

In addition, alcoholic drinks such as wine, beer, and liquor, which contain the drug ethanol, have been part of human culture for more than 8,000 years.

Non-alcoholic drinks often signify drinks that would normally contain alcohol, such as beer and wine, but are made with a sufficiently low concentration of alcohol by volume.

Soft drinks and alcoholic beverages

Production process includes:

- Purification of water
- Pasteurisation
- Juicing
- Infusion
- Percolation
- Carbonation
- Fermentation
- Distillation
- Mixing

Soft drinks and alcoholic beverages

Non-alcoholic drinks

A non-alcoholic drink is one that contains little or no alcohol.

This category includes low-alcohol beer, non-alcoholic wine, and apple cider if they contain a sufficiently low concentration of alcohol by volume (ABV).

Soft drinks and alcoholic beverages

Types of non alcoholic beverages:

- Water
- Milk
- Soft drinks
- Juice and juice drinks

Soft drinks and alcoholic beverages

Type of fruit drink	Description
Fruit juice	Largely regulated throughout the world; 'juice' is often protected to be used for only 100% fruit.
Fruit drink	Fruit is liquefied and water added.
Fruit squash	Produced using strained fruit juice, 45% sugar and preservatives.
Fruit cordial	All 'suspended matter' is eliminated by filtration or clarification. and therefore appears clear This type of drink, if described as 'flavoured,' may not have any amount of fruit
Fruit punch	A mixture of fruit juices. Contains around 65% sugar.
Fruit syrups	1 fruit crushed into puree and left to ferment. Is then heated with sugar to create syrup.

Soft drinks and alcoholic beverages

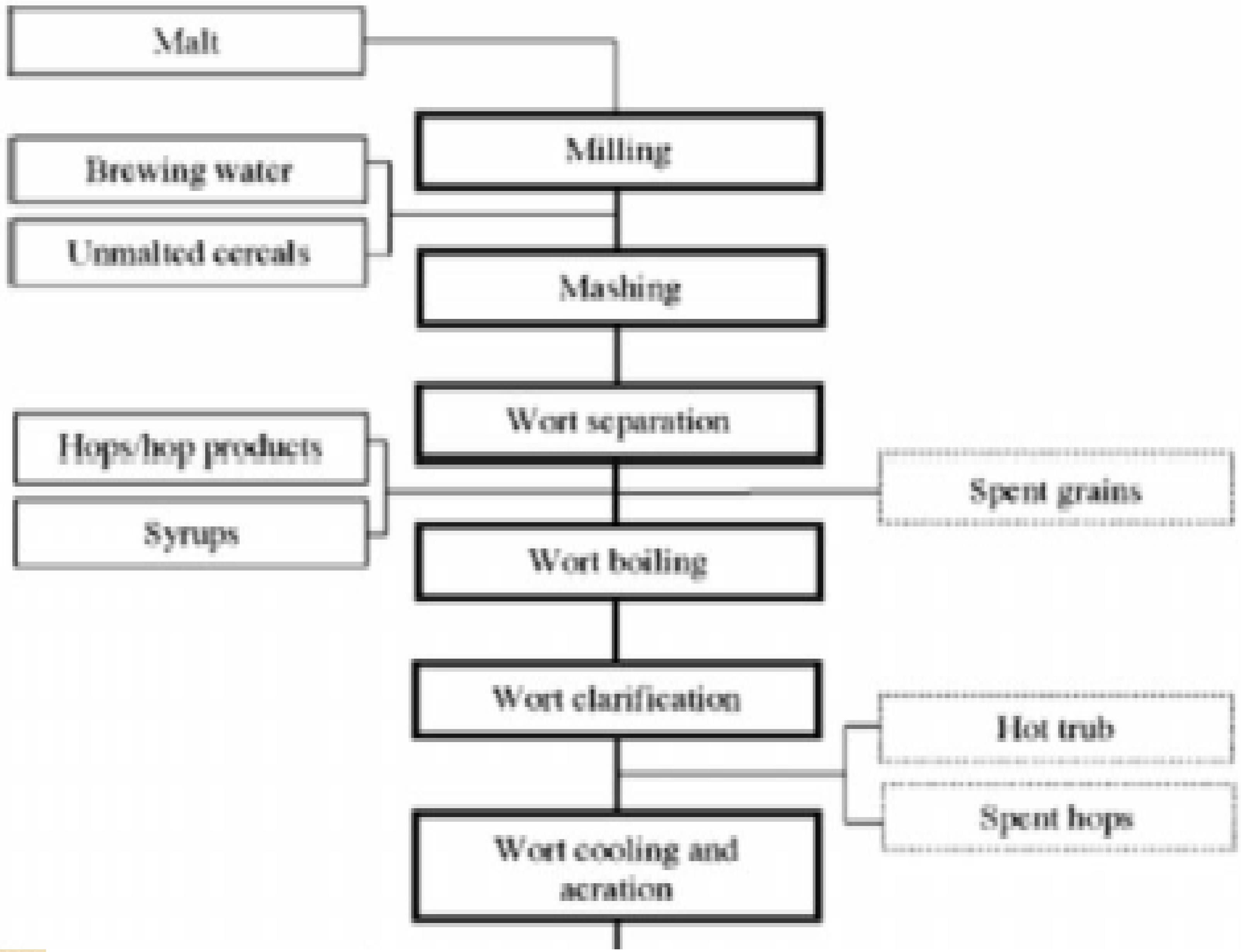
Type of fruit drink	Description
Fruit juice concentrates	Water removed from fruit juice by heating or freezing.
Carbonated fruit drinks	Carbon dioxide added to fruit drink.
Fruit nectars	Mixture of fruit pulp, sugar and water which is consumed as 'one shot'.
Fruit Sherbets	Cooled drink of sweetened diluted fruit juice.

Soft drinks and alcoholic beverages

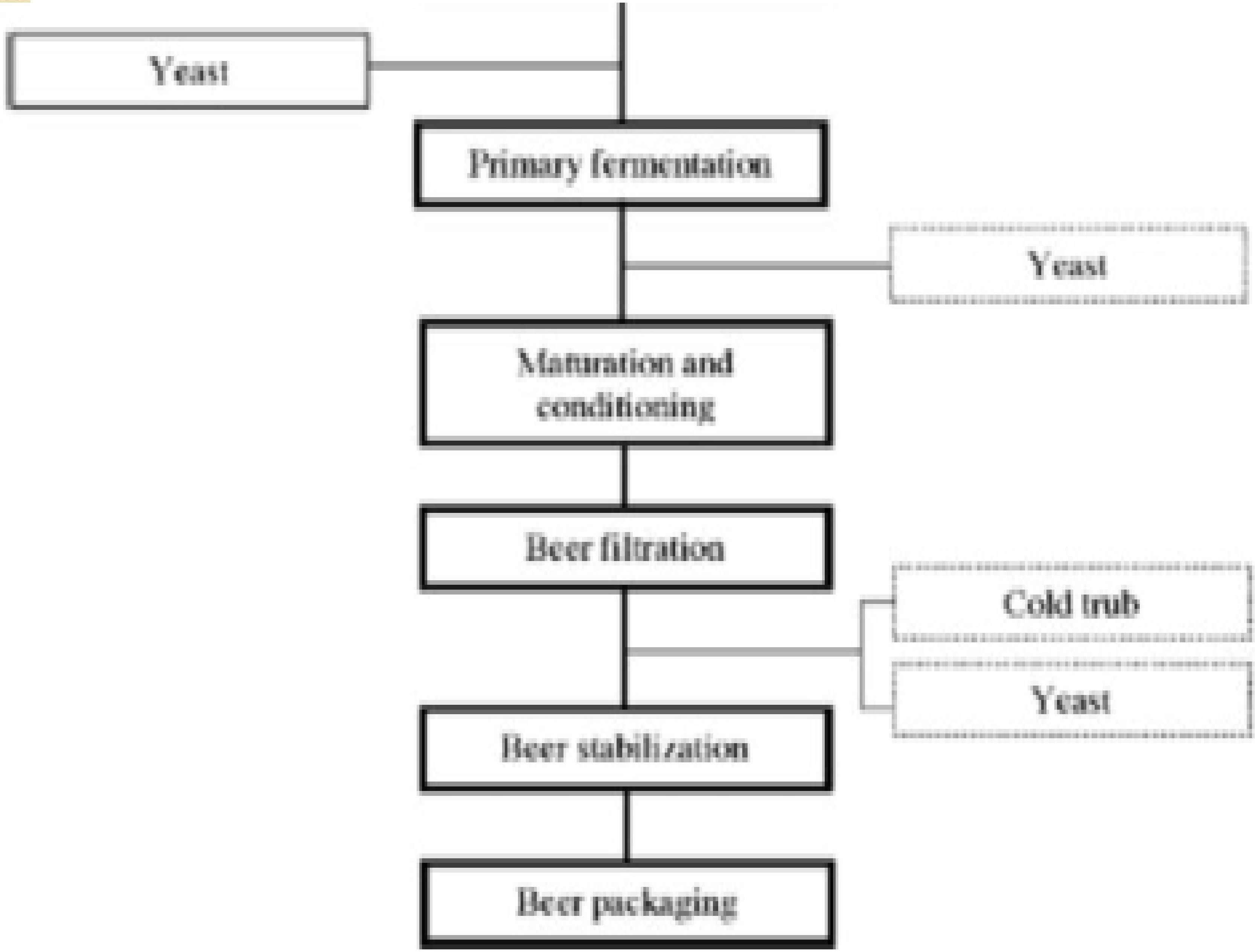
Alcoholic drinks

- Beer
- Cider
- Wine
- Spirits

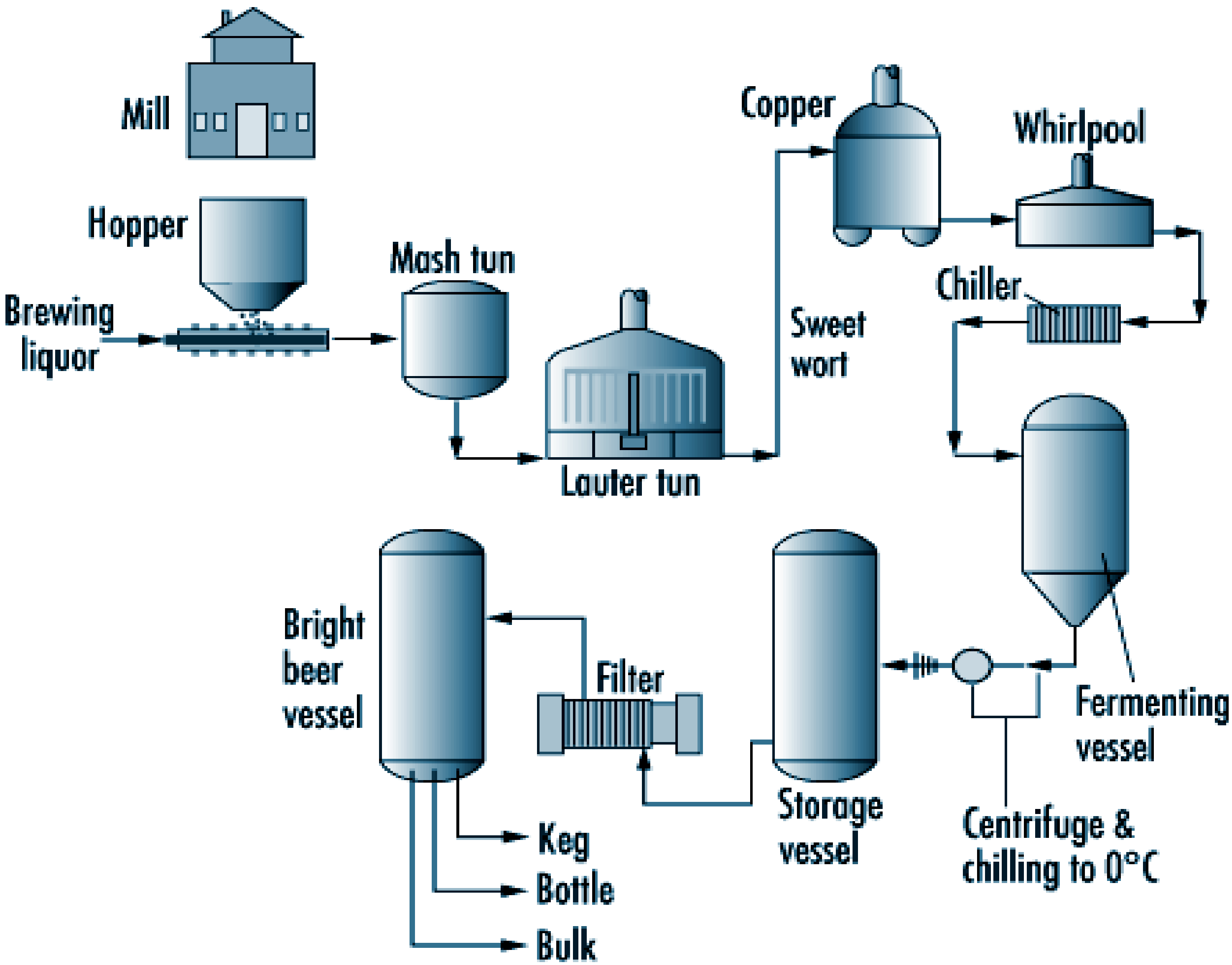
Beer Production :



Beer Production :

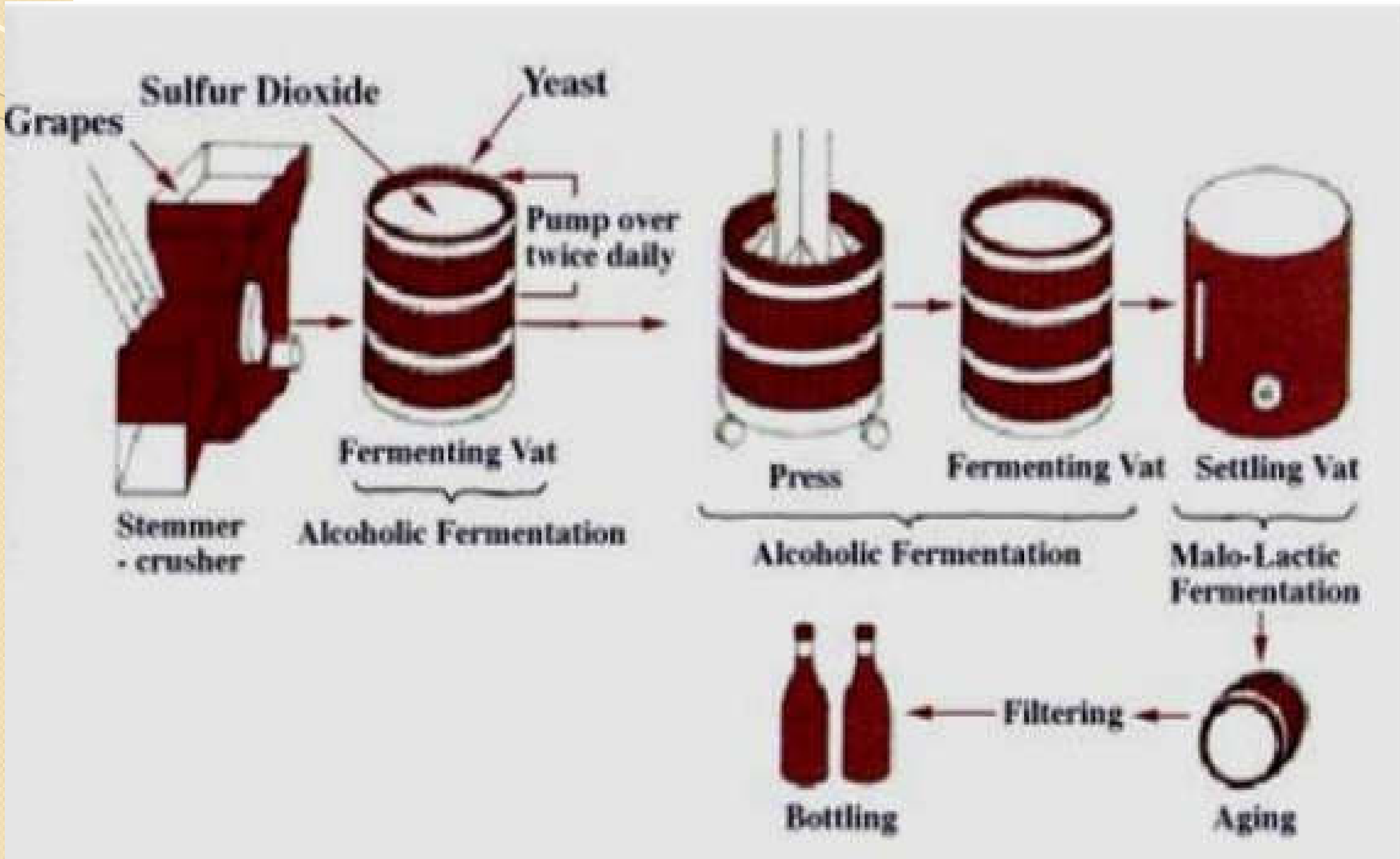


Soft drinks and alcoholic beverages

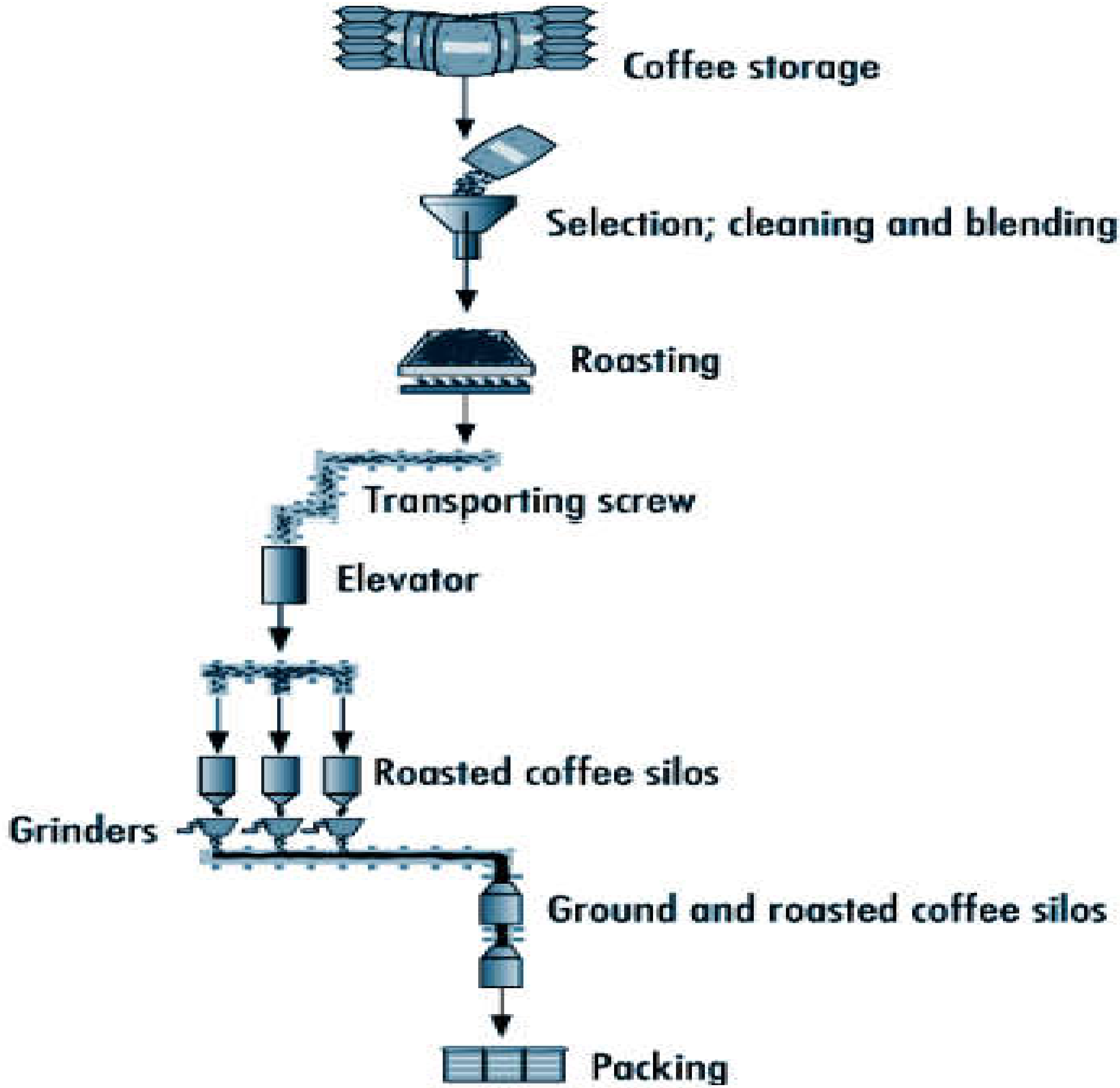


Soft drinks and alcoholic beverages

Wine production:



Coffee manufacturing flowchart:



Soft drinks and alcoholic beverages

Carbonated beverages:

Carbonated beverages in the form on naturally occurring carbonated mineral water have been known to exist since long.

Presence of carbon dioxide in aerated water and carbonated drinks enhance both palatability as well as appearance of these products.

Soft drinks and alcoholic beverages

Carbonated beverages:

The origin of carbonated water is traced back to the work of Joseph Priestly who produced first man-made carbonated water in 1767.

Carbonated drinks are invariably consumed without dilution and include crushes, lemonades, cola drinks and mixed drinks.

Soft drinks and alcoholic beverages

Water is the main ingredient of carbonated beverage that comprises more than 90% of the total volume.

The water which is used in preparation of carbonated beverages must of very high potable standards.

Therefore, water pre-treatment is necessary to ensure the high standards of finished beverage such as removal of microscopic and colloidal particles by coagulation, filtration, softening and pH adjustment in the areas where water is of poor quality.

Soft drinks and alcoholic beverages

Water used in carbonated beverage must possess following properties:

- Low alkalinity to check neutralization of acids otherwise it would affect flavours and may decrease preservation effect of acids.
- Low iron and manganese to prevent reaction with flavouring and coloring compounds
- No residual chlorine- as it affects flavour adversely and cause oxidation
- Very low turbidity and colour to impart attractive appearance to the drink.
- Organic matters and inorganic solids must be very low as it provides nuclei for CO_2 resulting in beverage boiling

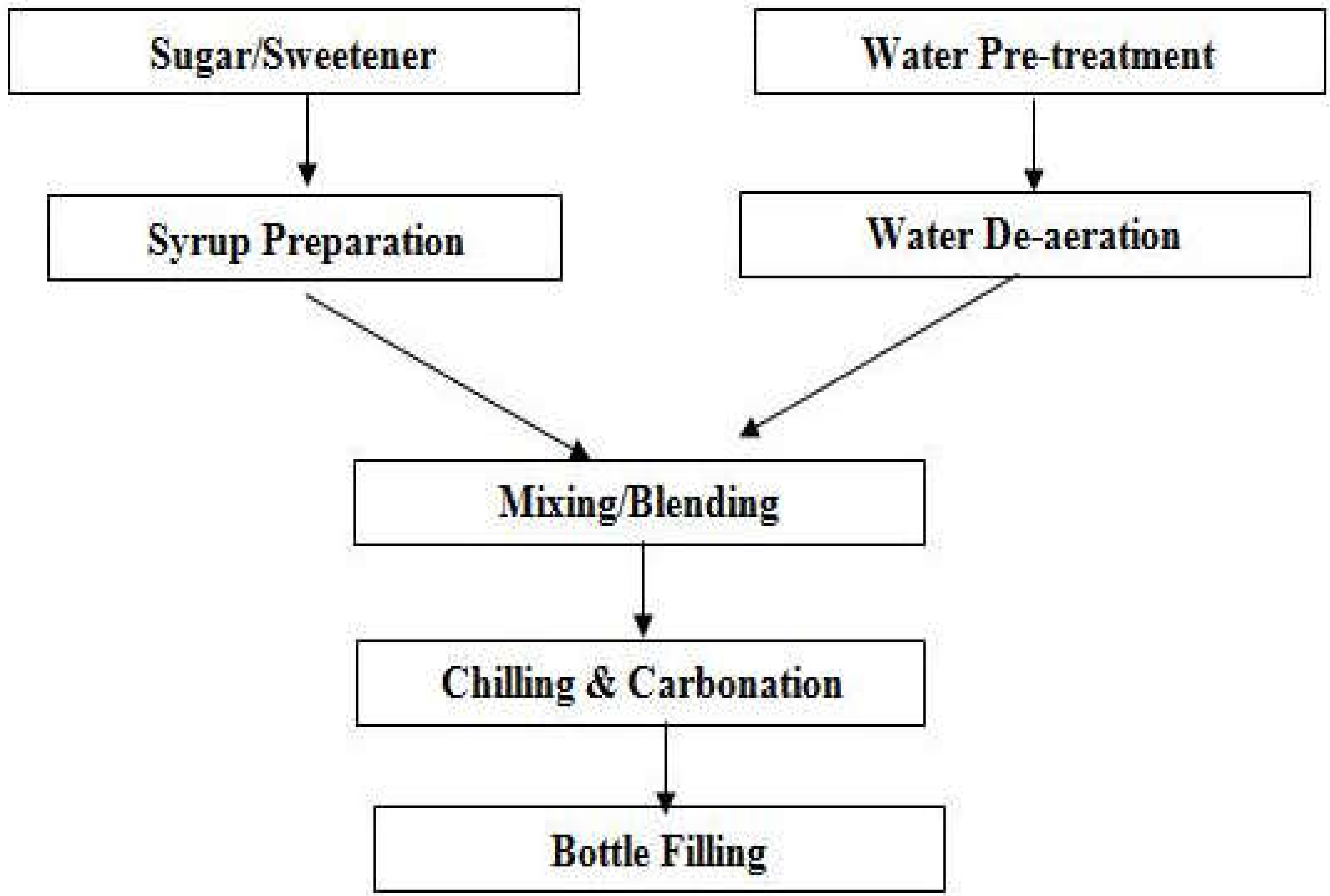
Soft drinks and alcoholic beverages

Water used in carbonated beverage manufacture must meet the following standards.

Particulars	Maximum Permissible Limit
Alkalinity	50 ppm
Total solids	50 ppm
Iron	0.1 ppm
Manganese	0.1 ppm
Turbidity	5 ppm
Colour	Colourless
Residual chlorine	None
Odour	Odourless
Taste	Tasteless
Organic Matter	No objectionable content

Soft drinks and alcoholic beverages

Manufacturing Process of Carbonated Beverages



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Muthayammal Engineering College (Autonomous)
Rasipuram 637408

16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Dairy products

Dr. N. Saravanan
Professor

Dairy products

Dairy products or milk products are a type of food produced from or containing the milk of mammals.

They are primarily produced from mammals such as cattle, buffaloes, goats, sheep, camels.

Dairy products include food items such as yogurt, cheese and butter.

A facility that produces dairy products is known as a dairy, or dairy factory

Dairy products

Milk is produced after optional homogenization or pasteurization, in several grades after standardization of the fat level.

Milk can be broken down into several different categories based on type of product produced, including cream, butter, cheese, infant formula, and yogurt.

Milk varies in fat content. Skim milk is milk with zero fat, while whole milk products contain fat.

Dairy products

The dairy industry involves processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk(milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization.

Typical by-products include buttermilk, whey, and their derivatives.

Dairy industries have shown tremendous growth in size and number in most countries of the world.

Dairy products

These industries discharge wastewater which is characterized by high chemical oxygen demand, biological oxygen demand, nutrients, and organic and inorganic contents.

Such wastewaters, if discharged without proper treatment, severely pollute receiving water bodies

Dairy products

Dairy processing plants can be divided into two categories:

Fluid milk processing involving the pasteurization and processing of raw milk into liquid milk for direct consumption, as well as cream, flavored milk, and fermented products such as buttermilk and yogurt.

Industrial milk processing involving the pasteurization and processing of raw milk into value-added dairy products such as cheese and casein, butter and other milk fats, milk powder and condensed milk, whey powder and other dairy ingredients, and ice cream and other frozen dairy products.

Dairy products

Dairy processing activities:

- Raw Milk Collection, Reception and Storage
- Separation and Standardization
- Homogenization
- Heat Treatment and Cooling of Milk Products
- Milk and Dairy Product Production
  - Milk production
  - Cheese production
  - Butter production
  - Milk powder production
- Packaging of Milk and Dairy Products

Dairy products

Raw Milk Collection, Reception and Storage

- The first steps in preserving the quality of milk should be taken at the farm.
- To achieve the best quality raw milk at intake, milking conditions must be as hygienic as possible.
- The milk must be chilled to below + 4°C immediately after milking and be kept at this temperature during transport to the dairy. Raw milk is collected and transported to the processing plant in stainless steel

Dairy products

Separation and Standardization

- Centrifugal separation and clarification is common in dairy processing to ensure further processing of standard products avoiding quality variations.
- Standardization of the dry matter for fat, protein, and lactose content of the milk usually takes place in the production phase of most dairy products

Dairy products

Homogenization

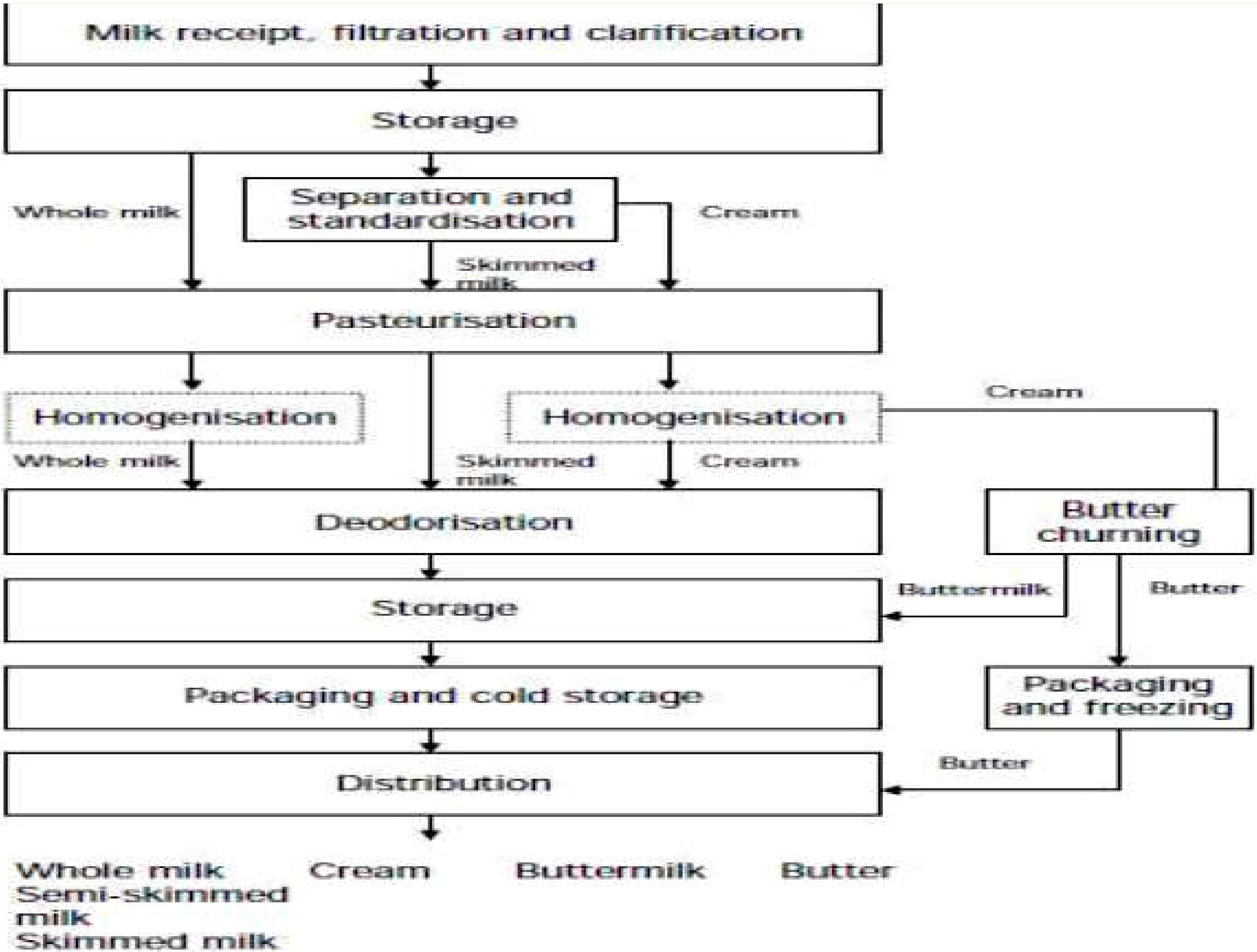
- The aim of homogenization is to prevent gravity separation of the fat in the product and to improve the stability of mainly cultured products.
- The homogenizer consists of a high pressure pump and homogenizing valve driven by a powerful electric motor.

Dairy products

MILK PRODUCTION

The processes taking place at a typical milk plant include:

- Receipt and filtration/clarification of the raw milk;
- Separation of all or part of the milk fat (for standardisation of market milk, production of cream and butter and other fat-based products, and production of milk powders);
- Pasteurisation;
- Homogenisation (if required);
- Deodorisation (if required);
- Further product-specific processing;
- Packaging and storage, including cold storage for perishable products;
- Distribution of final products.



Milk receipt, filtration and clarification
Storage
Whole milk
Separation and standardisation
Cream
Skimmed milk
Pasteurisation
Homogenisation
Homogenisation
Cream
Whole milk
Skimmed milk
Cream
Deodorisation
Butter churning
Storage
Buttermilk
Butter
Packaging and cold storage
Packaging and freezing
Distribution
Butter
Whole milk
Semi-skimmed milk
Skimmed milk
Cream
Buttermilk
Butter

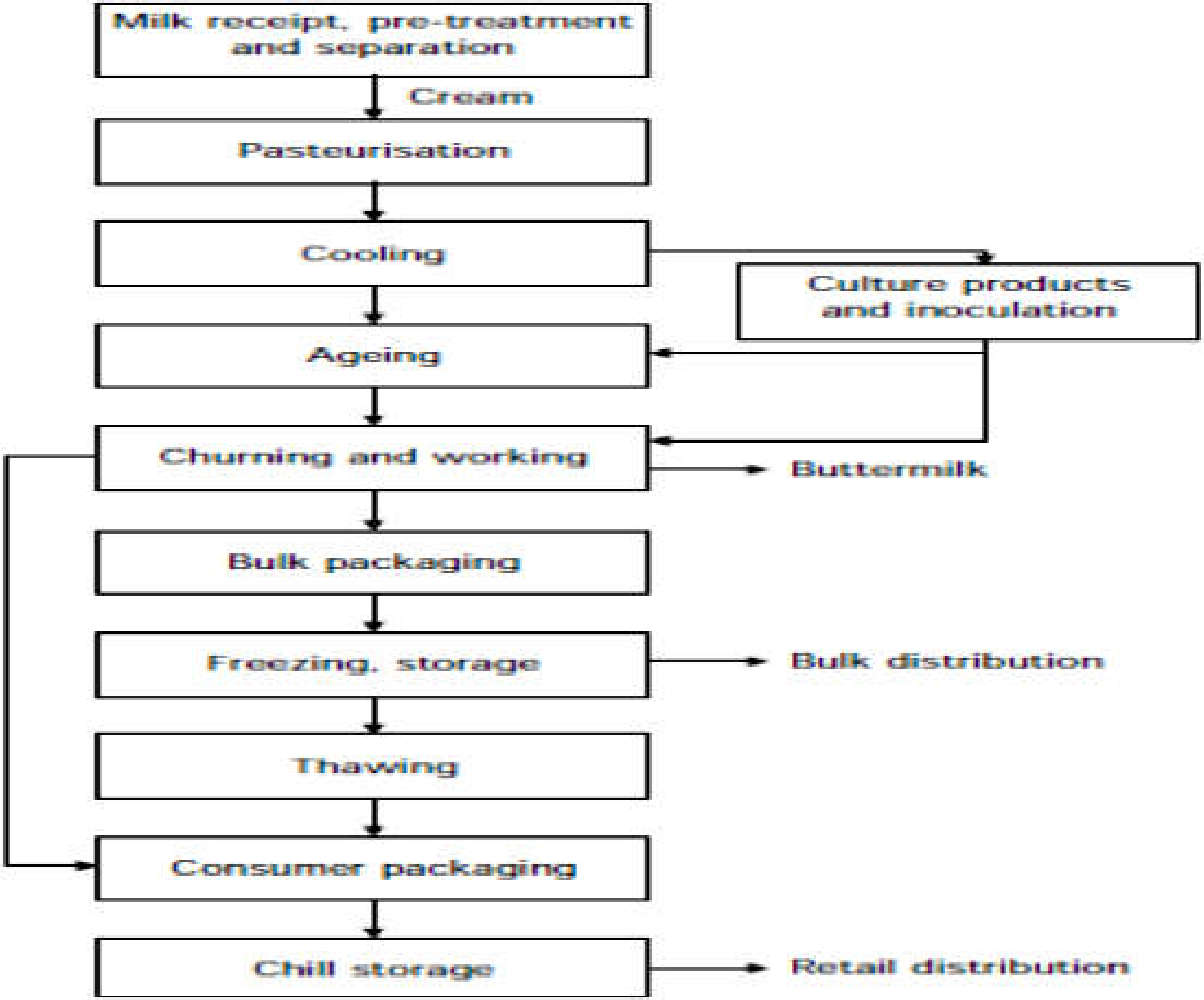
Dairy products

Butter Production

The butter-making process, whether by batch or continuous methods, consists of the following steps:

- Preparation of the cream;
- Destabilisation and breakdown of the fat and water emulsion;
- Aggregation and concentration of the fat particles;
- Formation of a stable emulsion;
- Packaging and storage;
- Distribution.

Dairy products



Milk receipt, pre-treatment and separation
Cream
Pasteurisation
Cooling
Culture products and inoculation
Ageing
Churning and working
Buttermilk
Bulk packaging
Freezing, storage
Bulk distribution
Thawing
Consumer packaging
Chill storage
Retail distribution

Dairy products

Cheese Production

Virtually all cheese is made by coagulating milk protein (casein) in a manner that traps milk solids and milk fat into a curd matrix.

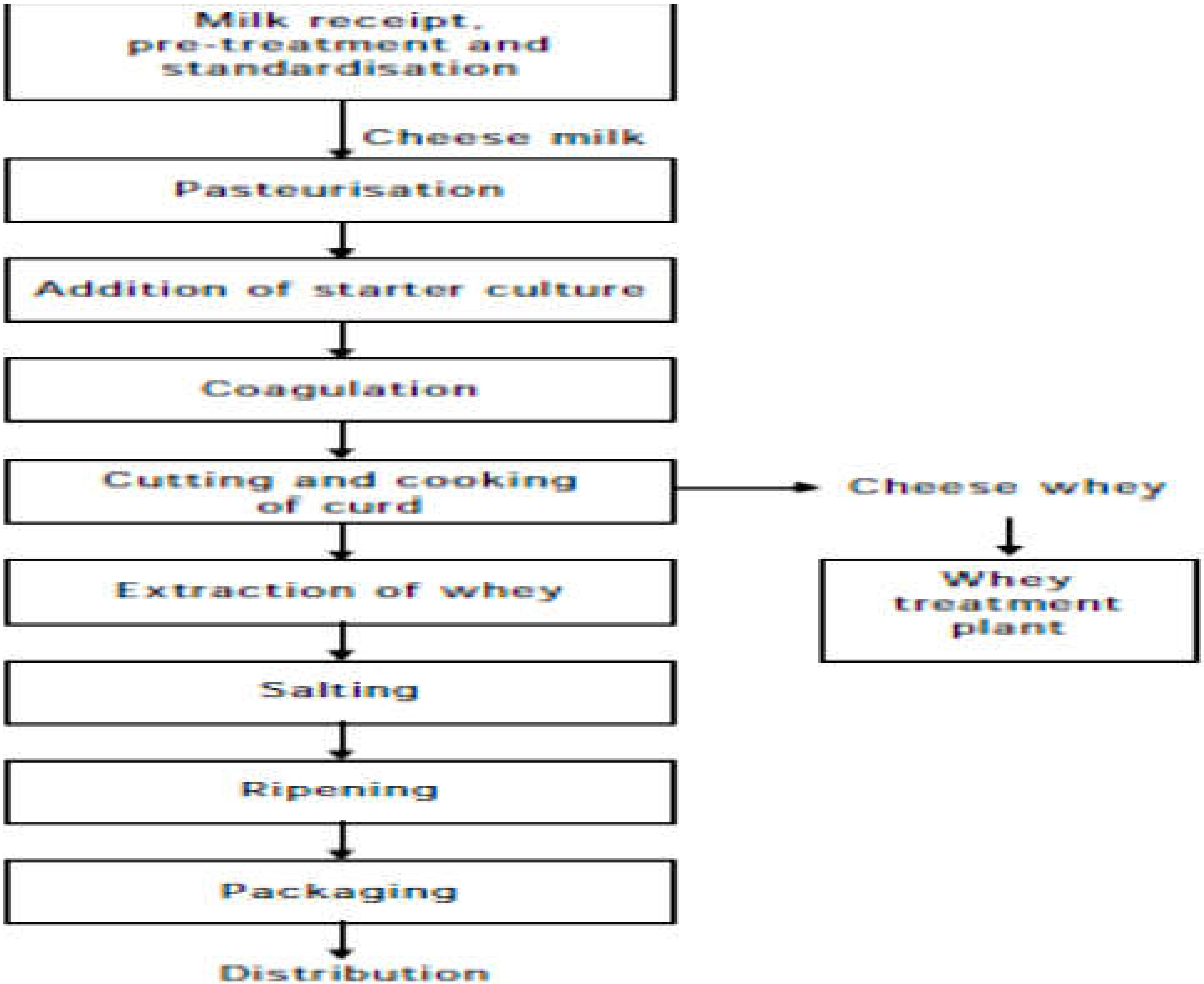
This curd matrix is then consolidated to express the liquid fraction, cheese whey.

Cheese whey contains those milk solids which are not held in the curd mass, in particular most of the milk sugar (lactose) and a number of soluble proteins.

Dairy products

Milk receipt, pre-treatment and standardization

- Pasteurisation
- Addition of starter culture
- Coagulation
- Extraction of whey
- Cutting and cooking of curd
- Salting
- Ripening
- Packaging
- Distribution


Milk receipt, pre-treatment and standardisation
Cheese milk
Pasteurisation
Addition of starter culture
Coagulation
Cutting and cooking of curd
Cheese whey
Whey treatment plant
Extraction of whey
Salting
Ripening
Packaging
Distribution

Dairy products

Milk Powder Production

The milk is preheated in tubular heat exchangers before being dried.

The preheated milk is fed to an evaporator to increase the concentration of total solids.

The solids concentration that can be reached depends on the efficiency of the equipment and the amount of heat that can be applied without unduly degrading the milk protein.

Dairy products

The milk concentrate is then pumped to the atomizer of a drying chamber.

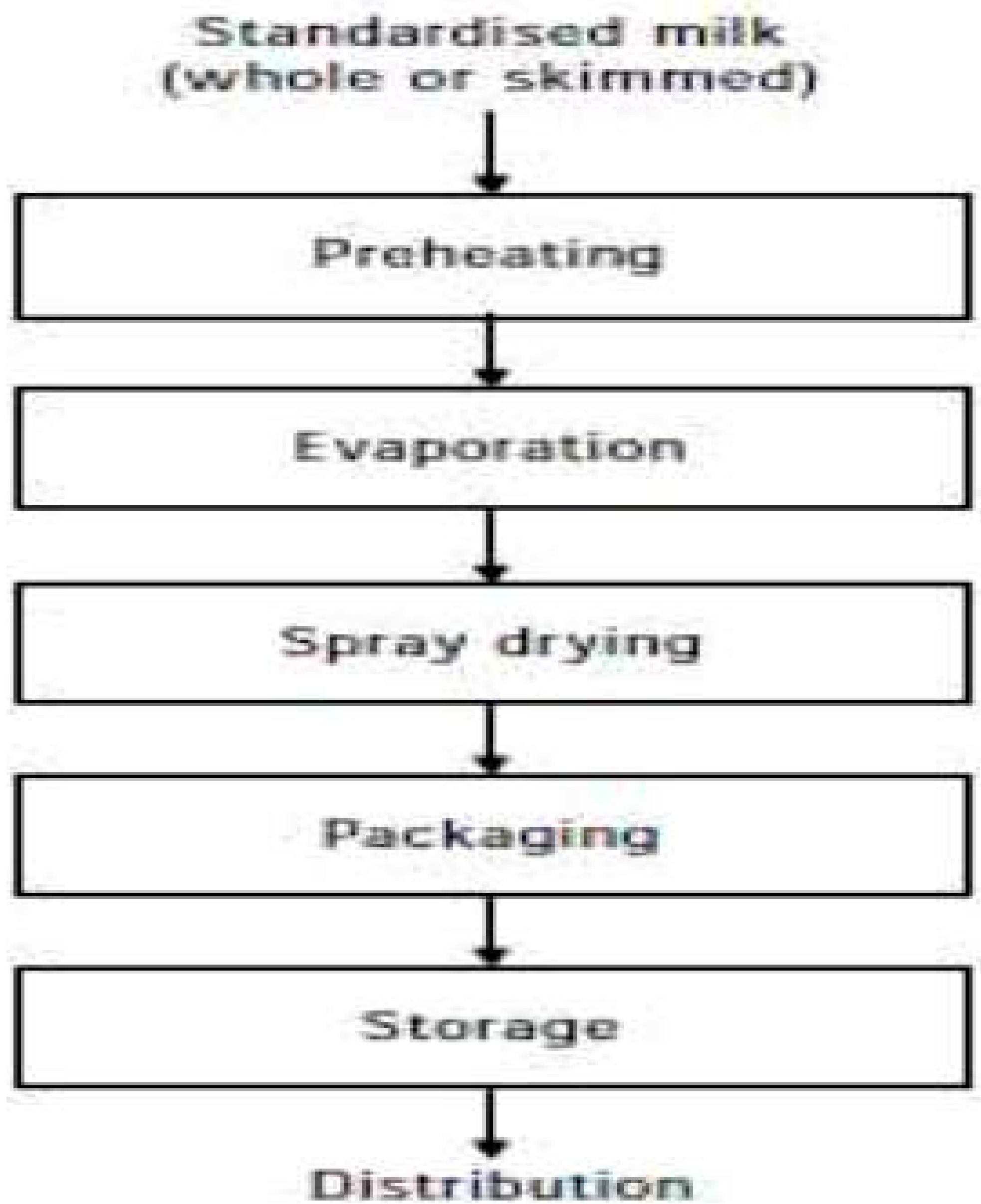
In the drying chamber the milk is dispersed as a fine fog-like mist into a rapidly moving hot air stream, which causes the individual mist droplets to instantly evaporate.

Milk powder falls to the bottom of the chamber, from where it is removed.

Fine milk powder particles are carried out of the chamber along with the hot air stream and collected in cyclone separators.

Dairy products

Dairy products

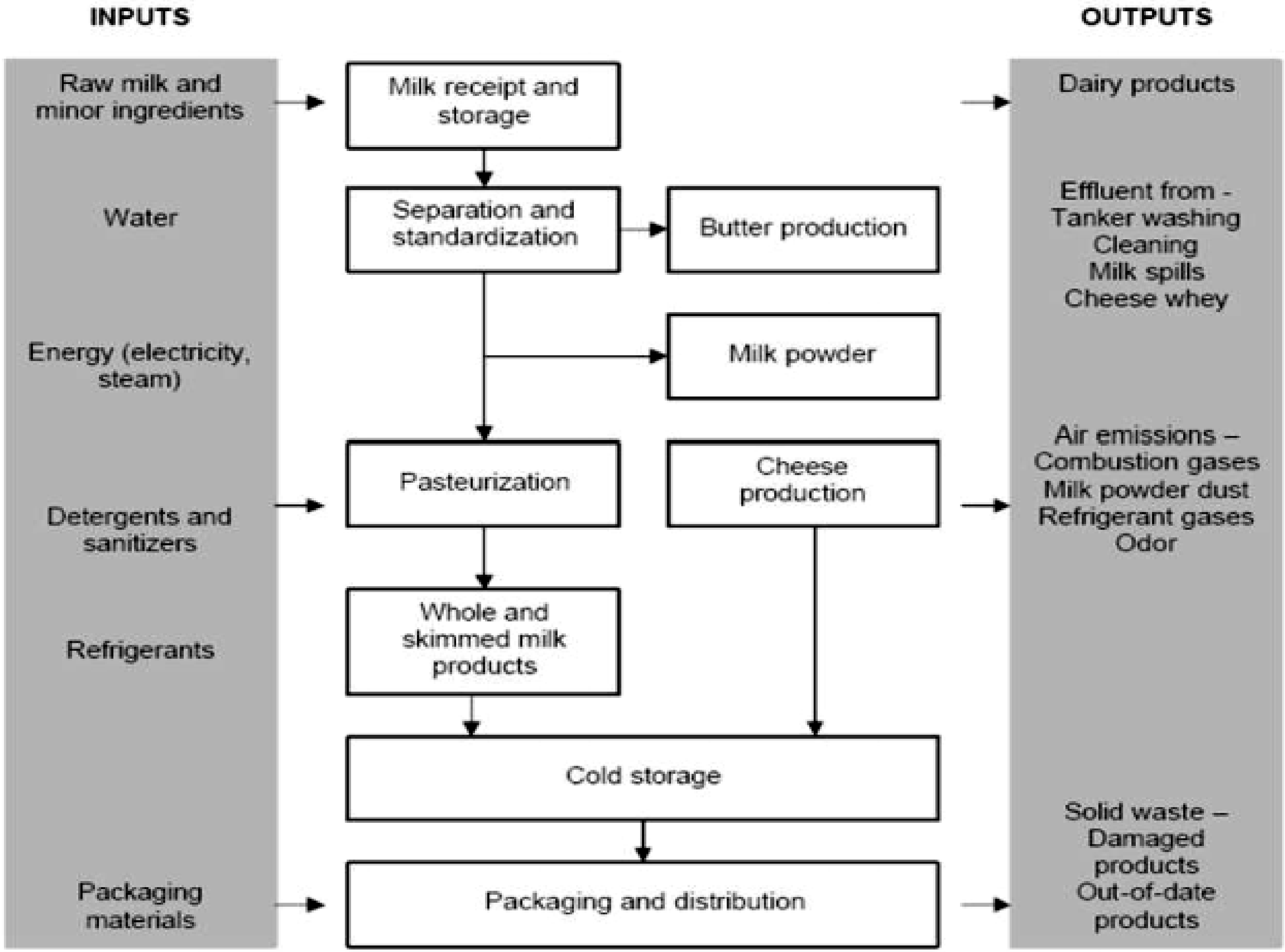


Dairy products

Packaging of Milk And Dairy Products

- Packaging protects the product from bacteriological, light, and oxygen contamination.
- Liquid milk products may be packed in a beverage carton, which is mainly paperboard covered by a thin layer of food-grade polyethylene on either side.
- Milk cartons for long-life milk have an additional layer of aluminum foil.
- Many other packaging materials are also used, ranging from simple plastic pouches to glass bottles, PET laminates and PVC bottles.

Flow chart of dairy processing activities



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Muthayammal Engineering College (Autonomous) Rasipuram 637408

16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Poultry meat products

Dr. N. Saravanan

Professor

Poultry meat products

- The term "poultry" refers to domestic fowl reared for their flesh, eggs or feathers and includes chickens, ducks, turkeys and pigeons.
- Of these, chicken and turkey are most commonly used for their meat.
- Poultry meat is a good source of protein and has a lipid content and low calorific value.
- It is palatable, tender and easily digestible

Poultry meat products

Properties of poultry

•High in protein

•Low in fat

•Excellent source of essential amino acids

•Also a good source of Phosphorus, iron, copper, zinc, B vitamins (12 & 6)

•Dark meat and skin are higher in fat than white

Poultry meat products

Key terms:

Abattoir: It is a food factory where all the operations are dictated by the standards of hygiene and animal welfare. It aims at producing wholesome meat for consumer in the most humane way possible.

Carcass: The harvested dressed animal, wherein the hide, hooves, head and internal organs are removed.

Lairage: place where the animals are rested before slaughtering to preserve enough glycogen to be converted to lactic acid.

Poultry meat products

Slaughtering

Slaughtering refers to killing of domestic livestock. The slaughter involves some initial cutting, opening the major body cavities to remove the entrails but usually leaving the carcass in one piece. Later, the carcass is usually butchered into smaller cuts.

Slaughtering is done by two methods:

1. Traditional method
2. Modern method

Poultry meat products

Traditional methods

1.Kosher

- A Jewish method
- Only sheep, goat, cattle, deer and poultry Slaughtered.
- Meat should not contain any blood vessel.
- Meat should not be preserved for more than 3 days

Poultry meat products

2. Halal

- Muslim method of slaughtering.
- Pork in prohibited.
- No blood should be left in carcass.

3. Jhatka

- Practiced by Sikhs.
- Head is completely removed in one stroke.

Poultry meat products

Some Pre-slaughter factors affecting the slaughtering process

- Environmental factors like temperature, humidity.
- Improper resting time
- Feeding of the birds
- Stress during loading and unloading of birds
- Feeling of strangeness

Leads to the conditions called

1. DFD (Dark, Firm, Dry)
2. PSE (Pale, Soft, Exudative)

Poultry meat products

Modern method of slaughtering

1. Procurement

Done by judging the age of the bird by feeling the pliability of the posterior portion of breast by fingers.

2. Lairage

Resting period of about 6 hours is provided to birds in order to preserve the glycogen residues.

3. Ante-mortem Inspection

Birds are checked for the obvious evidences of any disease, extreme emaciation, and lump formation on the body part.

Poultry meat products

4. Stunning

The standard in modern poultry processing plants is to render birds insensible—that is, unconscious and incapable of feeling pain—prior to slaughter. The process is known as "stunning."

Generally done by 3 methods

a) Captive Bolt/Concussion/Knocking

b) Electrical Stunning

c) Carbon dioxide method

Poultry meat products

5. Sticking

It is done to facilitate bleeding of the birds and is done by 3methods:

a) Manually using knife (cut made to the ventral side of the neck up to the ear and jugular vein is cut)

b) Slaughtering cone (birds dropped in revolving cone with sharp end)

c) Box method (birds are passed through the box with a rotating knife at the other end)

Poultry meat products

6. Bleeding

Done for 2 minutes for birds. About 60% blood is lost on sticking. 22-25% remains under viscera and 10% remains in carcass.

7. Scalding

It is the process of dipping the birds in hot water to facilitate the removal of hair follicles. It is done by two methods:

a) Dip scald

b) Spray scald

Poultry meat products

8. Picking

It is the feather removal from the skin of the birds. It can be done by:

a) Hand picking

b) Use of knife with blunt edge

c) Mechanical method

9. Pinning

Removal of pin like feathers with a knife

Poultry meat products

10. Singeing

Removal of filoplumes using flame for surface sterilization, clean, uniform and neat appearance.

11. Evisceration / Cropping and Venting

Removal of viscera, crop, neck and also the fecal matter that may be present in the lower intestine. After this carcass is immediately washed.

Poultry meat products

12. Post mortem inspection

The carcass is examined externally for signs of disease, bone abnormalities, wounds, tumors. Liver and spleen is examined for consistency, texture and color changes.

13. Washing

Dressed carcass are washed again with clean spray of water preferably maintained at 10°C-15°C

Poultry meat products

14. Chilling and Draining

Carcass is chilled in chilling tanks in order to cool to an internal temperature of 4°C for 30-35minutes and then drained on draining racks for 10 minutes to remove excess water.

15. Grading

Dressed carcass is then graded depending on many factors like conformation, degree of fleshing, bruises, cuts and other quality attributes

Poultry meat products

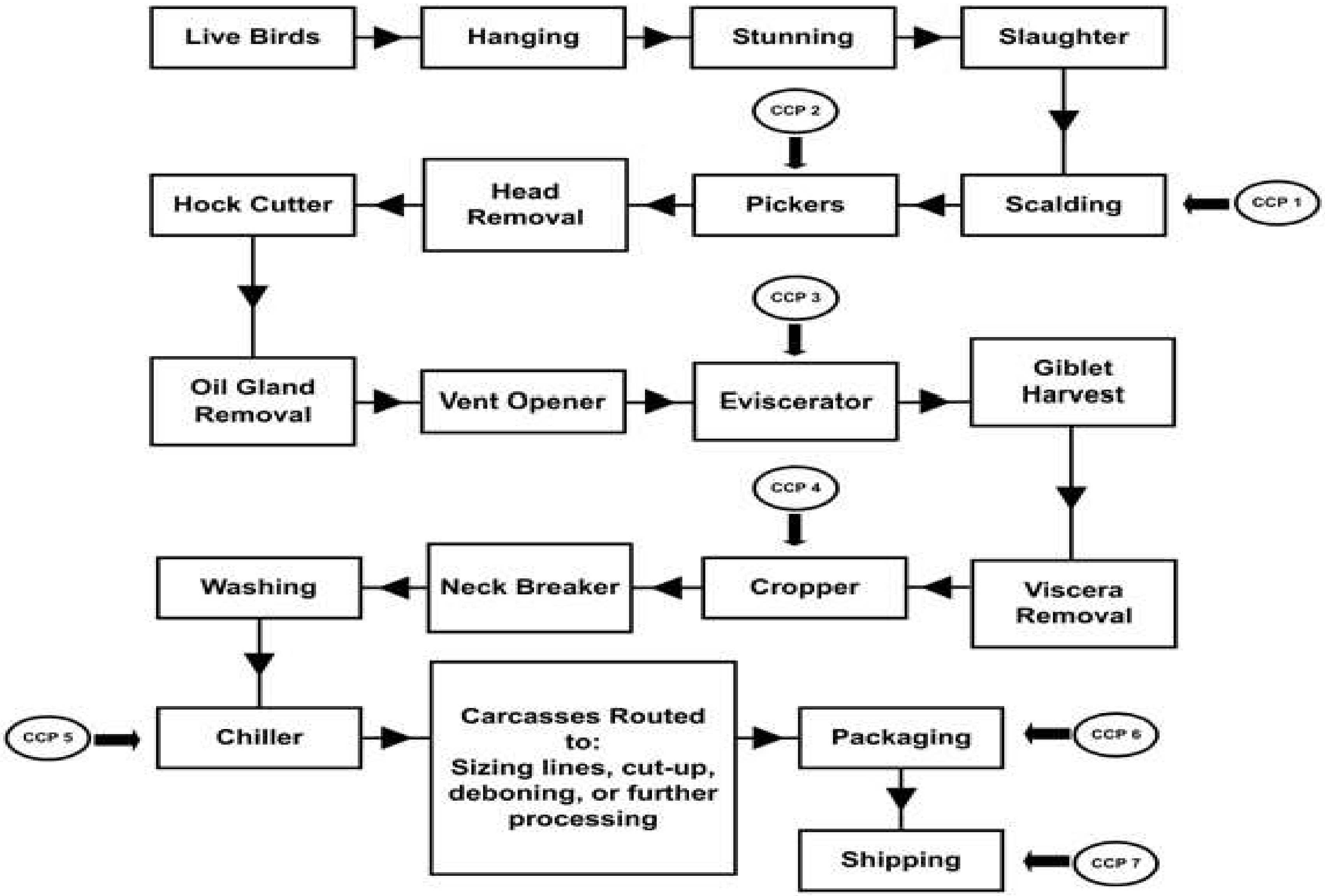
16. Packaging

Carcass is then according to their grading shrink packaged under cool conditions.

17. Storage

Dressed chicken can be stored in a refrigerator at 2°C for 7 days and deep freezer at -18°C to -20°C for a period of 4-6 months

Poultry meat products



Poultry meat products

Grading of meat

Grading is done for pricing segregation of products according to some grades and inspection.

In India, Grading is generally not practiced.

There are two types of grades:

1. Quality Grades (on the basis of pliability)
(USDA Prime, USDA Choice, USDA select, Good, Standard, Commercial, Utility, Cutter, Canner)

2. Quantity/ Yield grades
Ranking “1-5” according to the amount of useable meat from the carcass in the decreasing order of yield

Poultry meat products

Poultry processing in India

Even with a predominantly vegetarian population, the sheer number of poultry meat lovers in India is staggering. With a population of 1310 million, and a per capita annual broiler consumption of 4.3 kilograms, weekly slaughter exceeds 50 million numbers.

Of this, only 9% of the carcasses emerge from a processing plant of any description – whether modern automatic slaughterhouses or primitive table-top slaughter performed without the aid of any machinery.

Poultry meat products

The remaining ninety-one percent of India's broilers are slaughtered on the streets.

The good news is that the modern automated poultry slaughter sector exhibited 25% growth in capacity during 2017-2018.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Fish processing

Dr. N. Saravanan
Professor

Fish processing

The term fish processing refers to the processes associated with fish and fish products between the time fish are caught or harvested, and the time the final product is delivered to the customer.

Although the term refers specifically to fish, in practice it is extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or fish farming.

Fish processing

Larger fish processing companies often operate their own fishing fleets or farming operations. The products of the fish industry are usually sold to grocery chains or to intermediaries.

Fish are highly perishable.

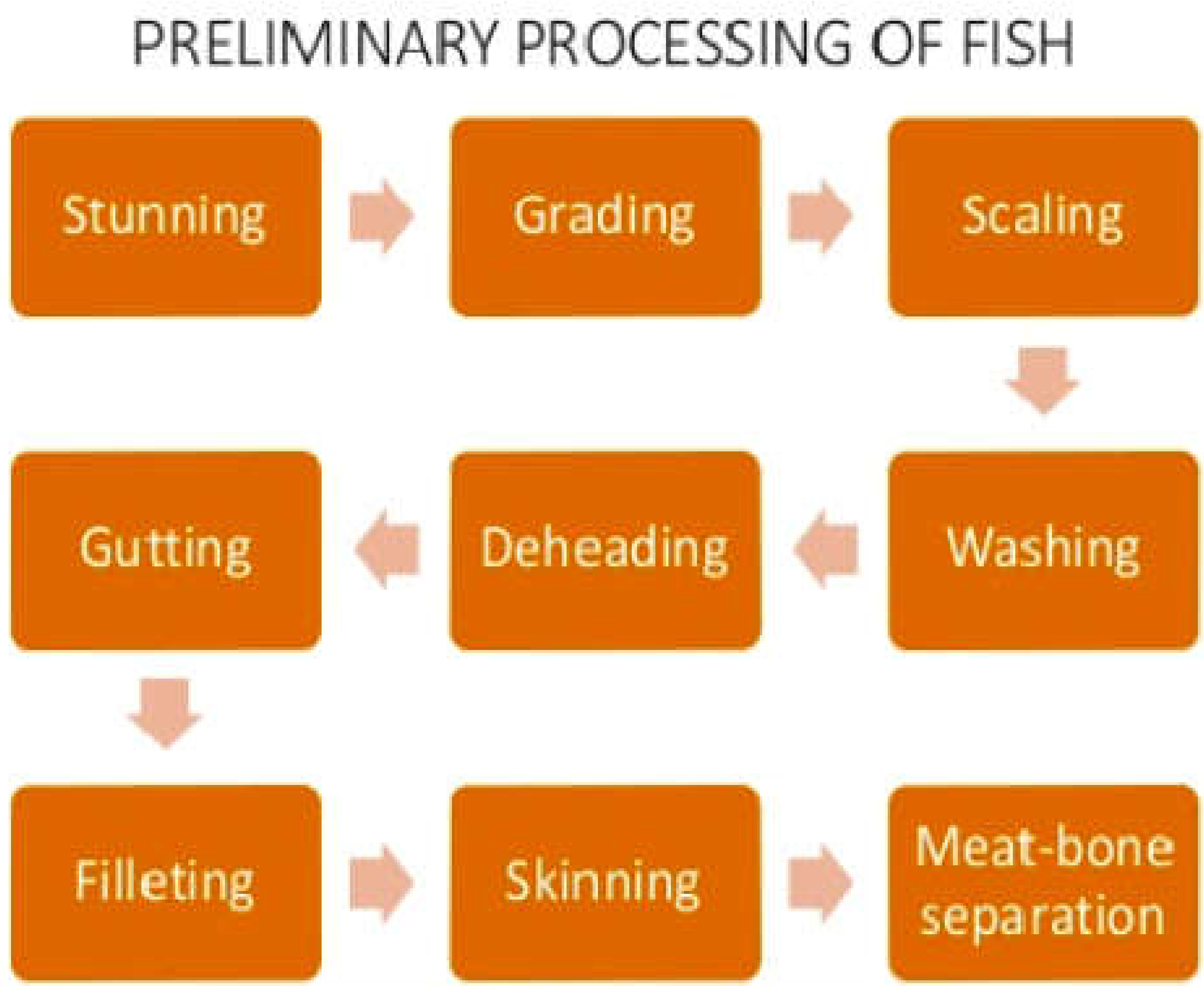
A central concern of fish processing is to prevent fish from deteriorating, and this remains an underlying concern during other processing operations.

Fish processing

Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish, and the manufacture of fish products.

Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products for the retail and catering trades

Fish processing



Fish processing

Stunning

- In many freshwater species the method of stunning is critical for final product quality because prolonged agony of fish causes production of undesired substances in the tissue. Oxygen deficiency in blood and muscle tissue results in accumulation of lactic acid and other reduced products of catabolic processes and consequently in a paralysis of the neural system.

- Stunning of freshly caught fish or fish delivered live to a processing plant is best done with an electric current. First, the fish are placed in a tank of water and an electric current is then passed through the water to stun or kill the fish.

- In some plants, water in the fish tanks is saturated with carbon dioxide which renders the animals unconscious or dead.

Fish processing

Grading

The processing sequence starts from grading the fish by species and size. Sorting by species or on the basis of freshness and physical damage are still manual processes, but grading of fish by size is easily done with mechanical equipment.

Size grading is very important for fish processing (i.e., smoking, freezing, heat treatment, salting, etc.) as well as for marketing

Automated grading is 6-10 times more efficient than manual grading. The sorting speed of different graders varies and depends on the type of device and size of fish sorted. Sorting capacity is 1-15 t/hour.

Fish processing

Scaling

Electrical hand-held scalers simplify and speed up the scaling procedure. They are most commonly used for secondary scaling of fish which has left the automated scaling device 80-90% free of scales. Use of electrical hand-held scalers reduces labour intensity and assures complete elimination of scales.

Another kind of cylindrical scaler with a horizontal rotation axis can be periodically tilted during a scaling cycle which causes fish to tumble inside the drum, and consequently scales more efficiently. In some fish species, the scales can be removed from fish with a pressurized stream of water while fish is placed inside the scaler drum

Fish processing

Washing

Washing is intended primarily to clean the fish and to remove accumulated bacteria. The effectiveness of the washing procedure depends, inter alia, on the kinetic energy of the water stream, ratio of fish volume to water volume and on the water quality.

To improve the effectiveness of the cleaning procedure, various mechanized scrubbing devices are utilized which can remove up to 90% of the initial bacterial contamination. Potable water is used for washing in freshwater fish processing plants.

The operation cycle for these machines is 1-2 minutes. The vertical drum washer is frequently used because of its conveniently small size. The most common is the horizontal tumbler washer.

Fish processing

Deheading

The head constitutes 10-20% of the total fish weight and it is cut off as an inedible part.

An average de-heading device can usually be used to process fish for which a difference between minimum and maximum length does not exceed 30-40 cm. The cutting elements used in the de-heading machines are either disc, contoured, cylindrical knives, band saws or guillotine cutters. A machine operator adjusts the position of the cutting element according to the fish size. Thus the amount of meat lost during the de-heading procedure depends not only on the type of head cut but on the experience and skill of the operator. The speed of a de-heading device depends on the size of fish processed and is usually 20-40 fish/minute.

Fish processing

Gutting

Manually cutting away the fins with either a knife, special mechanized scissors or rotating disc knives, is a labour-intensive and strenuous operation when handling larger fish. This operation is most frequently done after gutting during the production of deheaded whole fish and fish steaks. An automated device consisting of the rotating disc knives with a slit cutting edge, powered by electric motor facilitates and speeds up the fin removal procedure. The knife slot has a horizontal opening through which the dorsal and ventral fins are passed manually and cut out.

Fish processing

Filleting

A fillet which is a piece of meat consisting of the dorsal and abdominal muscles has been a most sought-after fish product in the retail market. Filleting efficiency depends upon fish species, size and nutritional condition.

Filleting machines for processing marine fish are quite costly and are not suitable for freshwater species; in the case of trout, for example, expensive multi-function devices have been designed which are not used in small processing plants.

Fish processing

Skinning

Compared with manual operations, this machine facilitates and speeds up skinning. Some devices are small and can be placed directly on the processing table; running water and electricity are necessary for their operation. Efficiency varies depending upon the fish species. The price of these devices varies; some are quite expensive and their use is profitable only when a certain level of production is maintained. Depending on fillet size and type of machine, 20 to over 40 fillets/minute can be skinned; faster machines require a conveyor to move the fillets.

Fish processing

Meat-bone separation

Meat is separated from the bones, skin and scales, in automated devices called separators. In the separator shown in Figure 3.23, meat is squeezed through holes into the cylinder under pressure applied by a conveyor belt partially encircling the cylinder (about 25% of the cylinder's perimeter). The cylinder rotates slightly faster than the conveyor.

The smaller the holes, the stronger the grinding action. Pressure applied by the conveyor to the cylinder can be regulated depending on the type and size of the raw product and on the hole diameter.

Fish processing

CAUSES OF SPOILAGE

The fish spoilage may be caused by 3 causes

a) Bacteria

b) Digestive enzymes

c) Others such as oxidation, etc.

The flesh of freshly caught fish is sterile while the spoiling microflora is present in external slime and digestive tracts.

Fatty fishes may develop spoilage due to all 3 above mentioned causes.

If not gutted soon after catch, strong digestive enzymes affect the viscera and belly walls and cause discoloration- ‘ belly bum’ or disruption- ‘ torn bellies’

Fish processing

Handling of market fish

- Fish should be purchased as fresh or frozen as possible
- Exposure to unsafe temperature should be avoided
- Exposure to contaminants should be avoided by keeping fishes in plastic bag
- It should be kept in refrigerators at home
- It should be stored at proper temperature- if hot, temperature should be 140°F and if to be kept cold, temperature should be 40°F or less

Fish processing

Handling of fresh catch

- Efforts should be done to keep the fish alive as long as possible- by keeping in metal link basket or live box.
- The fish should be checked for signs of disease or parasites or for any abnormal growth in the flesh.
- It should be made certain that the fish is being taken from safe water without any contaminants.
- If it is difficult to keep fish alive, it should be stored at temperature below 40°F.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Preservation Methods

Dr. N. Saravanan
Professor

Preservation Methods

Food preservation prevents the growth of microorganisms and slowing the oxidation of fats.

Food preservation may also include processes that inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut during food preparation.

Many processes designed to preserve food involve more than one food preservation method.

Preservation Methods

PRINCIPLES OF FOOD PRESERVATION

1. Keep the food alive as long as possible. Kill the animal or plant just before it is to be used
2. After killing the food clean it, cover it and cool it as quickly as possible. This will slowdown the deterioration for a short time
3. For long term and practical preservation inactivating or controlling microorganisms, enzymes and reducing or eliminating chemical reactions are to be done

Preservation Methods

Preservation by heat (thermal processes): microorganisms and enzymes are destroyed at high temperatures.

The extent of destruction depends on the temperature, the time of exposure and, of course, on the heat resistance of the microorganism or enzyme in question in the given medium.

Exposure to high temperature does not only destroy microorganisms and enzymes.

Preservation Methods

It also accelerates a multitude of chemical reactions leading to changes in texture, flavor, appearance, color, digestibility and nutritional value of the food.

Some of these changes are desirable and constitute the complex process known as ‘cooking’.

Others are objectionable and are collectively named ‘ thermal damage’.

Preservation Methods

Preservation by removal of heat (low temperature processes):

The activity of microorganisms and enzymes as well as the velocity of chemical reactions are depressed at low temperatures.

In contrast to heat, low temperature does not destroy enzymes and microorganisms to any significant extent, but merely depresses their activity.

Preservation by cold encompasses two distinct technological processes:

Preservation Methods

chilling (maintaining the food at low temperature above the freezing point of the food) and freezing (below the freezing point).

The difference between the two is not only in the temperature.

A substantial part of the preservation effect of freezing is due to the change of phase, from liquid to solid, with the corresponding reduction in molecular mobility

Preservation Methods

Preservation by reduction of water activity:

It is well known that microorganisms cannot develop at water activity levels below a limit value depending on the microorganism.

Enzyme activity is also water activity dependent. Drying, concentration, addition of solutes (sugar, salt) are preservation techniques based on the reduction of water activity.

Preservation Methods

Ionizing radiation has the capability of destroying microorganisms and inactivating enzymes.

This powerful preservation technique has great potential as a solution to many problems in food production and distribution.

Its widespread application is hindered by a number of problems, mainly in the area of consumer perception.

Preservation Methods

Chemical preservation: Two of the oldest food preservation techniques, namely salting and smoking, are based on the effect of salt and smoke chemicals on microorganisms.

Many pathogens cannot develop at low pH, hence the use of acids as food preservatives.

The pH of foods can be lowered, either by the addition of acids (vinegar, citric acid or lemon juice).

Preservation Methods

Thermal processing:

Depending on their intensity, thermal preservation processes are classified into two categories:

1. *Pasteurization*: heat processing at relatively mild temperature (70–100°C). Pasteurization destroys vegetative cells of microorganisms but has almost no effect on spores.

2. *Sterilization*: heat processing at high temperature (above 100°C) with the objective of destroying all forms of microorganisms, including spores.

Preservation Methods

Sterilization alone provides long-term preservation of foods, on the condition that recontamination is prevented by proper packaging.

Pasteurization, on the other hand, provides only short-term stability or requires additional preserving factors (hurdles) such as refrigeration or low pH for long-term effectiveness.

Following are some cases where pasteurization gives satisfactory results:

Preservation Methods

1. The process objective is to destroy non-spore-forming pathogens (e.g. *Mycobacterium tuberculosis*, Salmonella, Listeria etc. in milk, Salmonella in liquid egg)
2. The product is intended for consumption within a short time after production and is distributed under refrigeration (pasteurized dairy products, ready-to-eat meals prepared by cook–chill technologies)

Preservation Methods

3. The acidity of the product is high enough (pH 4.6) to prevent growth of spore-forming pathogens, particularly *Clostridium botulinum* (fruit juices, canned fruit, pickles)

4. The process objective is to prevent ‘ wild ’ fermentation and/or to stop fermentation (wine, beer).

Preservation Methods

In addition to pasteurization and sterilization, *blanching* may be considered a mild thermal treatment, the main purpose of which is to inactivate enzymes.

It is mainly applied as a step in the preparation of vegetables prior to canning, freezing or dehydration.

Blanching is carried out by immersing the vegetables in hot water or exposing them to open steam.

Preservation Methods

Although its main objective is to inactivate certain enzymes, blanching has additional desirable effects such as enhancing the color, expelling air from the tissue and cleaning the surface.

Thermal processes may be applied either to food in hermetic containers or to food in bulk before packaging. Thermal treatment before packaging is most commonly applied to pumpable products.

Preservation Methods

This category of thermal processes includes the technology commonly known as ' canning '.

In this method, the food is heated and cooled while contained in hermetically closed packages.

The hermetic package protects the sterilized or pasteurized food from recontamination.

The method is suitable for foods in all physical forms: solids, liquids or liquids with solid particles.

The packages can be cans, jars, bottles, trays, tubes, pouches etc

Preservation Methods

Classification of thermal process

In-package processing	Bulk processing	
	Hot filling	Aseptic filling
Food	Food	Food
↓	↓	↓
Preheating	Heating (heat exchanger)	Heating (heat exchanger)
↓	↓	↓
Filling	Holding	Holding
↓	↓	↓
Exhausting	Hot filling	Cooling (heat exchanger)
↓	↓	↓
Sealing	Sealing	Aseptic filling
↓	↓	↓
In-package heating	In-package cooling	Aseptic sealing
↓		
In-package cooling		

Preservation Methods

Filling into the cans

There exists a wide variety of methods and equipment for filling foods into cans.

The choice of a method depends on the product, the size of cans and the production rate.

Cans are never filled completely.

Some free space (*head-space*) is left above the product in order to form some vacuum in the sealed can at the end of the process.

Preservation Methods

Hand filling is practiced with fragile products such as grapefruit segments, with products such as sardines or stuffed vegetables requiring orderly arrangement or when production rate is too low to justify mechanical filling

Preservation Methods

Tumbler fillers consist of a rotating drum fitted with baffles and in it, a belt conveyor carrying the cans in the direction of the drum axis.

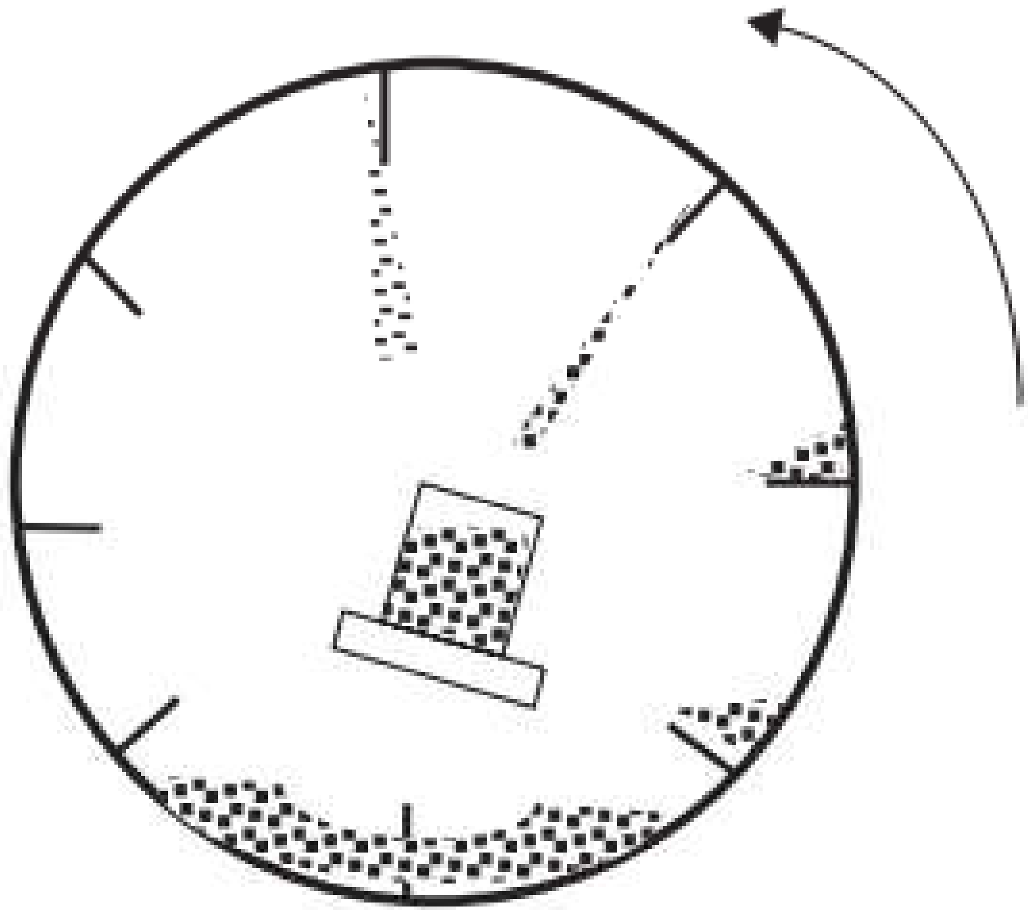
The product is fed into the drum.

As the drum rotates, portions of the product are lifted by the baffles then fall into the cans when the baffle reaches a certain angle.

The can conveyor is slightly tilted to prevent over-filling and leave a void volume (head-space) in the can

Preservation Methods

The operation of tumble filler



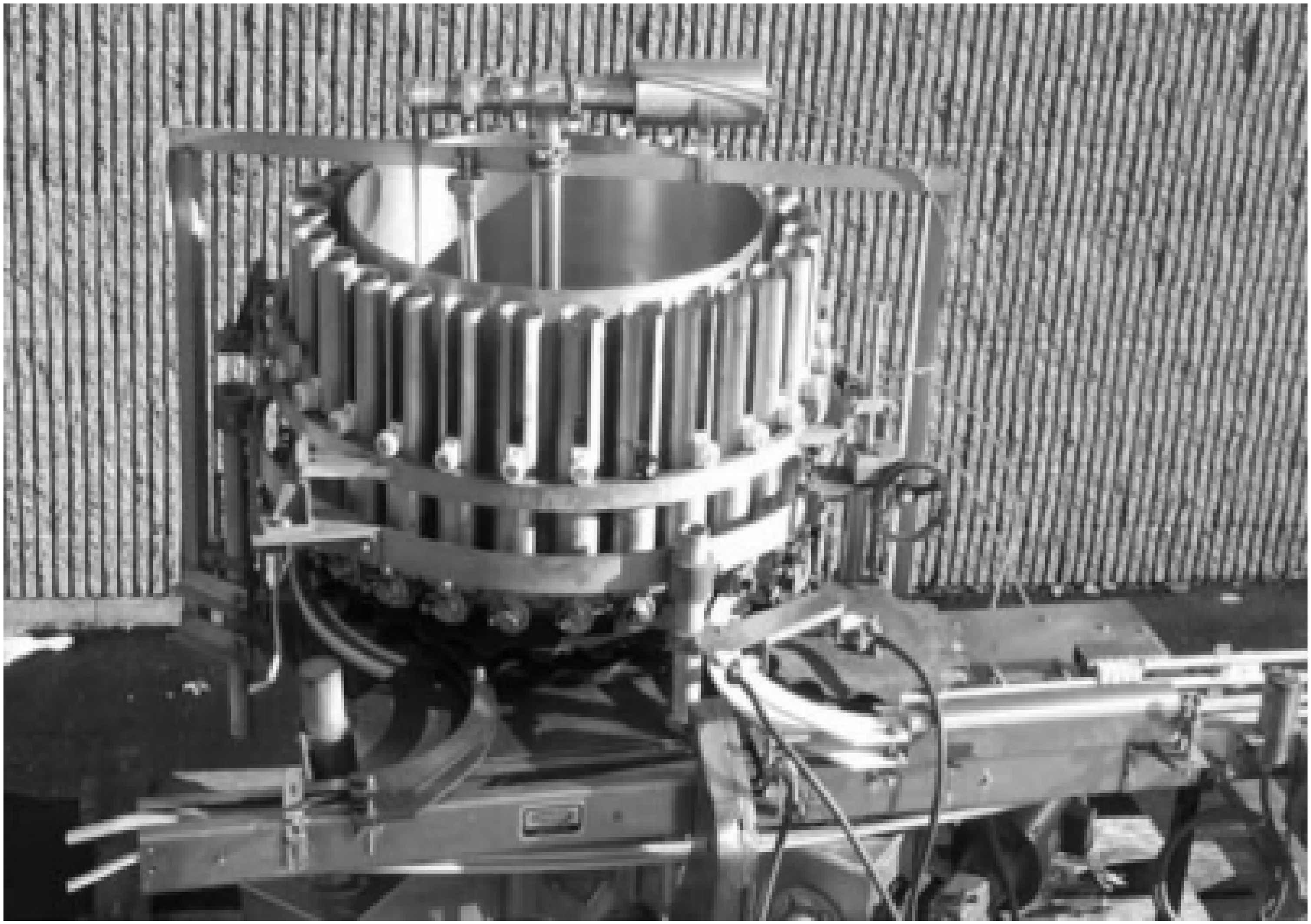
Preservation Methods

Piston fillers are suitable for filling pumpable products. The ‘ filling heads’ are actually piston pumps, transferring a fixed volume of product from a buffer reservoir to individual cans.

Piston fillers are usually equipped with a ‘ no-container-no-fill ’ control device, to prevent spillage when a container is, accidentally, not presented under the filling head.

Preservation Methods

Piston filler



Preservation Methods

Some of the air in the head-space must be expelled for several reasons:

- Air in the head-space expands and creates excessive internal pressure when the sealed can is heated. Damage to the seams and deformation of the can may result. This is particularly important in flexible packages (e.g. pouches)
- Expulsion of most of the air (reduction of the partial pressure of oxygen) helps reduce the risk of oxidative damage to the product and internal corrosion of the metal can during storage

Preservation Methods

- Vacuum in the container is particularly important in the case of products in jars. For most types of jar closures, internal vacuum is main condition for keeping the lids tightly attached to the jar body
- In flexible packages, good contact between the packaging material and the food is essential for efficient heat transfer during thermal processing. Vacuum causes the package to shrink as a 'skin' around the food and thus provides the required contact.

Preservation Methods

Sealing and sterilization

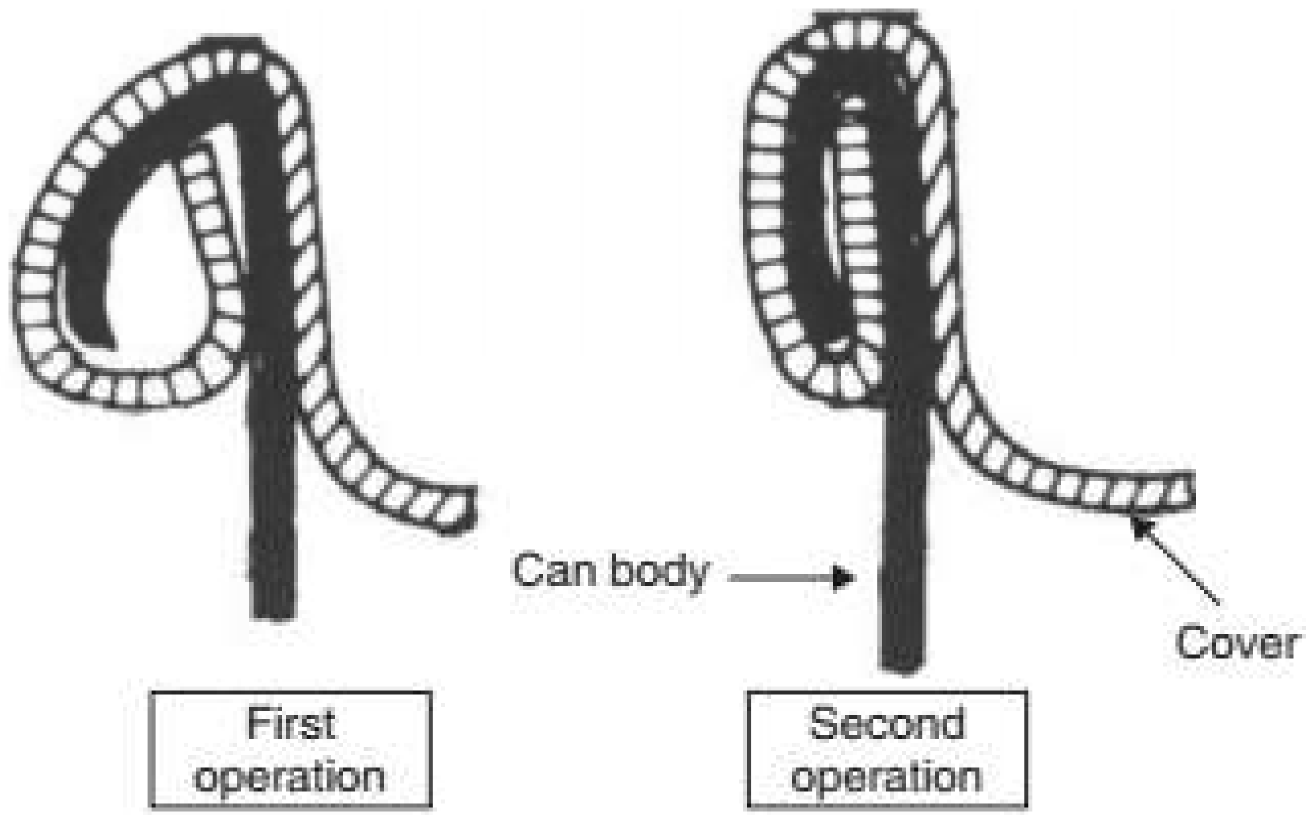
Double seam method of sealing, which is the only one used in industry today, was invented in the beginning of the 20th century.

The double seam is formed by mechanically bending the edge of the can body and the lid and then pressing the two to create an interlocking seam The double seam is formed in two steps or ‘ operations ’ : a *first operation* of bending and a *second operation* of tightening.

Next step is the sterilization, the filled cans are sterilized using high pressure steam.

Preservation Methods

Formation of double seam:



Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Preservation - Freezing

Dr. N. Saravanan

Professor

Food Preservation - Freezing

Food Freezing may be defined as the processing of food by lowering the temperature so that almost all of the water inside become frozen.

Temperature of a food is reduced to freezing point

A proportion of the water changes in state to form ice crystals

Preservation achieved due to combination of

- low temperatures
- Reduced water activity

Physical, biochemical, chemical and microbiological degradation restrained.

Food Preservation - Freezing

Refrigerant

A chemical substance usually a fluid that can readily absorb heat.

Used in cooling system such as air conditioner or refrigerator.

Have good thermodynamic properties

BP below the target temperature

Moderate density

High critical temperature

High heat of vaporization

Examples- CFC

Food Preservation - Freezing

Freezing System

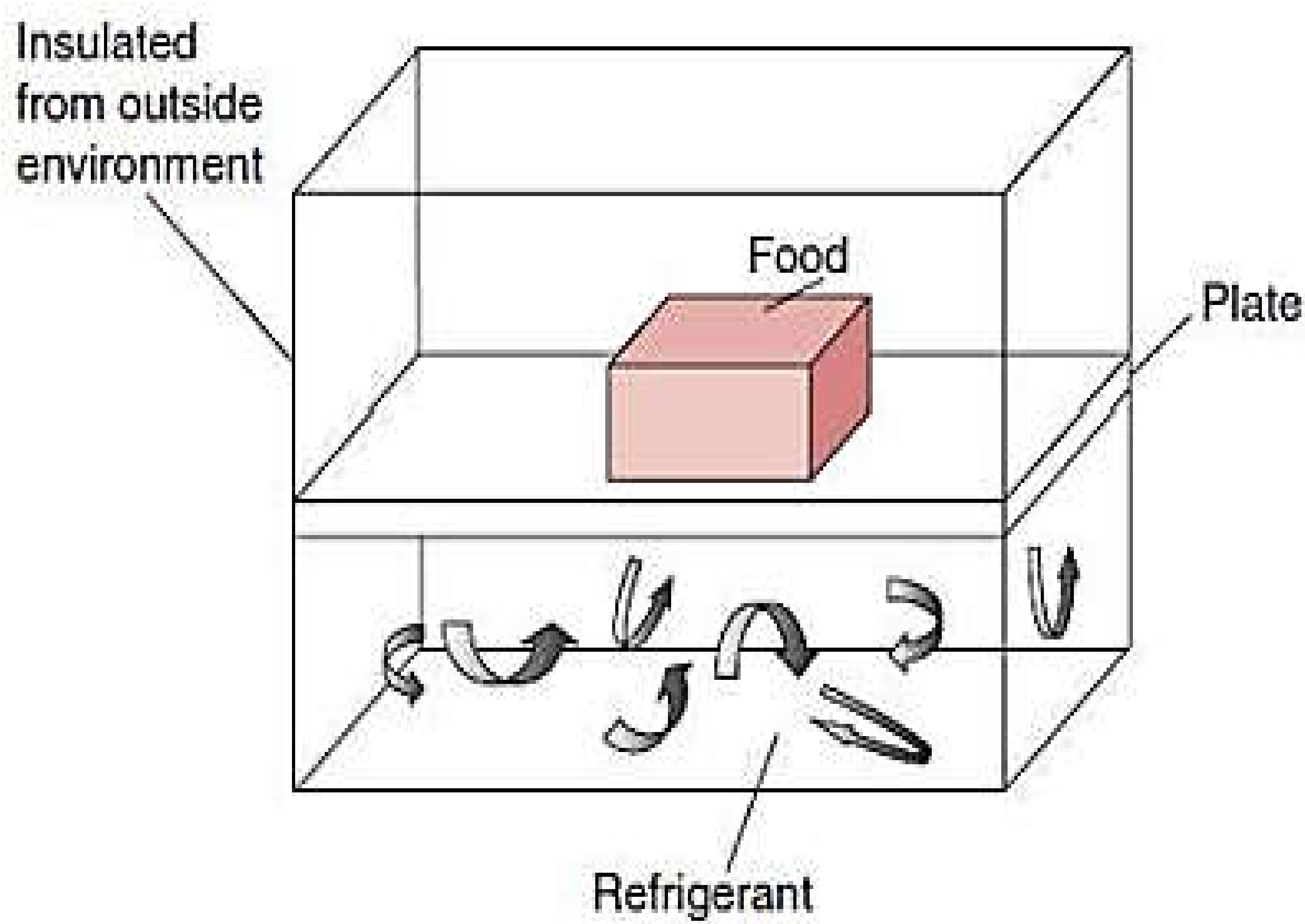
Indirect Contact Systems

In numerous food-product freezing systems, the product and refrigerant are separated by a barrier throughout the freezing process.

Although many systems use a nonpermeable barrier between product and refrigerant, indirect freezing systems include any system without direct contact,

including those where the package material becomes the barrier .

Food Preservation - Freezing

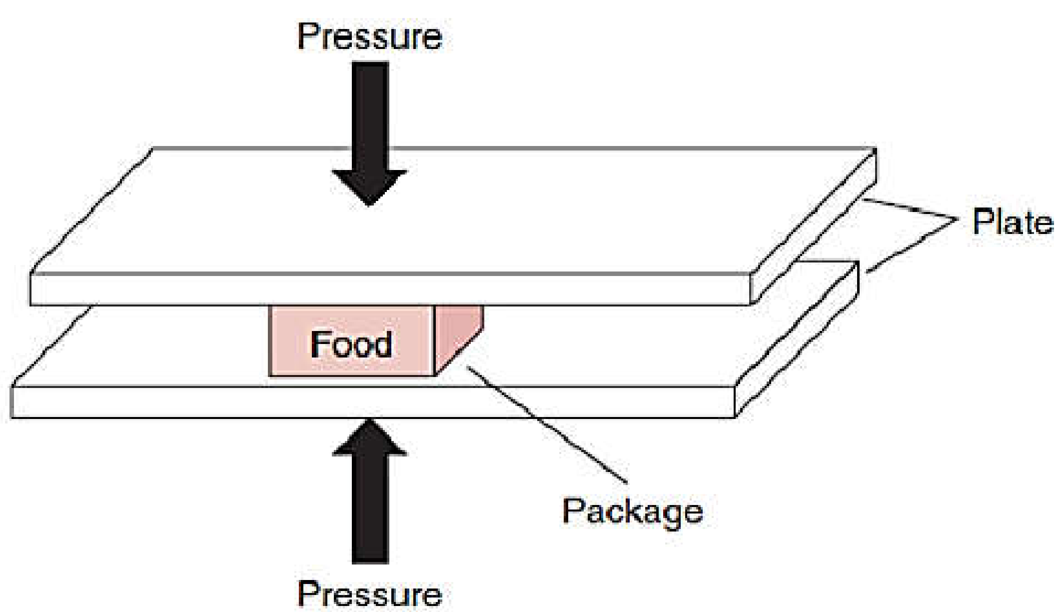


Food Preservation - Freezing

Plate Freezers

The most easily recognized type of indirect freezing system is the plate freezer, air-blast freezing.

As indicated, the product is frozen while held between two refrigerated plates.



Food Preservation - Freezing

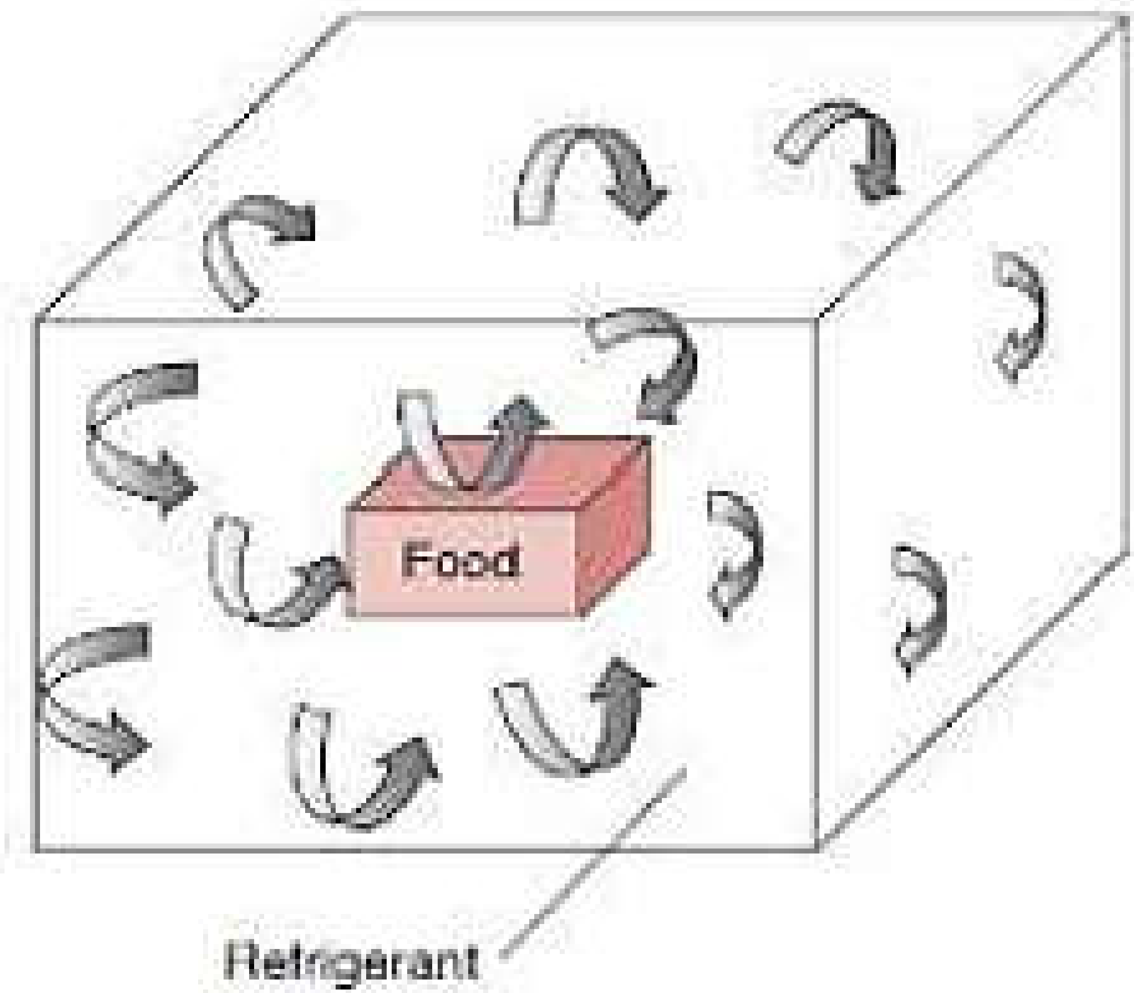
Direct-Contact Systems

Several freezing systems for food operate with direct contact between the refrigerant and the product

In most situations, these systems will operate more efficiently since there are no barriers to heat transfer between the refrigerant and the product.

The refrigerants used in these systems may be low-temperature air at high speeds or liquid refrigerants with phase change while in contact with the product surface.

Food Preservation - Freezing



Food Preservation - Freezing

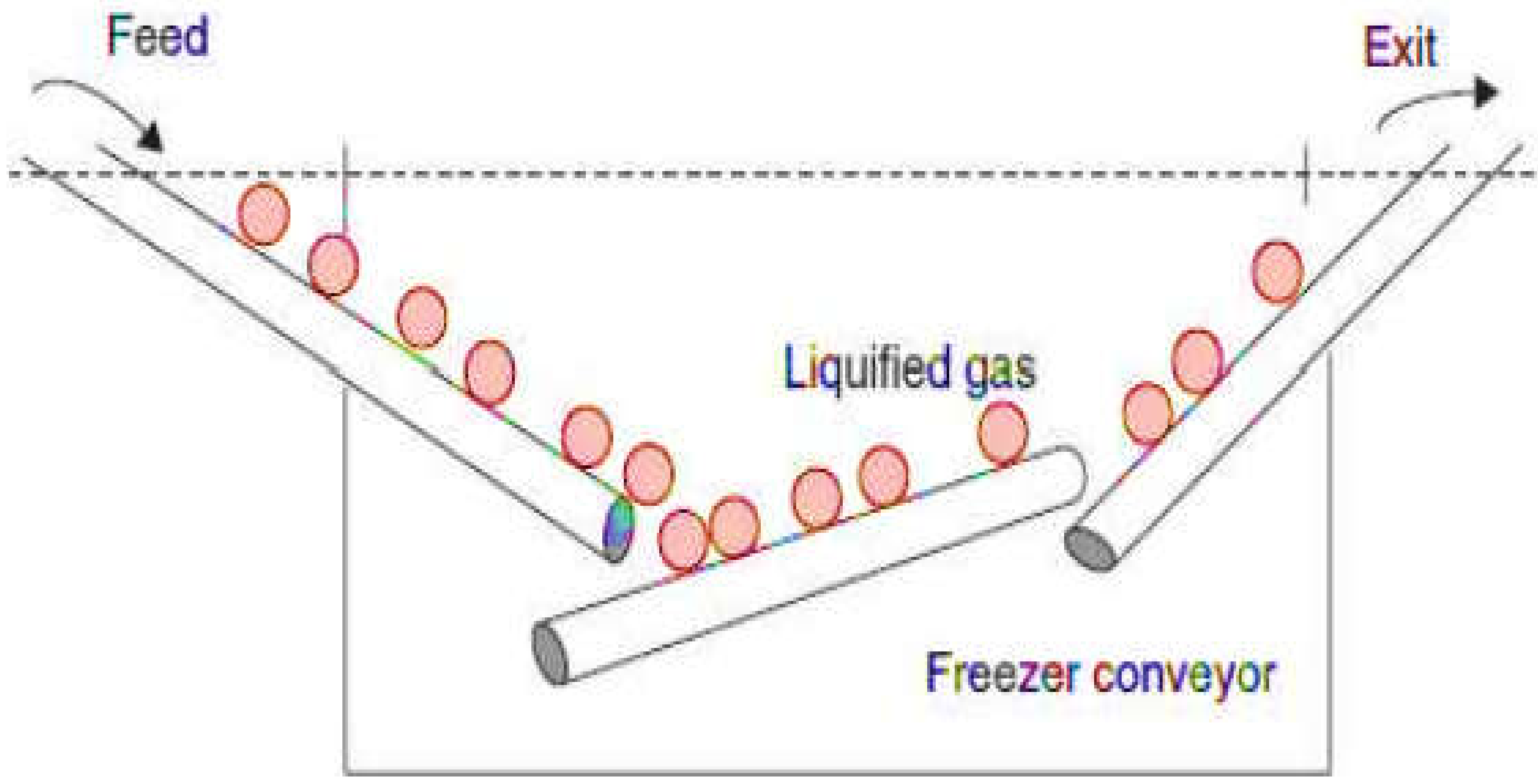
Immersion freezing

By immersion of the food product in liquid refrigerant, the product surface is reduced to a very low temperature.

Assuming the product objects are relatively small, the freezing process is accomplished very rapidly .

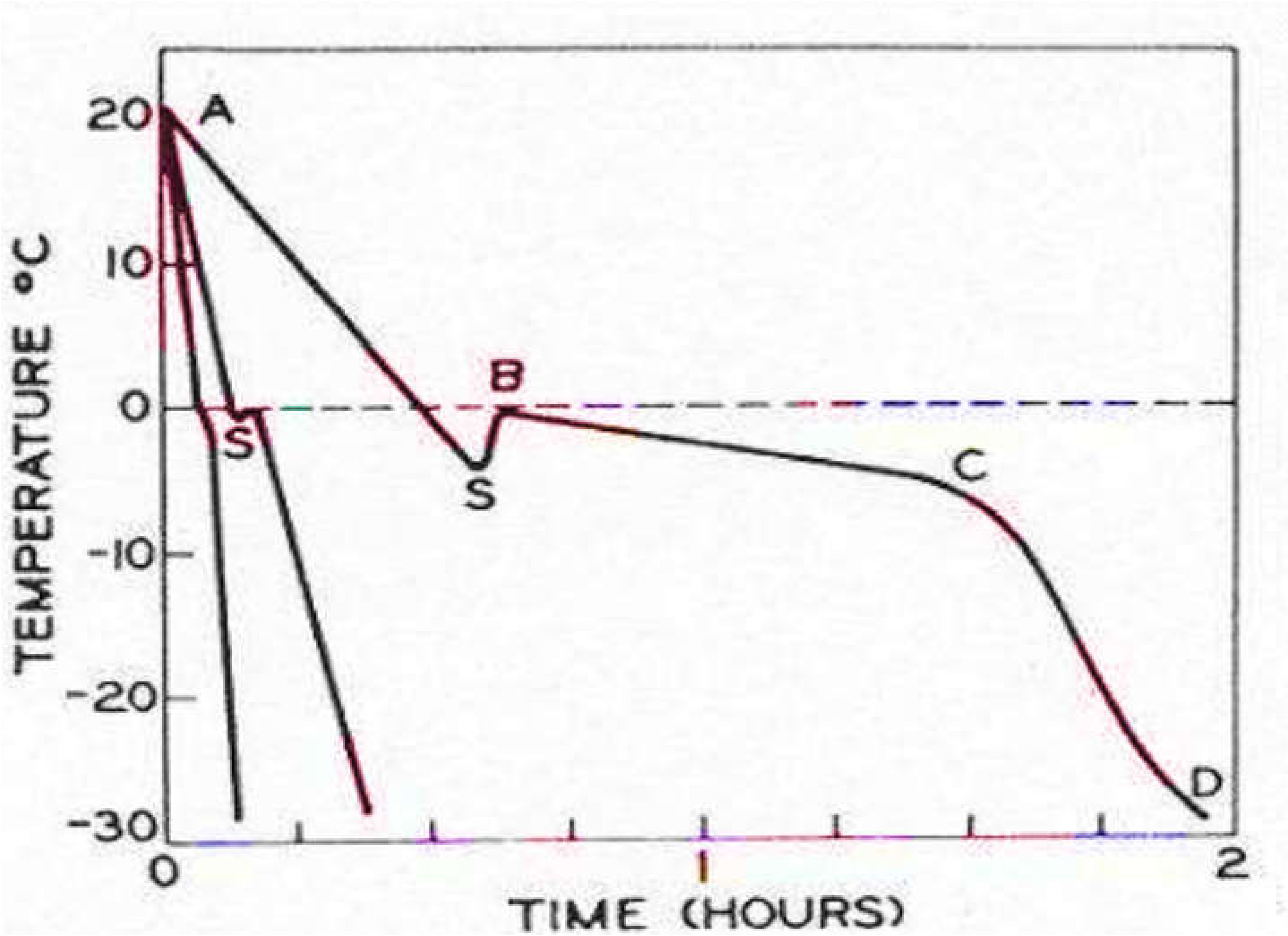
For typical products, the freezing time is shorter than for the air-blast or fluidized-bed systems.

Food Preservation - Freezing



Food Preservation - Freezing

Principles of freezing
Characteristic curve: FREEZING CURVE



Food Preservation - Freezing

Freezing curve

Section AS

The food is cooled to below its freezing point (=sensible heat)

At point S the water remains liquid, although the temperature is below the freezing point

Phenomenon is called super cooling and partly determines the crystal size

Section SB

The temperature rises rapidly to the freezing point as ice crystals begin to form and latent heat of crystallization is released

Food Preservation - Freezing

Freezing curve

Section BC

Heat is removed from the food at the same rate as before

Latent heat is removed and ice forms, but temperature almost constant

The freezing point is depressed by the increase in solute concentrations in the unfrozen liquor

Major part of the ice is formed

Section CD

The temperature of the ice-water mixture decreases to the temperature of the freezer

Food Preservation - Freezing

The freezing point varies in function of the composition of the food, but is almost never lower than -5°C

Product	°C
Milk, eggs	-0.5
Meat	-1.7 → -2.2
Fish	-0.6 → -2.0
Vegetables	-0.8 → -2.8
Fruit	-0.9 → -2.7
1 M sacharose solution	-2.65
1 M NaCl solution	-3.45

Food Preservation - Freezing

Crystallization

Crystallization occurs at point 'B' of the freezing curve and consists of nucleation and crystal growth

Nucleation: occurs by combining molecules into an ordered particle of a size sufficient to survive and serve as a rate for crystal growth

Homogeneous nucleation: in pure systems

Heterogeneous nucleation: nucleus formation around suspended particle or at a cell wall, in food systems, takes place during supercooling

Crystal growth: enlargement of nucleus by the orderly addition of molecules

Food Preservation - Freezing

The length of the supercooling period depends on the type of food and the rate at which heat is removed

High rates of heat transfer therefore produce large numbers of nuclei

Fast freezing: a large number of small ice crystals

Large differences in crystal size, in different types of food and even in similar foods which have received different pre-freezing treatments

The rate of ice crystal growth is controlled by the rate of heat transfer for the majority of the freezing

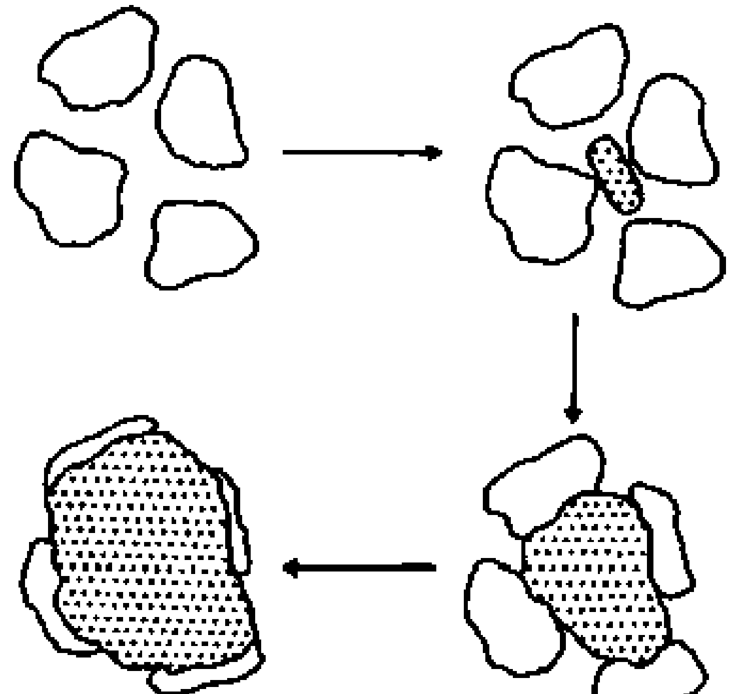
Food Preservation - Freezing

The localization of the crystals is determined by the freezing rate, the cellular structure and the temperature.

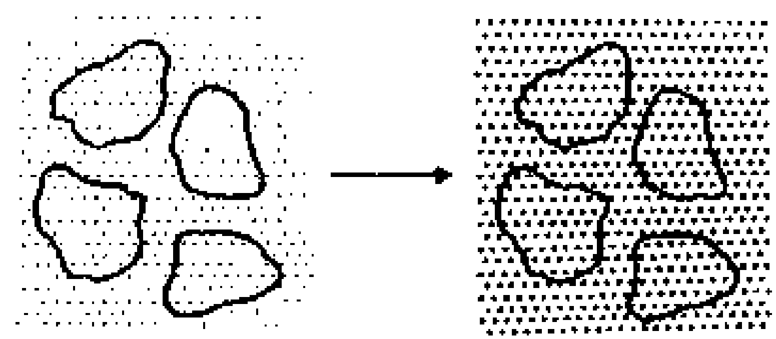
Effect of freezing on plant tissues

a) slow freezing

b) fast freezing



(a)



Food Preservation - Freezing

Slow freezing

Ice crystals grow in intercellular spaces and deform and rupture adjacent cell walls

Ice crystals have a lower water vapor pressure than regions within the cells water moves from the cell to growing crystals cells: dehydrated and permanently damaged by the increased solute concentration

On thawing, cells do not regain their original shape and turgidity the food is softened and the cellular material leaks out from ruptured cells (drip loss)

Food Preservation - Freezing

Fast freezing

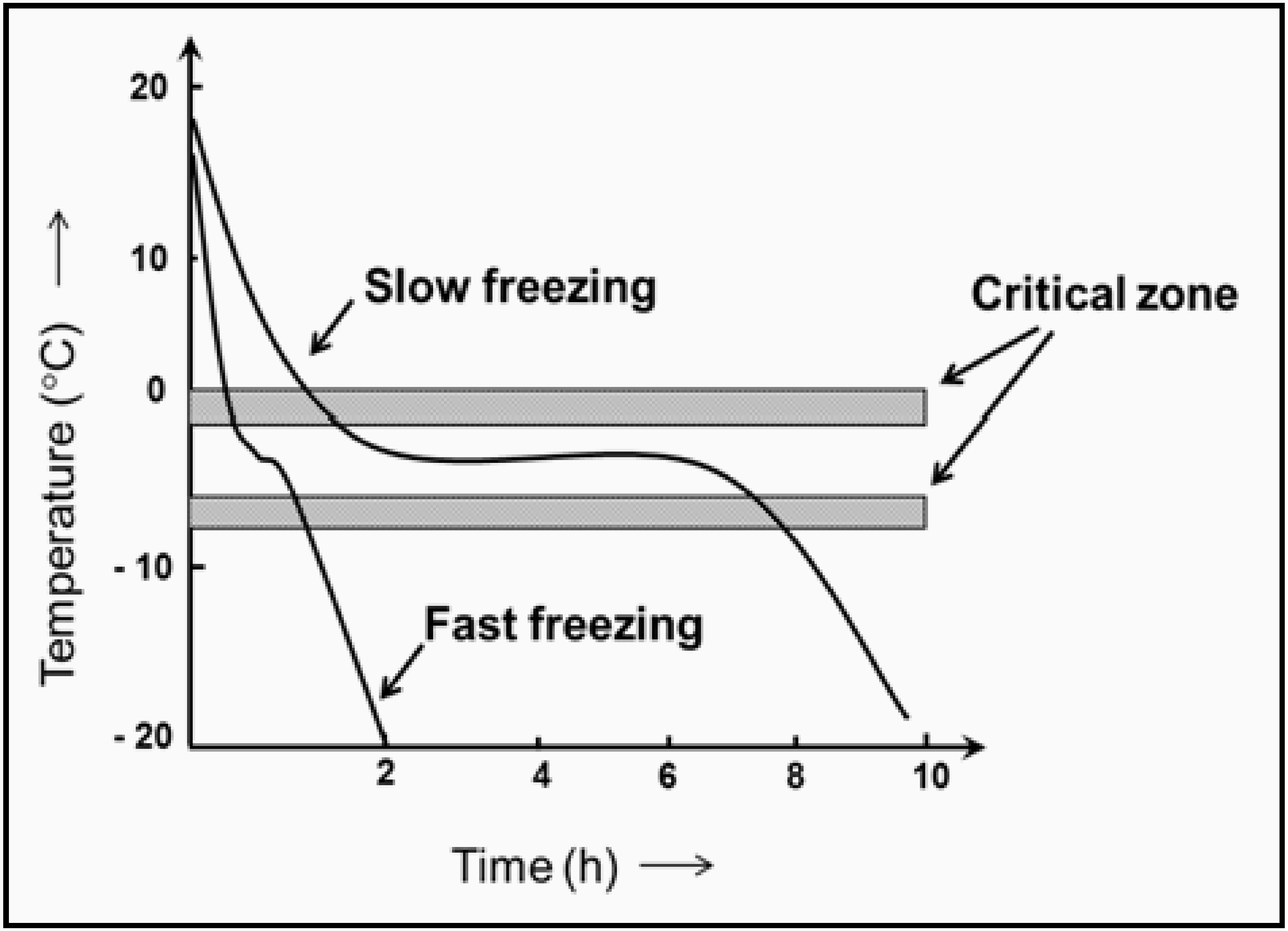
Smaller ice crystals form within both cells and intercellular spaces

Little physical damage to cells, and water vapor pressure gradients are not formed

Minimal dehydration of the cells

Texture of the food is thus retained to a greater extent

Food Preservation - Freezing



Food Preservation - Freezing

Freezing point depression of a solution (liquid food) is defined as the decrease in freezing point over that of pure water, at a given pressure.

Freezing point depression describes the phenomenon that the freezing point of a liquid (a solvent) will be lower when another compound is added, meaning that a solution has a lower freezing point than a pure solvent.

This happens whenever a non-volatile solute, such as a salt, is added to a pure solvent, such as water .

Food Preservation - Freezing

Freezing Equipments

In air blast freezers: cold air (T = -30°C to -45°C) is blown over the product with an air velocity of mostly 3-7 m/s

In tunnel freezers: the products are put on trays placed in racks or trolleys which are usually moved on rails by a pushing mechanism

Tunnels are designed with a conveyer which leads the product through the tunnel

Both mechanisms allow operation in-line with the production line

Advantages: independent of the product size

Disadvantage: weight losses occur when non-packaged foods are frozen

Food Preservation - Freezing

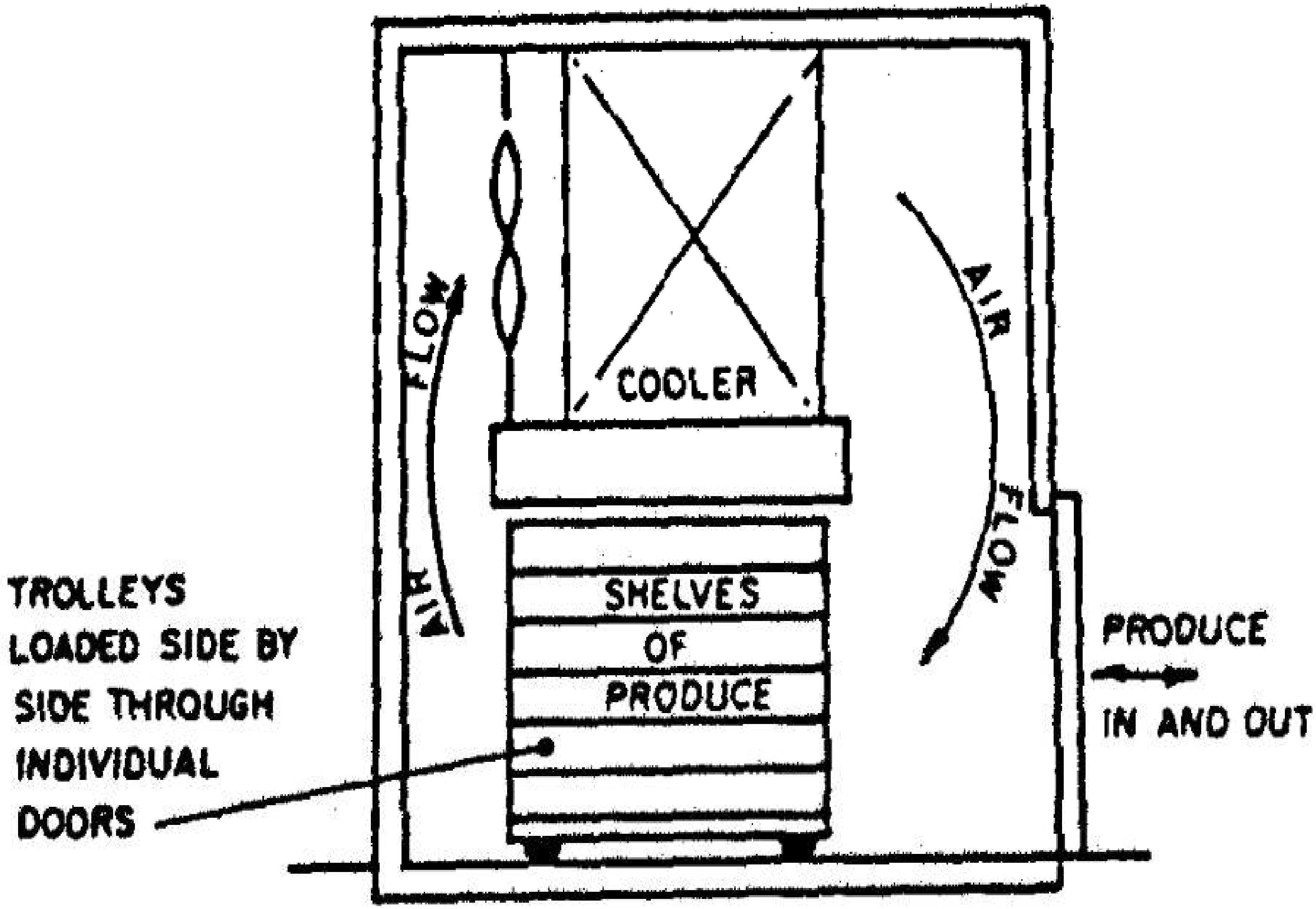
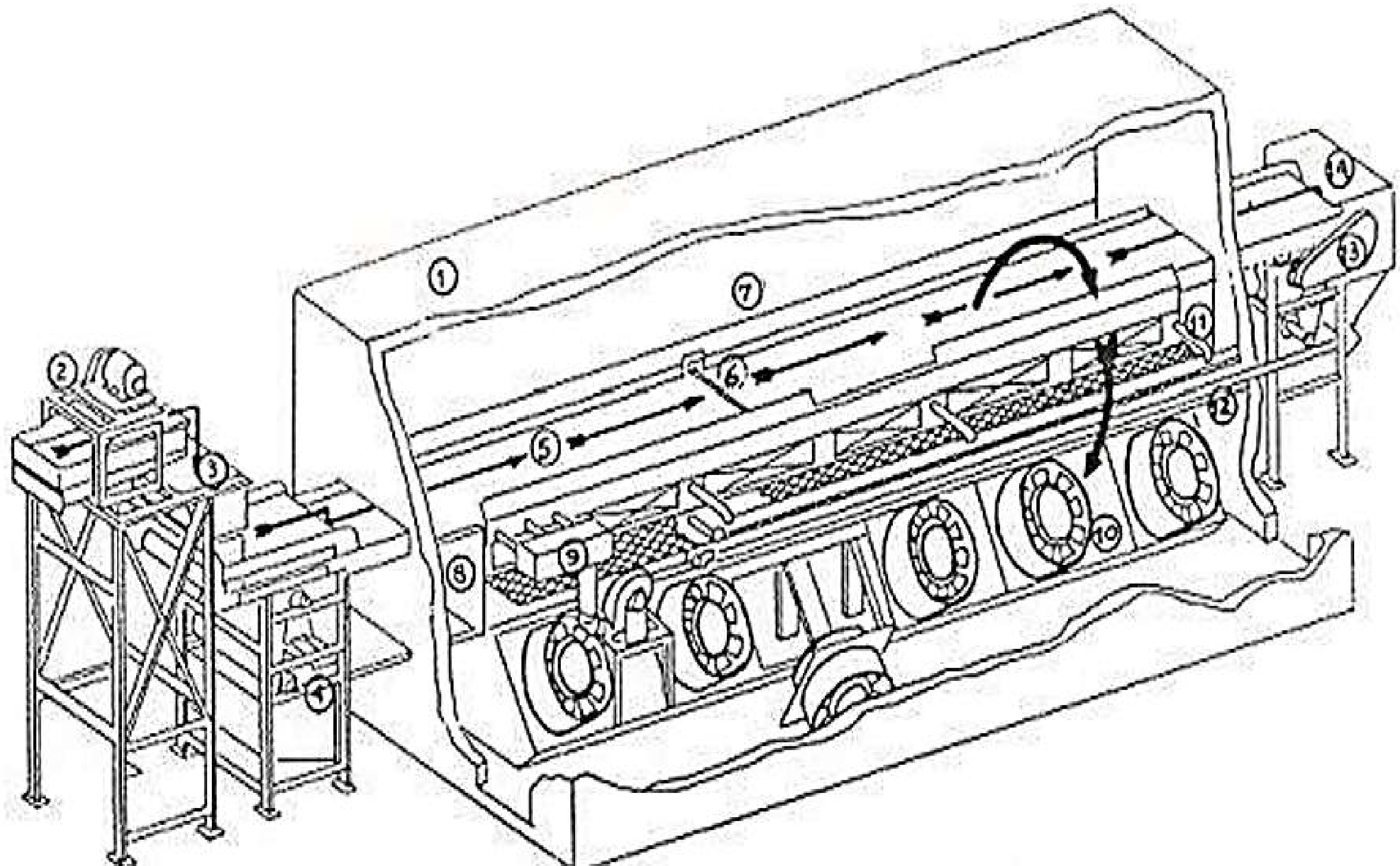


Fig. Batch-continuous air-blast freezer with crossflow air circulation

Food Preservation - Freezing

Tunnel freezer



Food Preservation - Freezing

	application	Distance between cooling medium and product	Temperature Difference: Cooling medium-Product	advantage disadvantage
Air blast freezer	universal	large	small	dehydration
Fluidization freezer	specific	rather large	small	dehydration, individually freezing, short freezing time
Contact freezer	limited	small	small	high freezing rate, limited in scale
Scraped wall freezer	specific	small	small	only liquids and pastes
Immersion freezer	limited	small	small	contact cooling medium

Food Preservation - Freezing

Frozen food storage

- **Causes of quality loss:**
  - Chemical causes
  - Biochemical causes
  - Microbiological causes
  - Physical causes
  - Specific problems
- Time, temperature, tolerance (TTT)

Food Preservation - Freezing

Quality loss: chemical causes

- Denaturation of proteins → modified water bonding capacity and structure
  - fish gets a stringy structure, red meat and poultry become firmer
- Lipids: taste rancid because of oxidation
- Color changes in meat: **oxymyoglobine (red)** is converted to **metmyoglobine (brown)**
- Color changes in vegetables: conversion of chlorophyl and phenols
- Loss of vitamins

Food Preservation - Freezing

Biochemical cause:

Enzymes:

Often cause changes in frozen products

The enzyme activity decreases with decreasing

temperatures, but most enzymes stay active in freezing conditions

During freezing, enzymes are partly denaturated in the crystallization area

When temperature is further decreased, the activity will increase or decrease because of concentration effects

Food Preservation - Freezing

Microbiological cause:

During freezing:

A limited amount of micro-organisms are destroyed in the crystallization zone

Lethal damage (cold shock) possible but depends on the type of organism but generally sublethal damage

After thawing: micro-organisms recover total plate count of a deep frozen product is normally lower compared with the total plate count after the resuscitation period

Food Preservation - Freezing

Physical cause:

The most important type is the migratory recrystallization: small crystals are converted into large crystals

With small temperature increases small crystals melt preferably because of their lower melting point, higher vapor pressure and higher solubility

When temperature decreases afterwards all the liquid water will form bigger crystals

Pressure recrystallization: pressure in stacked product

Causes moisture losses (drip) and structure damages

Food Preservation - Freezing

Time, Temperature, Tolerance (TTT)

Food producers and distributors demand temperatures lower than -18°C in order to secure a high quality of the products and avoid the effect of recrystallization, sublimation, moisture migration and freezer burn

The cornerstones of the TTT theory are:

For every frozen product a relationship between the storage temperature and the time it takes at this temperature for the product to undergo a certain degree of quality change

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Preservation – Dehydration / Drying

Dr. N. Saravanan

Professor

Food Preservation - Dehydration

Food drying is a method of food preservation in which food is dried (dehydrated or desiccated).

Drying inhibits the growth of bacteria, yeasts, and mold through the removal of water.

Dehydration has been used widely for this purpose since ancient times; the earliest known practice is 12,000 B.C. by inhabitants of the modern Middle East and Asia regions.

Water is traditionally removed through evaporation (air drying, sun drying, smoking or wind drying), although today electric food dehydrators or freeze-drying can be used to speed the drying process and ensure more consistent results

Food Preservation - Dehydration

DRYING:

- Removal of water from the food by non-conventional energy sources like sunlight and wind.

DEHYDRATION:

- The process of removal of water from the food under the controlled conditions like temperature, relative humidity and air flow etc.

Food Preservation - Dehydration

DRYING AND DEHYDRATION

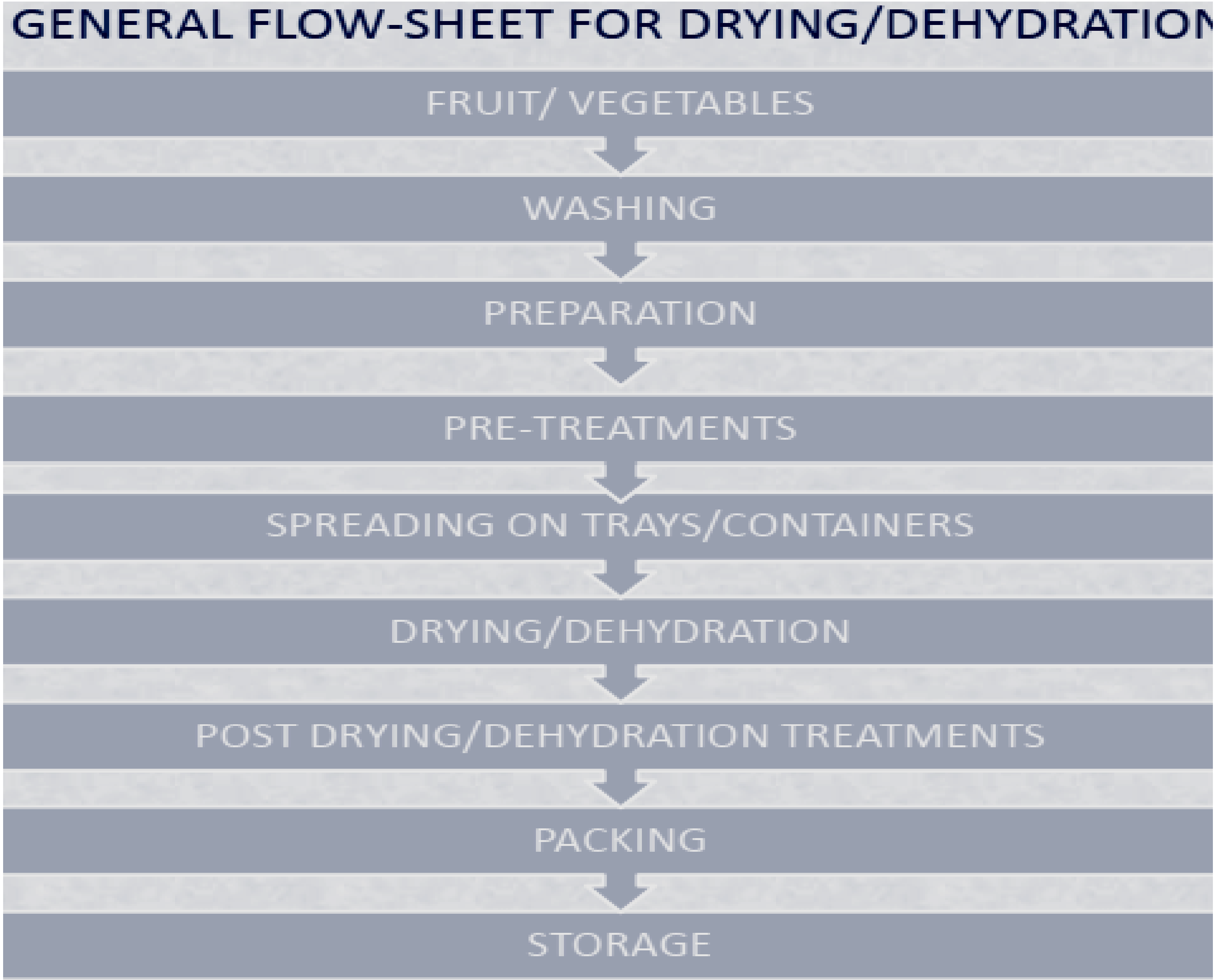
- One of the oldest methods of preserving food.
- Both drying and dehydration mean the removal of water.
- Removes moisture stops the growth of bacteria, yeasts & moulds that normally spoil food.
- Slows down but does not completely inactivate enzymes.

Food Preservation - Dehydration

BENEFITS OF DREID FOOD

- The main benefit of dry food is that it is convenient for the owner – it's easy to measure, easy to serve and easy to store.
- They have unlimited shelf life under proper storage conditions.
- Transportation, handling and storage costs are reduced.
- Provide an important modern marketing requirements.
- Easy and economical way to save surplus food for a later time.
- Portability – Can take it anywhere you go.
- Helps in minimizing post harvest loses

Food Preservation - Dehydration



Food Preservation - Dehydration

MECHANISM INVOLVED

1. HEAT AND MASS TRANSFER

Heat into product

Moisture out of product

2. DEVELOPMENT OF DRIED THICK LAYER

At initial stages of drying moisture from surface of food is removed later it becomes slow because of development of dried thick layer, which is due to loss of more moisture from outer surface of food and remaining of more moisture in the centre of food.

Food Preservation - Dehydration

3. ESTABLISHMENT OF MOISTURE GRADIENT

When dried thick layer is formed and act as insulation against rapid heat transfer.

Water retain in the centre of food which have moisture gradient to get out on the surface which will not loose faster and establishes moisture gradient.

4. ESTABLISHMENT OF NORMAL EQUILIBRIUM RELATIVE HUMIDITY (ERH)

This is the humidity at which the product neither looses nor gains moisture from atmosphere.

Below this atmospheric humidity level, the food can be further dried while above this humidity, it cannot.

Rather it picks up moisture from atmosphere.

Food Preservation - Dehydration

FACTORS AFFECTING DRYING RATE

- Temperature
- Velocity of air
- Surface area
- Size of product
- Tray load
- Relative humidity of air
- Atmospheric pressure and vacuum

Food Preservation - Dehydration

Changes during dehydration

1. Cell/ tissue shrinkage
2. Case hardening
3. Chemical changes

1. Shrinkage

- Shrinkage water migrates- interior of the food surface
- Evaporates by the drying medium
- Water carries with it water soluble substances dissolved in it

Food Preservation - Dehydration

2. *Case hardening*

- Rapid drying- compounds (such as sugar) form a hard, impermeable "case" around the food piece.
  - Can slow down the dehydration
  - Common in high sugar products
    - Tropical and temperate fruit products

3. *Chemical changes*

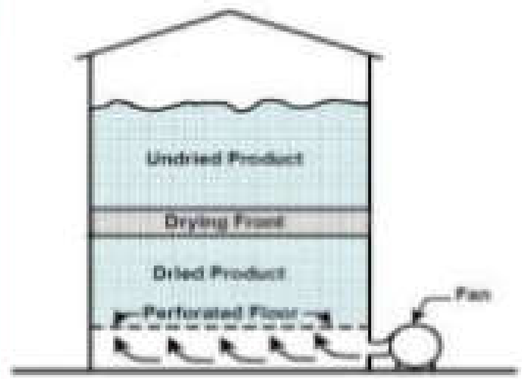
- Browning and flavor changes due to reactions
  - ✓ Maillard browning = from increased solution concentration
- Denaturation of proteins, aggregation of polysaccharides
  - ✓ Loss of water soluble binding capacity
- Loss of water soluble components
- Concentration on the surface of the food (case hardening)
- Loss of volatiles (especially flavor compounds)

Food Preservation - Dehydration

Dehydration Equipments

1. Bin Drying

- Bin drying systems are common in on-farm grain drying operations.
- Bin is filled with grain and drying air
- As drying progresses; a layer of drying grain separates the dried grain from the undried grain.
  - *"drying front"* process
- *Other drying methods* include stirring of grain in the bin during drying and use of continuous flow dryers to dry grain before storage.

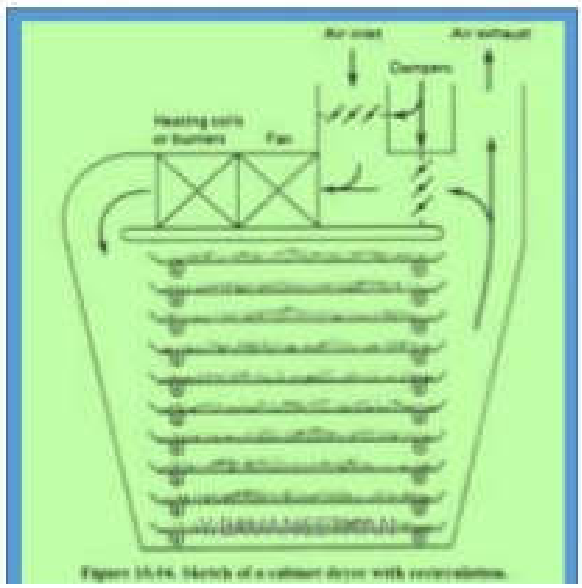


10.03. Bin drying diagram showing the drying front with about half the product dried.

Food Preservation - Dehydration

2. Cabinet Drying

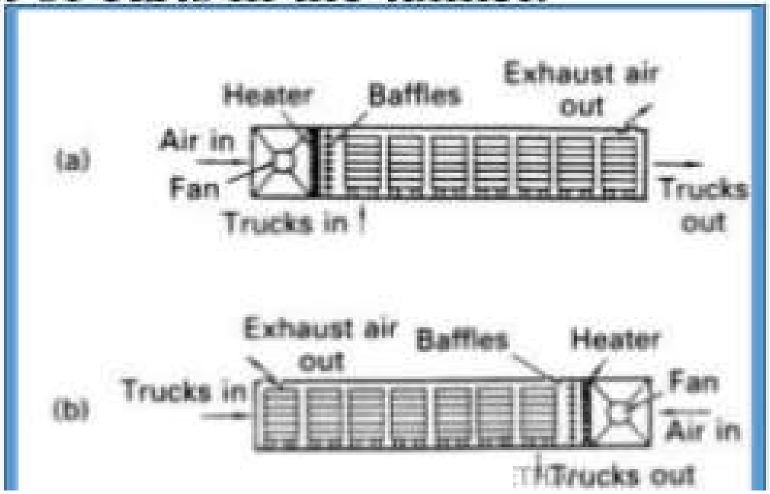
- Cabinet dryers are usually small, insulated units with;
  - A heater, circulating fan, and shelves to hold the product to be dried.
- General procedure is to force heated air over multiple trays.
  - However, greater energy efficiencies can be obtained if some of the heated air is recirculated.
- Basic operation of a cabinet dryer with recirculation.
  - Energy savings of 50% or more can be achieved with recirculation.



Food Preservation - Dehydration

3. Tunnel Drying

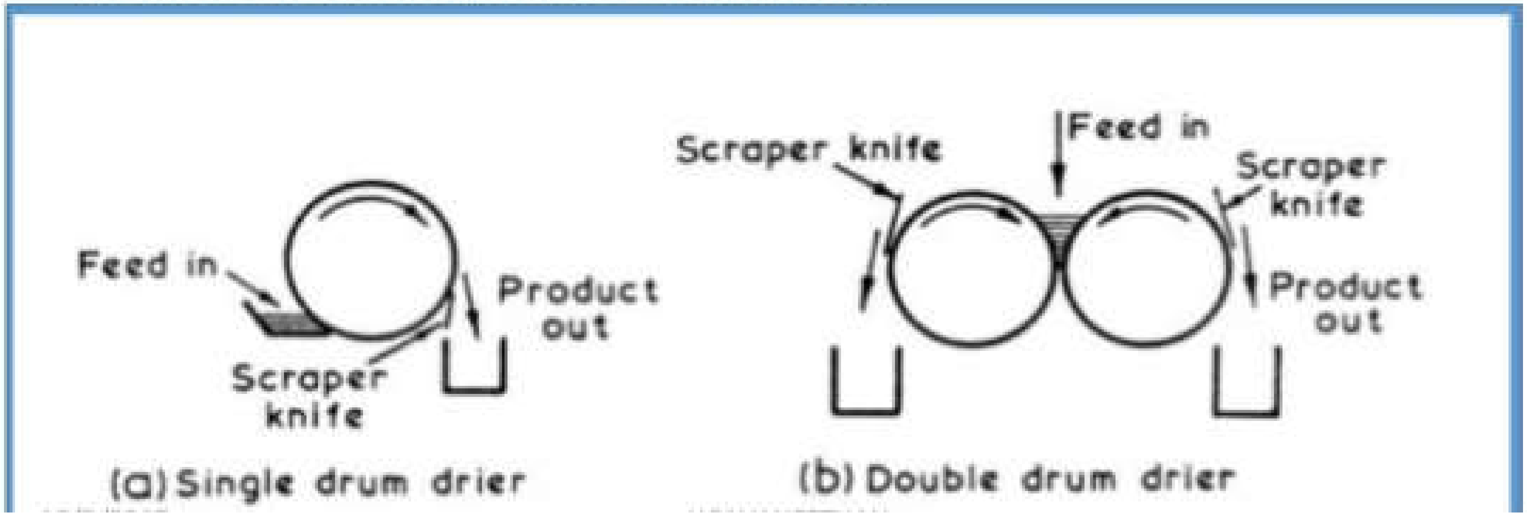
- Tunnel dryers are a large-scale modification of the cabinet dryer concept.
- The drying chamber is a tunnel with multiple carts containing trays.
- New carts of undried product are loaded at one end of the tunnel.
  - product are removed from the other end.
- Air flow in these dryers may be *Parallel **or** Counter* to the movement of carts in the tunnel.



Food Preservation - Dehydration

4. Drum Drying

- Large rotating drums are used for drying slurries (liquids with a high solids content).
- A thin film of the slurry is deposited on the bottom of a rotating drum as it passes through the slurry.
- The slowly rotating drum is heated and sometimes held under a vacuum.
- The dried product is scraped from the drum *(doctor blade)* before the one full circle rotation.

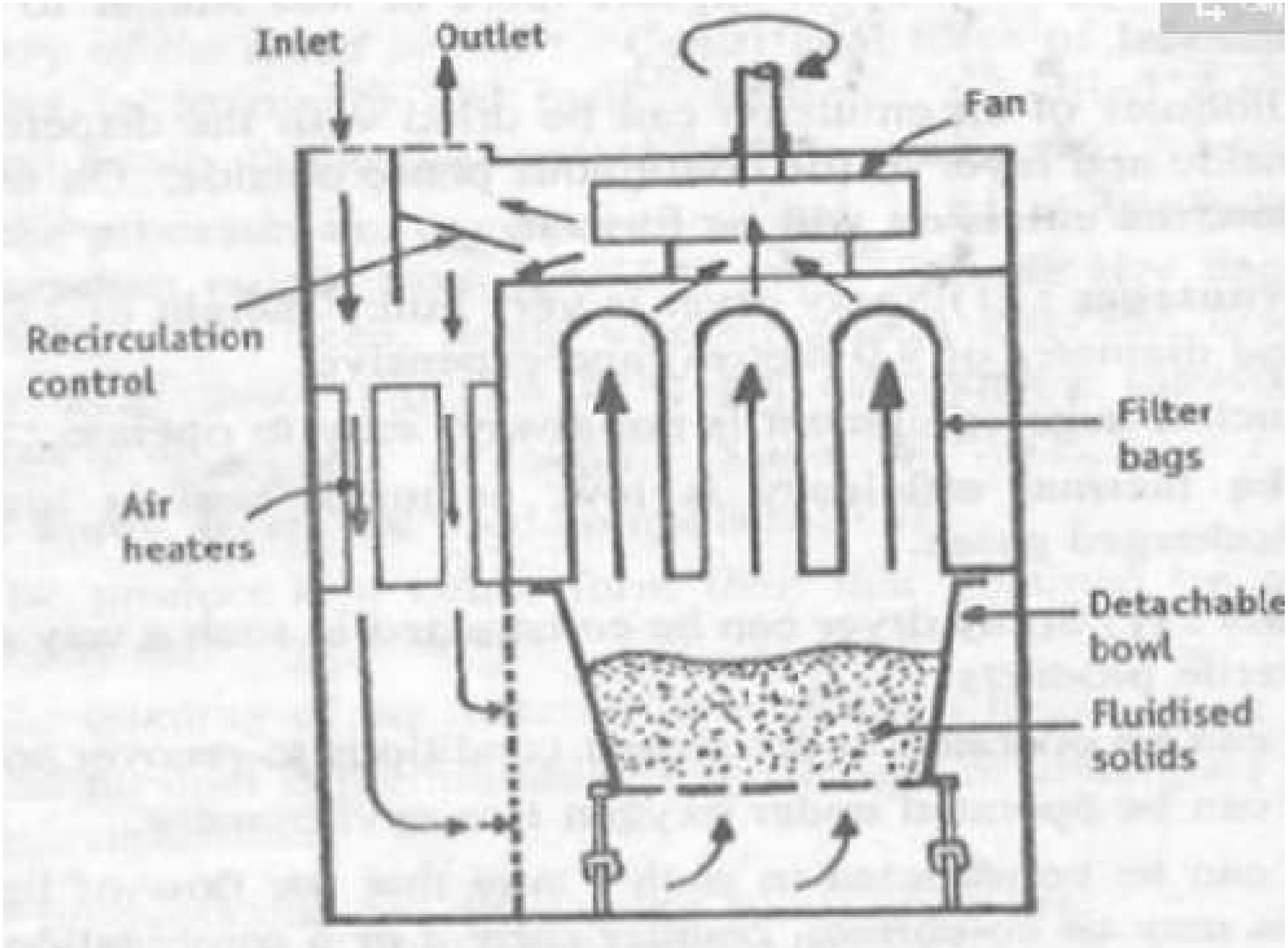


Food Preservation - Dehydration

5. Fluidised-bed driers

- The main features of a fluidised-bed drier;
  - evenly distribute the air at a uniform velocity around the bed of material.
- Produce an homogenous region of air and prevent localised high velocities,
  - disengagement or 'freeboard' region above the bed to allow disentrainment of particles.
- Hot air is blown through the bed, causing;
  - the food to become suspended (Problem)
  - ➢To overcome this;
    - ➢vigorously agitated (fluidised), exposing the maximum surface area of food for drying.

Food Preservation - Dehydration

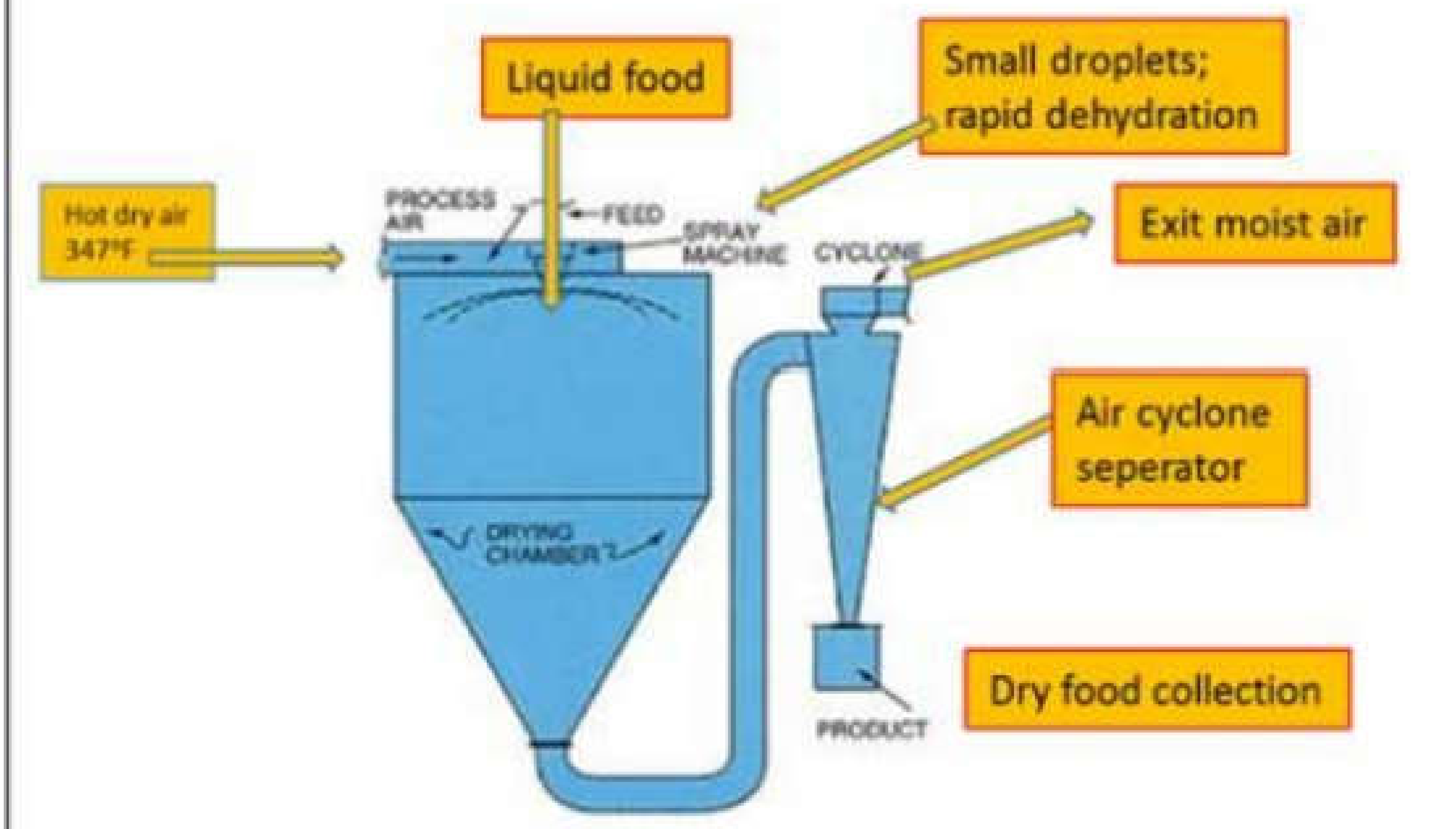


Food Preservation - Dehydration

6. Spray Drying

- Spray drying is used to dry liquid products. The product to be dried is sprayed into a *stream of heated air*.
- The two major operations of concern in spray drying are;
  - Droplet atomization and
  - Powder collection.
- To optimize drying, droplets should be small and uniform in size.
  - Special procedures must be used to insure that atomization is satisfactory.
- Collection of the dried powder also requires special techniques.
  - The powder particles are small and move easily within an air stream.

Food Preservation - Dehydration



SPRAY DRYER

Food Preservation - Dehydration

7. Freeze Drying

- Freeze drying involves the removal of moisture from a frozen product .
- The temperature must be below freezing for that product (insure that product remains frozen)
  - And the vapor pressure must be maintained at a very low level to permit moisture removal by sublimation.
    - Because of the low temperature, low pressure, and low drying rate, *freeze drying is quite expensive* compared other drying methods.
    - However, freeze drying produce high quality dried products.
- "Freezer burn," sometimes seen in frozen foods,
  - undesirable of freeze drying. (very slow type freeze).

Food Preservation - Dehydration

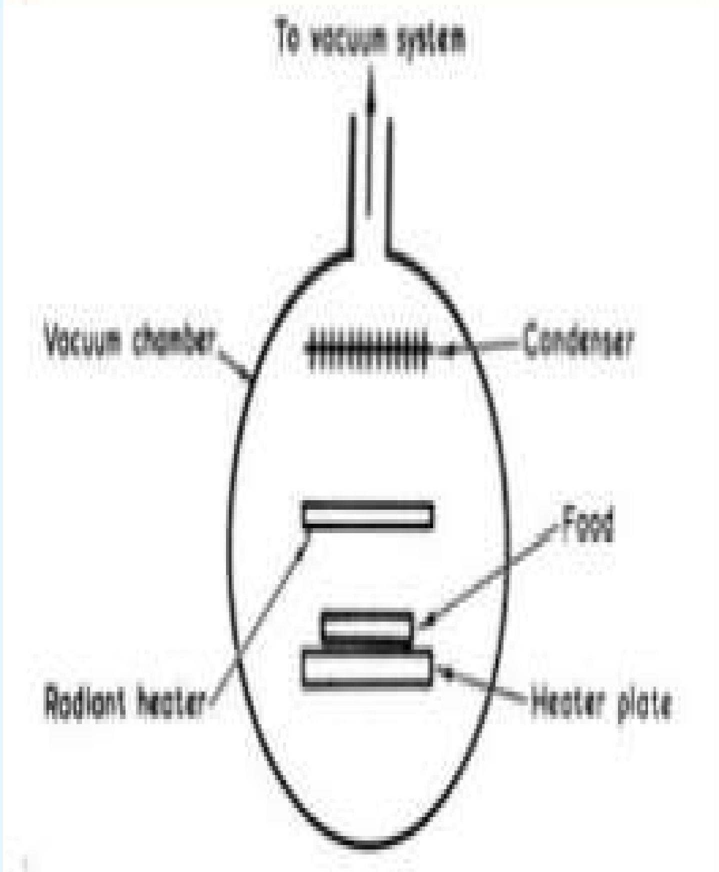
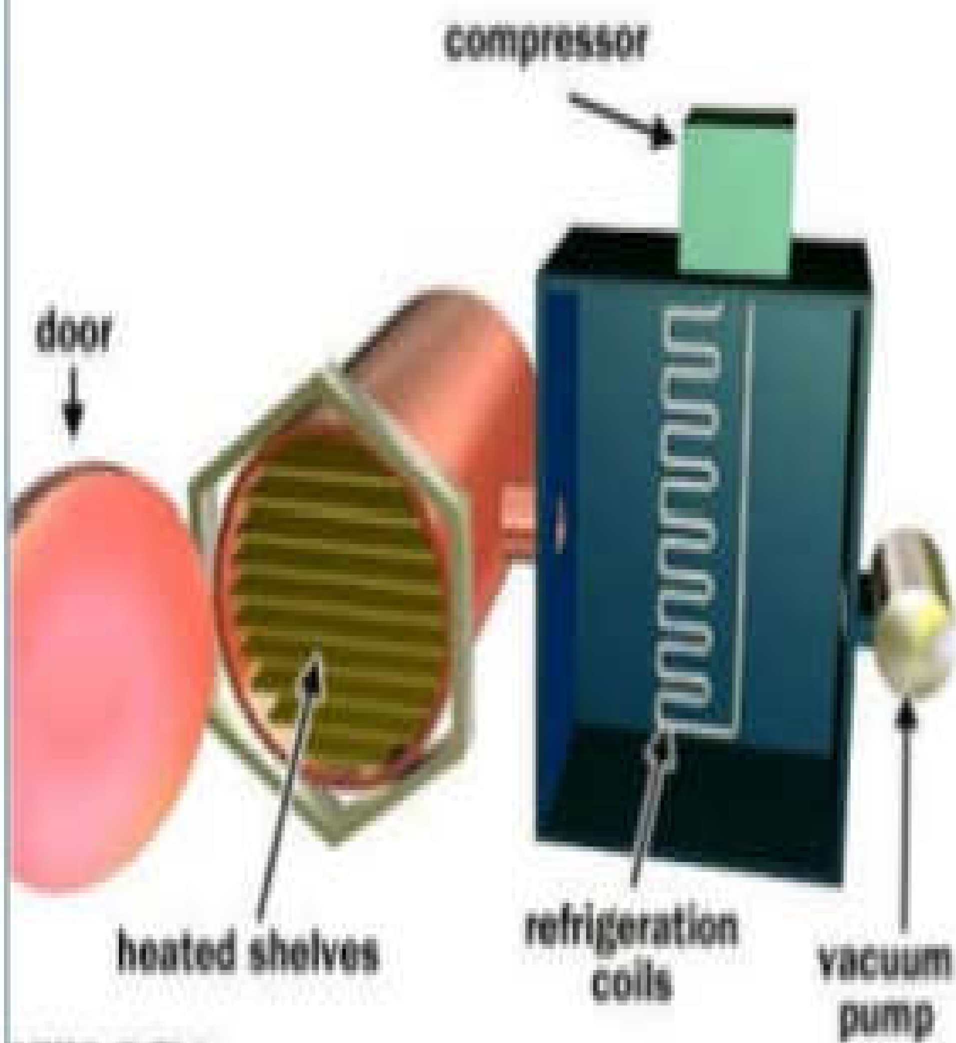


Figure 10.08. Representation of freeze drying components. Low temperature and pressure are required. (From Brennan et al. 1990.)



Food Preservation - Dehydration

Effect on Foods

- Products undergo changes during drying that reduce their quality compared to the fresh material.

1. *Texture*

- Rupture, crack, compress and permanently distort the relatively rigid cells,
  - Change texture apperance
  - To give the food a shrunken shriveled appearance.
- Re-hydrated product absorbs water more slowly and does not regain the firm texture of the fresh material.
- Drying pieces of meat - severe changes in texture.
  - Caused by aggregation and denaturation of proteins and loss of water-holding capacity.
- *Case hardening effect.*
  - reduces the rate of drying to produce a food with a dry surface and a moist interior.

Food Preservation - Dehydration

2. Flavor and Aroma

- Heat not only vaporises water during drying but also causes loss of volatile components.
- Volatile loss depends on;
  - Temperature and moisture content of the food
  - And the vapour pressure of the volatiles and their solubility in water.
- The open porous structure of dried food allows access of oxygen,
  - which is a *second important cause of aroma loss* due to oxidation of volatile components and lipids during storage.
- These changes are can reduced by:
  - vacuum or gas packing
  - low storage temperatures
  - maintenance of low moisture contents
  - addition of synthetic antioxidants
  - preservation of natural anti-oxidants.

Food Preservation - Dehydration

3. Colour

- Causes of colour loss or change in dried foods;
  - drying changes the surface characteristics of a food and alter the reflectivity of surface.
- Fruits and vegetables,
  - Chemical changes to carotenoid and chlorophyl pigments.
    - Caused by heat and oxidation during drying
  - Residual polyphenoloxidase enzyme activity causes browning.
- Prevented by treatment of fruits with ascorbic acid or sulphur dioxide.
  - However, sulphur dioxide bleaches anthocyanins, and residual sulphur dioxide is also health problem.

Thank you

Muthayammal Engineering College (Autonomous) Rasipuram 637408

16BTE01 / 16CHE03 –
FOOD TECHNOLOGY

Topic: Introduction to Food Technology

Dr. N. Saravanan
Professor

Food Technology

- **Food Technology** is a **science** branch that deals with the techniques involved in production, processing, preservation, packaging, labeling, quality management, and distribution of **food** products.
- The field also involves techniques and processes that are used to transform raw materials into **food**.

What is Food Technology?

- **Food technology** is the application of **food** science to the selection, preservation, processing, packaging, distribution, and use of safe **food**.
- Related fields include analytical chemistry, biotechnology, engineering, nutrition, quality control, and **food** safety management.

Food Technology

- Technology is the science and application of scientific, as well as socio-economic knowledge and legal rules for production.
- Food technology uses and exploits knowledge of Food Science and Food Engineering to produce varied foods.
- Study of Food Technology gives in-depth knowledge of science and technology, and develops skills for selection, storage, preservation, processing, packaging, distribution of safe, nutritious, wholesome, desirable as well as affordable, convenient foods.

Food Science

Food Science: It is a distinct field involving the application of basic sciences such as chemistry and physics, culinary arts, agronomics and microbiology.

It is a broad discipline concerned with all the technical aspects of food, beginning with harvesting or slaughtering and ending with cooking and consumption.

Food Processing

It is the set of methods and techniques used to transform raw ingredients into finished and semi-finished products.

Food processing requires good quality raw materials from either plant and/or animal source to be converted into attractive, marketable and often long shelf-life food products

Food Manufacturing

It is the mass production of food products using principles of food technology to meet the diverse needs of the growing population.

Food manufacturing is one of the largest manufacturing industries in the present times.

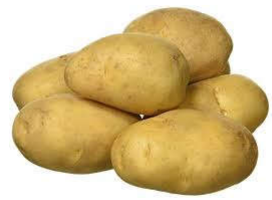
Classes of Foods Based on Perishability

Perishable foods are foods that spoil quickly within one or two days

e.g., milk, curds, fish and meat.

Classes of Foods Based on Perishability

Semi perishable foods can last for 1-2 weeks. Examples are fruits and vegetables. Root crops like onions and potatoes last for 2-4 weeks.



Classes of Foods Based on Perishability

Non-perishable are those foods that generally last for one year

e.g., Grains like rice, wheat, pulses and dals, oilseeds

Processed foods

1. *Minimally processed foods:* These are processed as little as possible in order to retain the quality of fresh foods. Processes used are cleaning, trimming, shelling, cutting, slicing and storage at low i.e., refrigeration temperatures.
2. *Preserved foods:* Foods do not change the character of the product substantially e.g., frozen peas and frozen vegetables, dehydrated peas, dehydrated vegetables, canned fruits and vegetables.

Processed foods

3. *Manufactured foods:* In such products, the original characteristics of the raw products are lost and some basic methods of preservation are used, often using various ingredients such as salt, sugar, oil or even chemical Examples are pickles, jams, papads.
4. *Formulated foods:* These are products prepared by mixing and processing of individual ingredients to result in relatively shelf stable food products such as bread, biscuits, ice cream, cakes, kulfi.

Processed foods

5. *Food derivatives:* In industry, components of foods may be obtained from the raw product through purification, e.g., sugar from sugarcane or oil from oil seeds. In some cases, the derivative or the component may be processed further, e.g., conversion of oil to vanaspati (the process is called hydrogenation).
6. *Functional foods:* These are foods that can have a beneficial effect on human health, e.g., probiotics, lycopene.

Processed foods

7. *Medical foods:* These are used in dietary management of diseases, for example, low sodium salt, lactose–free milk for persons with lactose intolerance.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Constituents of Food – Carbohydrates, Proteins, Lipids

Dr. N. Saravanan
Professor

Food sources

Primarily there are two main sources of food:

Plants Sources and Animal Sources

Fishes are sometimes treated separately as a third group:

Marine source: All kind of fish.

Plant Sources:

Fruits, vegetables, roots, stems, leaves, flowers, seeds, nuts, legumes, pulses, herbs, spices etc.

Food sources

Animal Sources:

Worldwide numerous species are considered edible.

For Muslims only ruminants and selected birds are Halal / edible.

Cows, buffalo, sheep, lamb, goat, deer, camel, hen, duck, turkey, quail.

Food Constituents

Chemically food is composed of following constituents:

- Carbohydrates
- Proteins
- Fats/Lipids
- Vitamins
- Minerals
- Water

Food Constituents

Types of food constituents:

On the basis of their functionality

1. Energy giving: Carbohydrates, Proteins, Fats
2. Growth & Body building: Proteins, Some minerals
3. Maintenance: Vitamins, Minerals

On the basis of requirement

1. Macronutrients: Carbohydrates, Proteins, Fats, Water
2. Micronutrients: Vitamins, Minerals

Carbohydrates

Carbohydrates:

- General chemical formula Cn(H2O)n
- Organic compounds
- Hydrates of carbon (2:1 ratio of H and O)
- Most abundant class of organic compounds on earth

Carbohydrate Sources

Carbohydrates are ingested in a variety of forms

Starch from grains, glycogen from meat, and disaccharide and monosaccharide sugars from fruits and vegetables.

Carbohydrates

Formation:

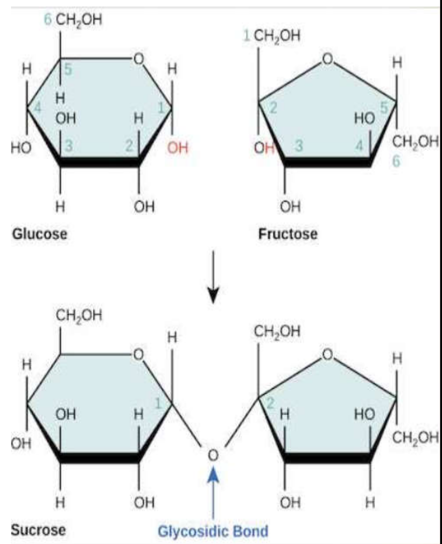
Formed by the process photosynthesis

$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

Classification:

Simple: monosaccharide, disaccharides

Complex: oligosaccharides, polysaccharides



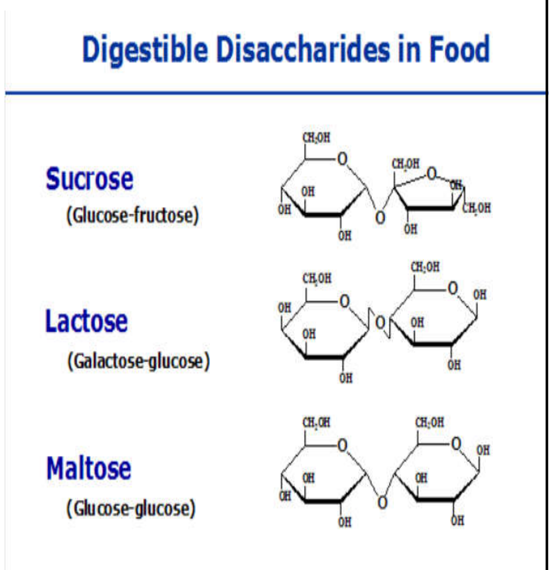
Carbohydrates

Simple:

These can't be hydrolysed any further Composed of 3 to 9 carbon atoms Only some trioses, pentoses and hexoses occur in nature

Monosaccharide: 1sugar unit e.g. Glucose, fructose, galactose

Disaccharide: 2 sugar units e.g. maltose, sucrose, lactose



Carbohydrates

Complex:

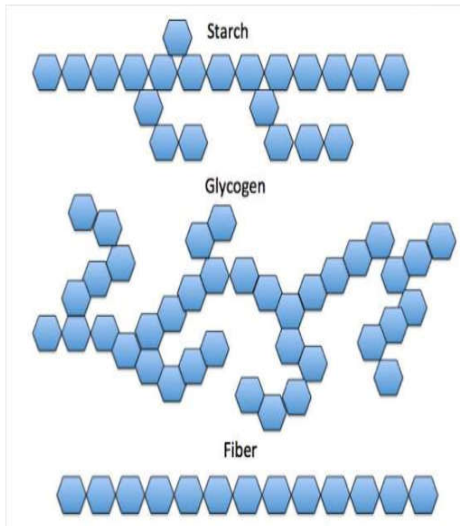
These can be hydrolysed into smaller simpler sugar units

Composed of 3 or more than 3 sugar units attached by glycoside bonds

Oligosaccharides: 3-7 sugar units e.g. raffinose, starchyose

Poly Saccharides: more than 7 sugar units e.g. amylose(70-350), amylopectin (several hundreds)

Starch, cellulose, glycogen, pectin, agar etc.



Carbohydrates

Carbohydrate metabolism

- Various biochemical processes responsible for the formation, breakdown and inter conversion of carbohydrates in living organisms.
- During digestion, complex carbohydrates are broken down into monosaccharides, which can be absorbed by the body.
- The most important carbohydrate is glucose, a simple sugar (monosaccharide) that is metabolized by nearly all known organisms.

Carbohydrate Utilization

- The monosaccharides that are absorbed in the small intestine are fructose, galactose, and glucose; the liver converts the first two into glucose.
- Excess glucose is stored as glycogen in the liver or is converted into fat and stored in adipose tissue.

Carbohydrates

Carbohydrate Requirements

- The need for carbohydrates varies with a person's energy requirements; the minimum requirement is unknown.
- An estimated intake of 125-175 grams of carbohydrate is needed daily to avoid protein breakdown.
- Energy share 50-60% from daily diet must be supplied from Carbohydrates
- Carbohydrates provide 16kJ or 3.75 kcal/gram energy when metabolised

Proteins

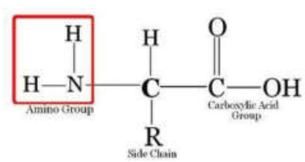
- Complex nitrogenous compounds
- Very high molecular weights
- About 2000 proteins exist in nature
- Composed of amino acids linked by peptide linkage
- Constituents of every living cell
- Participate in every aspect of cell metabolism
- Energy source providing 4 kcal (17 kJ) per gram
- Body protein is approximately 19% of flesh weight; 45% of this protein is present in muscle

Proteins

Classification

- Classified on the basis of heat:
  - Coagulable
  - Non-coagulable
- Classified on the basis of solubility:
  - Globulins
  - Albumins
- On the basis of functionality:
  - Structural, homones, enzymes, antibiotics, transport, storage, toxins
- On the basis of composition:
  - Simple
  - Conjugated: phosphoproteins, lipoproteins, glycoproteins, nucleoprotein, flavoproteins, metalloproteins.

Proteins



Amino Acids:

- Building blocks of proteins
- 20 naturally occurring
- Low molecular weight compounds
- Found in different combinations in different proteins Characterized by presence of a terminal (-COOH) & ($-NH_2$)
- Connected by peptide linkages; formed between the carboxyl and amino group of two adjacent amino acids.
- In addition, disulfide bonds may form between the sulfur moieties of two sulfur-containing amino acids in the polypeptide chain.
- May be alkaline, acidic or amphoteric in nature
- May be aromatic or aliphatic

Proteins

Amino acids classification

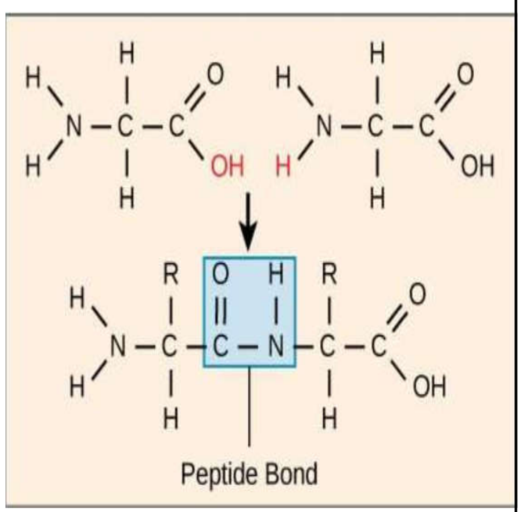
Essential:
- Required in daily diet
- Synthesized in low quantity or cannot be synthesized in human body

Non-essential:
- Not required in daily diet
- Can be synthesized in body from other amino acids

Essential	Non-Essential
Histidine	Alanine
Isoleucine**	Arginine
Leucine**	Asparagine
Lysine	Aspartic acid
Methionine	Cysteine
Phenylalanine	Glutamic acid
Threonine	Glutamine
Tryptophan	Glycine
Valine**	Proline
	Serine
* Branch Chain Amino Acids	Tyrosine

Proteins

Formation:
- Peptide linkage: Amino group of one amino acid links with acid group of second liberating a water molecule
- 2 dipeptide, 3 tripeptide,….. Polypeptide
- Hundreds of such peptide bonds are present in protein



Protein

Application: Functional/Nutritional/Chemical

- Functional Roles:
  - Emulsification:
  - Solubility: drinks, beverages, soups
  - Foaming: whipping creams, bread dough
  - Gelling ability: gelatin production, bread dough, yogurt
  - Binding water and fat: Mayonnaise
- Nutritional Roles:
  - Provide energy for growth and maintenance of body
  - Children require more protein as compared to adults
  - Deficiency disease- Kwashiorkor

Protein

Other Chemical Roles:

- Takes part in growth, maintenance and repair in following ways:
  - Enzymes catalysing metabolic reactions
  - Structural proteins maintaining the shape of the cell
  - Hormones regulating cell activities
  - Antibodies providing a defence mechanism
  - Contractile proteins
  - Transport proteins
  - Toxins and components of intracellular structures

Protein

Proteins may form biologically significant compounds through conjugation with other molecules:

- Chromo-proteins
- Lipoproteins
- Nucleoproteins
- Glucoproteins
- Metalloproteins.
- Plasma proteins are also important in maintaining fluid and acid-base balance.

- Digestive processes depend upon acids, alkalis, enzymes from the stomach, intestinal glands and pancreas.

Protein

Sources

- Animal:
  - Lean meat, poultry, fish, egg, milk, cheese, yogurt are rich protein sources
- Vegetable:
  - Beans, pulses, nuts, seeds are good vegetative sources Cereals contain some amounts
  - Vegetables and fruits general less sources

Lipids

Lipids constitute a heterogeneous compounds related by their physical properties

- Insoluble in water
- Soluble in non-polar organic solvents
  - Alcohol, ether, benzene, chloroform and acetone
- Important dietary constituents
  - High energy value
  - Deliver fat soluble vitamins
- Include fatty acids, triglycerides, phospholipids, sphingolipids, sterols, waxes, glycolipids and lipoproteins.

Lipids

- Fats are esters of saturated or unsaturated fatty acids with glycerol; (Fatty acid+glycerol is called glyceride)
- Fats and oils are basically mixture of triglycerides.
- Fatty acids vary with respect to their size, number and position of double bonds found in the molecule.
- Classification:

  Classified by the number of carbon atoms:
  - Short chain (C4-6)
  - Medium chain (C8-12)
  - Long chain (C12+)

  Classification by nutritional requirement
  - Essential: Linoleic and α-linolenic acid
  - Non-essential: Palmitic, stearic, oleic acid

Lipids

Classified by the saturation

- Saturated:
  - Devoid of double bonds
  - General formula CH3(CH2)nCOOH, (n= 2 to 24)
  - Stearic acid CH3(CH2)16COOH
- Unsaturated:
  - Presence of double bonds
  - Monounsaturated fatty acids:
  - Oleic acid (CH3(CH2)7CH=CH(CH2)7COOH)
  - Polyunsaturated fatty acids:
  - Linolenic acid
    CH3CH2CH=CH. CH2CH=CH. CH2CH=CH(CH2)7COOH

Lipids

Properties

- Saturated fats are solid at room temperature
- Oils/unsaturated fats are liquid at room temperature
- Saturation of the unsaturated fatty acids by hydrogenation convert liquid oil into a hard fat (example, solid white vegetable shortening and margarine)
- Mixing in water is dependent on emulsifier
- Milk (fat in water emulsion)
- Butter (water in fat emulsion)
- Fat/oils reacts with alkalis to form soaps
- Most of the fats melt between 30-40°C

Lipids

Rancidity

- Oxidative rancidity
  - Oxidative change results in changed odour due to liberating aldehyde, ketones or alcohols
  - Oxidation is enhanced by the presence of light, high temperature, inorganic elements like iron & copper Antioxidants like tocopherols are added and fats/oils are stored in airtight containers and cool dark places.
- Hydrolytic rancidity
  - Lipase hydrolysis of fats/oils
  - Acid–glycerol bond is broken down
  - Enzymes are destroyed or denatured by heat application

Lipids

Nutritional Significance

- Most concentrated source of energy supply 9 kcal/g (37 kJ/g)
- Enhance flavour and aroma
- Source of fat-soluble vitamins and essential fatty acids
- Required for growth, reproduction, skin integrity, maintenance of cell membranes.
- Stored in the form of adipose tissue to insulates and protects internal organs, maintain body temperature, while serving as a reserve source of energy

Lipids

Sources

- Animal:
  - Animal fats, butter, ghee
- Vegetable:
  - Vegetable oils, oils of seeds and nuts

Thank you

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16BTE01 / 16CHE03 –
FOOD TECHNOLOGY

Topic: Vitamins - Classification

Dr. N. Saravanan
Professor

Micro Food Constituents

These are required in very small (micro) quantities in our daily diet.

These include group of two constituents:

- Vitamins
- Minerals

Vitamins

A group of organic compounds essential in small quantities for the normal metabolism of other nutrients and maintenance of physiological well-being.

- Essential/vital for life
- Cannot be synthesized by the body
- Must be obtained from the diet
- Found in varying quantities in different foods
- No single food contains all of them in sufficient quantities
- Absence or relative deficiency of vitamins in the diet can lead to a characteristic deficiency state and disease

Vitamins

Classification:

The vitamins are classified according to their solubility in water and fat solvents.

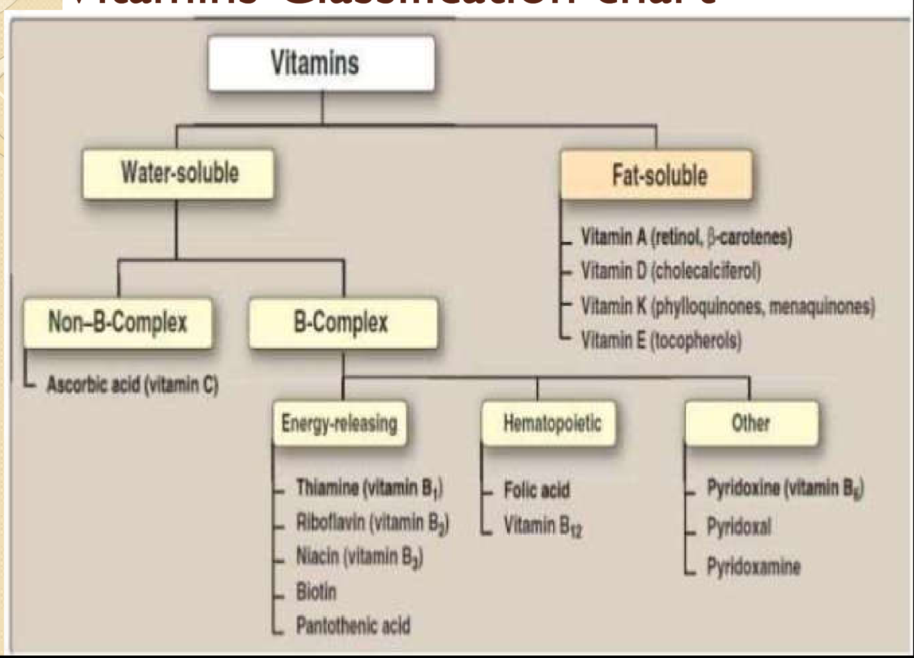
- Water Soluble Vitamins:
  - vitamin B1(thiamin), vitamin B2(riboflavin), vitamin B3(niacin),
  - biotin, vitamin B6(pyridoxine), pantothenic acid, folate, vitamin
  - B12(cobalamin) and vitamin C (ascorbic acid).

Vitamins

- The water soluble vitamins are not stored to any great extent and therefore need to be included in the diet every day.

- Fat Soluble Vitamins:
  - vitamin A(retinol), vitamin D (calciferol), vitamin E (tocopherol), and vitamin K (Phylloquinone)
  - Fat soluble vitamins are stored in appreciable amounts in body tissues and, do not have to be supplied daily in the diet.

Vitamins Classification chart



Fat Soluble Vitamins - Vitamin A

Introduction:

- Mixture of compounds having Vitamin A activity
- Include retinol, retinal, retinyl ester or retinoic acid
- Retinol is a pale, viscous, fat soluble compound
- Fairly heat stable but easily destroyed by oxidation
- Sources:
  - Animal origin:
    - ❖ Abundantly present in cod liver oil, beef liver, butter, cheese

Fat Soluble Vitamins - Vitamin A

- Plant origin:

❖ Present in the form of precursors carotenoids which may be converted into vitamin A; dark green leafy vegetables (chlorophyll masks the yellow carotene color), deep yellow vegetables, tomatoes and deep yellow fruit.

❖ Carotenoids closely related natural pigments include Beta-carotene, alpha-carotene, lutein and lycopene.

❖ Only beta and alpha carotene are precursors of retinol

Fat Soluble Vitamins - Vitamin A

Functions:

- Plays an important role in normal vision
- Essential for the integrity and normal growth of epithelial cells
- Required for proper growth and development of bones and teeth
- Important for the maintenance of membrane integrity and functions
- Anti-infective

Deficiency diseases:

- Hyperkeratinization (Cell disorder)
- Night blindness.

Fat Soluble Vitamins - Vitamin D

Introduction:

- Not strictly a vitamin, since it can be synthesized in the skin.
- Becomes essential/vital only when body fails to synthesise due to inadequate sunlight exposure.
- Its natural form is Cholecalciferol or Vit D3: a white crystalline compound that resembles to cholesterol.
- Stable to heat and processing.

Functions:

- Regulation of calcium absorption
- Utilization of Calcium and Phosphorus
- Homeostasis

Fat Soluble Vitamins - Vitamin D

Deficiency Disease:

- Strict vegetarians are especially at risk of deficiency
- Rickets in children
- Osteomalacia in adults (softening of bones).

Sources:

- There are relatively few sources of vitamin D
- Mostly found in animal origin of high fatty nature
- Oily fish, eggs, liver and butter providing modest amounts

Fat Soluble Vitamins - Vitamin E

Introduction:

- Found in many foods
- Known as Tocopherols and Tocotrienols
- Seven different forms exist
- Most active is α-tocopherol

Function:

- Lipid-soluble natural antioxidant that can be replaced by synthetic antioxidants
- Regulate reproductive function
- Maintain healthy immune system
- Prevent degeneration of tissues
- Protect hormones from oxidation

Fat Soluble Vitamins - Vitamin E

Deficiency Disease:

- Dietary deficiency of vitamin E in human beings is unknown.
- Patients with severe fat mal-absorption may suffer some forms of chronic liver disease

Sources:

- Vegetable oils are rich sources of vitamin E.
- Significant amounts are found in nuts, seeds, eggs, milk, most green leafy vegetables and a variety of fish.

Fat Soluble Vitamins - Vitamin K

Introduction:

- Discovered as a result of investigations into the cause of a bleeding disorder (hemorrhagic disease)
- Three compounds have the biological activity of vitamin K;
  - Phylloquinone K1: Yellow viscous oil, found in dietary origin (green leafy vegetables)
  - Menaquinones K2: compounds synthesized by intestinal bacteria
  - Menadione K3: synthetic compounds that can be metabolized to phylloquinone

Fat Soluble Vitamins - Vitamin K

Sources:

- Green leafy vegetables like spinach cabbage, cauliflower and sprouts.
- In addition, soybean, rapeseed, cottonseed, and olive oils are relatively rich in vitamin K

Functions:

- Anti-haemorrhagic and required for blood clotting

Deficiency Disease:

- Liver damage
- Blood fails to clot

Water Soluble Vitamins - Vitamin B1

Introduction:

- Thiamine- white solid
- widely distributed in foods
- readily lost by leaching into cooking water
- unstable to light

Functions:

- Coenzyme in glucose metabolism
- Energy-yielding metabolism at cellular level
- Takes part in nerve conduction therefore promotes healthy
- nervous system
- Promotes appetite and digestion

Water Soluble Vitamins - Vitamin B1

Sources:

- Potatoes, whole-grain cereals, peas, dry beans, milk, yeast, meat, and fish are the major sources in most diets.

Deficiency Disease:

- Beri Beri

weakness, palpitation of heart along with degeneration of nervous system and odema (wet beri beri)

Water Soluble Vitamins - Vitamin B2

Introduction:

- Riboflavin-yellow crystalline water soluble
- Deficiency is a significant public health problem in many areas of the world
- Fairly stable to heat but sensitive to light

Sources:

- Milk and dairy products are important sources providing 25% or more of total riboflavin intake in most diets average riboflavin status in different countries reflects milk consumption to a considerable extent.
- Other rich sources are eggs, meat, fish, cheese, lean meat, liver and dark leafy vegetables.

Water Soluble Vitamins - Vitamin B2

Functions:

- Takes part as coenzyme FAD in energy-yielding metabolism
- Healthy eyes and smooth skin

Deficiency Disease:

- Glossitis: swollen tongue and lips
- magenta tongue
- Seborrheic dermatitis

Water Soluble Vitamins - Vitamin B3

Introduction:

- Niacin is not strictly a vitamin, since it can be synthesized in the body from the essential amino acid tryptophan.
- Two compounds, nicotinic acid and nicotinamide have the biological activity of niacin.
- Sources:
- Liver, meat, poultry, fish, leafy vegetables, beans, cereals Chemical analysis reveals niacin in cereals (largely in the bran), but this is biologically unavailable.

Water Soluble Vitamins - Vitamin B3

Functions:

- Takes part in cellular metabolism and energy yielding reactions
- Nicotinamide nucleotide coenzymes, NAD and NADP

Deficiency disease:

- Pellagra: photosensitive dermatitis, like severe sunburn, typically with a butterfly like pattern of distribution over the face, affecting all parts of the skin that are exposed to sunlight.
- Advanced pellagra is also accompanied by dementia (more correctly a depressive psychosis), and there may be diarrhea.

Water Soluble Vitamins - Folic Acid

Introduction:

- The Latin word *folium* means "leaf," and the word *folate* from Italian means "foliage."
- *Folic acid* - oxidized form of the vitamin found in fortified foods
- *Folate*- reduced form of the vitamin found naturally in foods and in biological tissues.
- Discovered during the search to cure the disorder megablastic anemia.

Properties:

- Soluble in hot water and Crystallizes in yellow-orange needles
- Less heat stable

Water Soluble Vitamins - Folic Acid

Functions:

- Synthesis of nucleic acid
- Formation of red blood cells
- Involved in the metabolism of several amino acids, including histidine, serine, glycine, and methionine.

Deficiency Disease:

- Megaloblastic Anaemia

Sources:

- Liver, kidney, green leafy vegetables, peanuts

Water Soluble Vitamins - Vitamin B5

Introduction:

- The Greek word *pantos* means "everywhere"
- It is widely distributed in food sources of all plant and animal origins.
- Known as Pantothenic acid
- Occurs in foods in free and bound forms.
- About 85% of in food occurs bound as a component of coenzyme A.

Properties:

- Yellow viscous oil, soluble in water
- More stable in pH ranges 4-7
- Less heat resistants and lost during thermic processing

Water Soluble Vitamins - Vitamin B5

Deficiency disease:

- A deficiency is quite unlikely.
- "Burning feet syndrome": numbness of the toes and a sensation of burning in the feet.

Sources:

- Meats (particularly liver), egg yolk, legumes, wholegrain cereals, potatoes, mushrooms, broccoli, and avocados, among other foods, are good sources of the vitamin.

Water Soluble Vitamins - Vitamin B6

Introduction:

Pyridoxine represents the alcohol form, pyridoxal the aldehyde form, and pyridoxamine the amine form.

Functions:

Acts as coenzyme

Deficiency Disease:

Signs of vitamin B6deficiency include sleepiness, fatigue, cheilosis, glossitis, and stomatitis in adults.

Neurological problems and convulsions in infants.

Microcytic anemia due to impaired heme synthesis.

Water Soluble Vitamins - Vitamin B6

Sources:

•Pyridoxine-found almost exclusively in plant foods.

•Pyridoxal phosphate and pyridoxamine phosphate are found primarily in animal products.

•Good sources are meats, whole-grain products, vegetables, some fruits (e.g., bananas), and nuts.

Water Soluble Vitamins - Vitamin B7

Introduction:

- Discovered on investigating the cause of "egg white injury".
- Eating raw eggs was known to result in hair loss, dermatitis, and various neuromuscular problems.
- Combines with avidin (raw egg white protein) which makes its unavailable
- Later it was called vitamin H (the H refers to *haut* in German and means "skin") as well as vitamin B7.

Properties:

Crystallizes in needles in water.

- Heat and light stable
- Favourable pH range 5-8

Water Soluble Vitamins - Vitamin B7

Functions:

- Takes part as coenzyme in carboxylation and transcarboxylation reactions

Deficiency:

- Lethargy, depression, hallucinations, muscle pain, paresthesia in extremities, anorexia, nausea, alopecia (hair loss), and scaly, red dermatitis.

Sources:

- liver, soybeans, and egg yolk, as well as cereals, legumes, and nuts.
- Can also be produced by intestinal bacteria.

Water Soluble Vitamins - Vitamin B12

Introduction:

- Vitamin B12 also called cyanocobalamin.

Properties:

- Red coloured water soluble vitamin
- Stable in pH range 4-6
- Fairly heat stable

Functions:

- Acts as coenzyme

Water Soluble Vitamins - Vitamin B12

Deficiency Disease:

- Deficiency occurs mostly in strict vegeterians
- Deficiency of vitamin B12, like that of folate, results in megaloblastic macrocytic anemia

Sources:

- Found only in animal origin
- The best sources of the cobalamins are meat and meat products, poultry, fish, shellfish (especially clams and oysters), and eggs (especially the yolk).
- Milk and milk products such as cheese, cottage cheese, and yogurt contain less of the vitamin

Water Soluble Vitamins – Vitamin C

Introduction:

- White crystalline substance
- Destroyed by heat, oxidation, light
- Lost during peeling, trimming, cooking.

Functions:

- Ascorbic acid is required in several reactions involved in body processes, including collagen synthesis, carnitine synthesis, tyrosine synthesis and catabolism, and neurotransmitter synthesis.
- It takes part as a reducing agent and important antioxidant in the body.
- Strengthen blood vessels, Aids iron absorption, Healing of wounds

Water Soluble Vitamins - Vitamin C

Deficiency Disease:

- Scurvy

Sources:

- The best food sources of vitamin C include asparagus, papaya, oranges, orange juice, cantaloupe, cauliflower, broccoli, Brussels sprouts, green peppers, grapefruit, grapefruit juice, kale, lemons, and strawberries. of these foods, citrus products are most commonly cited as significant sources of the vitamin.

Minerals

Introduction:

Very important in normal nutrition and metabolism

Constitute only about 4% of total body weight.

Functions:

Their functions are many and varied.

Two general functions include building and regulating

They provide the medium essential for normal cellular activity.

Minerals

They maintain electrolyte balance/osmotic properties of body fluids.

Provide hardness to bones and teeth.

Function as obligatory cofactors in metallo enzymes.

Classified by their occurrence in the Body:

- Macrominerals: required in amounts >100 mg/day
- Microminerals: required less than macrominerals.

The major minerals of the human body:

calcium, phosphorus, magnesium, sodium, potassium, and chloride.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Additives

Dr. N. Saravanan
Professor

Food Additives

Food additives are substances added to food to preserve flavour or improve its taste and appearance.

Some additives have been used for centuries; for example, preserving food by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulphur dioxide as in some wines.

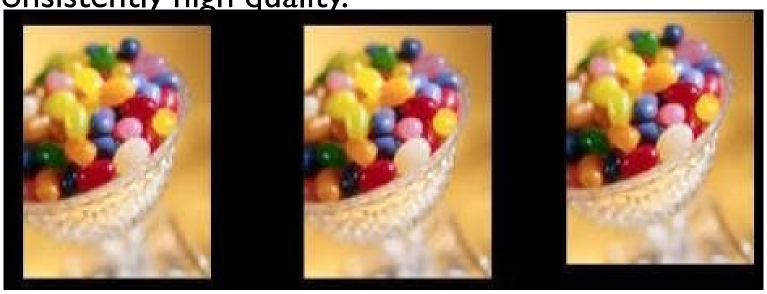
With the advent of processed foods in the second half of the 20th century, many more additives have been introduced, of both natural and artificial origin

Food Additives

Food produced on the large scale that is needed to supply supermarkets and other food shops has to be transported and stored before it is consumed

It has to stay in top condition over a much longer period of time than home cooked food.

Additives are used so that these foods still have a consistently high quality.



Food Additives

They are chemicals ,or ingredients which are added to food products for maintaining their stability.

Additives are artificial or natural chemicals, added to food, for microbial and chemical stability of foods or delay or even stop food rancidity.

Food Additives

The Codex Alimentarious Commission has defined "Food Additive" as under:

Food Additive means any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in the manufacture, processing, preparation, treatment, packing, or holding of such food results, or may be reasonably expected to result in it or its byproducts becoming a component or otherwise affecting the characteristics of such foods.

Food Additives

Functions of food additives:

• Improve the taste or appearance of a processed food

Eg: beeswax –glazing agent is used to coat apples

• Improve the keeping quality or stability of a food

Eg: sorbitol –added to mixed dried fruit to maintain moisture level and softness of the fruit

Food Additives

Improve shelf life or storage time
Eg: sulphur dioxide added to sausage meat to avoid microbial growth

- Ensure nutritional value
- Maintain uniform quality and to enhance quality parameters like flavour, colour etc., in large scale production

Food Additives

Types of food additives:

Direct or intentional food additives which are added deliberately to improve its sensory quality, stability, ease in processing and retention of quality during handling and retailing .

Indirect or unintentional food additives which get included into foods incidentally during handling, processing and packaging

Food Additives

Classes of food additives

- Preservatives
- Food colours
- Food flavors and flavor enhancers
- High intensity / lowcalorie sweeteners.
- Antioxidants.
- Emulsifiers.
- Acidulants
- Anti-caking agents

Food Additives

E-Codes

E-codes are codes sometimes found on food labels in the European Union (Great Britain, France, Germany, Spain, Italy, Portugal etc.)

- The codes indicates an ingredient which is some type of food additives
- The "E" indicates that is a "European Union Approved" food additive
- Other countries have different food labeling laws

Food Additives

E-Codes number	Groups of Food Ingredients
E-100	Coloring agents
E-200	Preservatives
E-300	Anti-oxidants
E-400	Thickeners, Stabilizers, Gelling agents, Emulsifiers
E-500	Agents for physical characteristics
E-600	Flavor enhancers

Food Additives

What are the effects of food additives?

***Immediate effects*:**

- Headache
- Change in energy level
- Alterations in mental concentration, behavoiur, or immune response

Long term effects:

- Increase risk of cancer, cardiovascular disease and other degenerative conditions

Food Additives

Preservatives:

- They prevent spoilage of food due to fungi , bacteria and other microorganisms

Commonly used in

- Low fat spreads

  Cheeses, margarine, mayonnaise

- Bakery products

  Dried fruit preparations

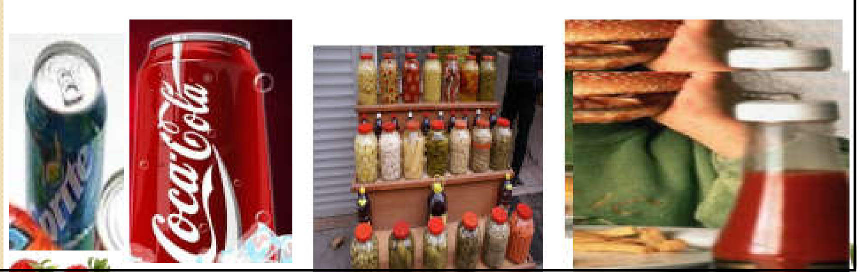
Eg: sodium benzoate , sodium nitrite, benzoic acid, BHA(butylated hydroxy anisole) / BHT(butylated hydroxy toluene)

Food Additives

Sodium benzoate- carbonated drinks, pickles, sauces

Side effects:

- Aggravates asthma and suspected to be a neurotoxin and carcinogen, may cause fetal abnormalities.
- Worsens hyperactivity

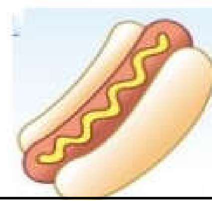


Food Additives

Sodium nitrite and nitrate – **sausages, hotdogs, smoked fish, canned meats**

Side effects:

- Nitrite is a Carcinogen (breast and stomach cancer in humans)
- Nitrate -Increases risk of miscarriages, fetal deaths and birth defects in lab. animals



Food Additives

Benzoic acid – **drinks, low sugar products, cereals , meat products**

Side effects:

- May temporarily inhibit digestive enzyme function. May deplete Glycine levels

Food Additives

BHA/BHT – **potato chips , vegetable oils**, chewing gum (butylated hydroxy anisole/toluene)

Side effects:

- May be carcinogenic to humans.
- BHA also interacts with nitrites to form chemicals known to cause changes in the DNA of cells.
- Toxic to liver.

Food Additives

- Make the food look appealing and so, taste better
- These are described as one of the **most dangerous** additives.
- Synthetic colours are made from coaltar or petroleum

Food Additives

Used to colour beverages, dessert powders, icecreams, custards

Cause allergies, asthma, hyperactivity

Eg:

- Erythrosine,
- Allura red,
- Tartrazine
- Brilliant blue

Food Additives

Erythrosine (Red No.3) – cherries in fruit cocktail and in **canned fruits** for salads, **baked foods**, dairy products, snack foods
Side effects: cancer

Food Additives

Tartrazine (yellow No. 5)- **ice cream,** carbonated drinks , fish sticks, cake mixes , **squashes**

Side effects: hyperactivity , asthma ,skin rashes, and migraine


Food Additives

Allura red - **carbonted drinks ,** bubble gum, **sauces , soups** , wine

Side effects: may worsen or induce asthma, rhinitis, utricaris(hives)



Food Additives

Brilliant blue –**dairy products** , **sweets**

Side effects:

- hyperactivity and skin rashes
- Listed as human carcinogen.

Causes DNA damage and tumours

Food Additives

Flavor enhancers:

Taste is a complex mixture of flavors and aroma.

Flavourings are added to food products to give orintensify flavour.

Eg: monosodium glutamate – is the sodium salt of the aminoacid glutamic acid and a form of glutamate

Food Additives

Monosodium glutamate is found in **restaurant food** , soups, chips, **salad dressings**, frozen foods, sauces ,**instant meals**

Side effects :

headache , weakness, nausea , altered heart rate, a burning sensation in the forearms and back of the neck ,tightness in the chest

Food Additives

***Sweeteners:**(nonnutritive or alternative sweeteners):*

Substances that impart sweetness to food but supply little or no energy to the body

Functions :

- Provide texture in baked foods
- Humectant in cakes
- Lowers the freezing point in icecream
- Preservative in jams
- Adds bulk to baked foods
- Strengthens “mouthfeel” in soft drinks

Food Additives

Side effects of sweeteners :

- Behavioral Problems,
- Hyperactivity ,
- Allergies And
- Possibly carcinogenic

Food Additives

Antioxidants :

Oxidation is a destructive process , causing loss of nutritional value and changes in chemical composition

Antioxidants are added to food to slow the rate of oxidation and if used properly can extend the shelf life of food in which they have been used.

Eg: BHA(butylated hydroxy anisole), BHT(butylated hydroxy toulene)

Food Additives

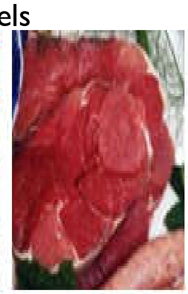
Commonly used in **Vegetable oil Meat, fish, poultry,** Margarine, **Dairy products**

Side effects:

Hyperactivity ,

- Asthma
- Angiodema,
- May affect ESTROGEN levels






Food Additives

Emulsifiers:

Emulsions in food are mixtures of oil and water.

Emulsifier keeps the mixture stable and prevents the oil and water from separating into two layers.

Other Functions:

- Make food appealing
- Effect on the texture of food
- Prevent the growth of moulds in low fat spreads
- Aid in processing and help maintain quality and freshness

Food Additives

Examples of food emulsifiers are:

Egg yolk (in which the main emulsifying agent is lecithin) Proteins and low-molecular-weight emulsifiers are common as well

Soy lecithin is another emulsifier and thickener In some cases, particles can stabilize emulsions through a mechanism called Pickering stabilization sodium stearoyl lactylate

DATEM (Diacetyl Tartaric Acid Ester of Monoglyceride) is an emulsifier primarily used in baking

Food Additives

Acidulants:

They are additives that give a sharp taste to foods.

Also assist in the setting of gels and to act as preservative

The acid environment they produce prevents the growth of microbes

Eg: widely used organic acid is **citric acid** in food products drinks and pharmaceuticals

Food Additives

Anticaking agents:

Processed food often contains ingredients that are mixed as powders.

anti-caking agents are added to allow them to flow and mix evenly during the food production process.

Eg: silicon dioxide ,calcium silicate

Food Additives

Commonly found in

- **vending machine powders(coffee , cocoa)**
- Milk and cream powders
- **Grated cheese**
- **Icing sugar**
- Baking powder
- Cake mixes
- Instant soup powders
- **Drinking chocolate**
- **Table salt- magnesium carbonate is the agent added**

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Deterioration

Dr. N. Saravanan
Professor


Food Deterioration

Foods undergo deterioration to varying degrees in organoleptic properties, nutritional value, safety and aesthetic appeal.

The term food deterioration is often associated with advanced spoilage, which may make food unfit for human consumption.

In the broader sense any adverse change in attributes from an agreed upon measure of quality may be considered deterioration.

Food Deterioration

Most of the foods, from harvest, slaughter, or manufacture, undergo progressive deterioration which, depending upon the food, may be very slow or very rapid.

Food is subject to physical, chemical, and biological deterioration.

The highly sensitive organic and inorganic compounds of food, the biochemical balance between these compounds, and the uniquely organized structures and dispersions that contribute to texture and consistency of unprocessed.

Food Deterioration

Food Deterioration: A series of continuous degradative changes occurring in a food item which may affect the product's wholesomeness, result in a reduction of its quality, and/or alter its serviceability.

Wholesomeness: Wholesomeness is a term that refers to freedom from pathogenic or otherwise harmful microorganisms.

or

A characteristic possessed by a food product that is conducive to good health and well being of the consumer.

Food Deterioration

Spoilage: food spoilage as an arbitrary end point of the deterioration process which denotes that a food item is unwholesome and, therefore, is no longer suitable for human consumption

Unwholesome: Unwholesome food is food procured, packed, or held under unsanitary conditions that renders it injurious to the health of the consumer

Off-condition: Off-condition is any variation from the expected appearance, feel, smell, or taste characteristics of a product when it was initially produced or processed for resale

Food Deterioration

- **Quality:** Quality is a term that refers to the degree of excellence or grade of a Product.
- **Serviceability:** Serviceability is a term that refers to the usefulness of a food item. Reduced serviceability in a product may result in the use of additional processing methods to return the food item to its original state

Food Deterioration

Useful Storage Life of Plant and Animal Tissues

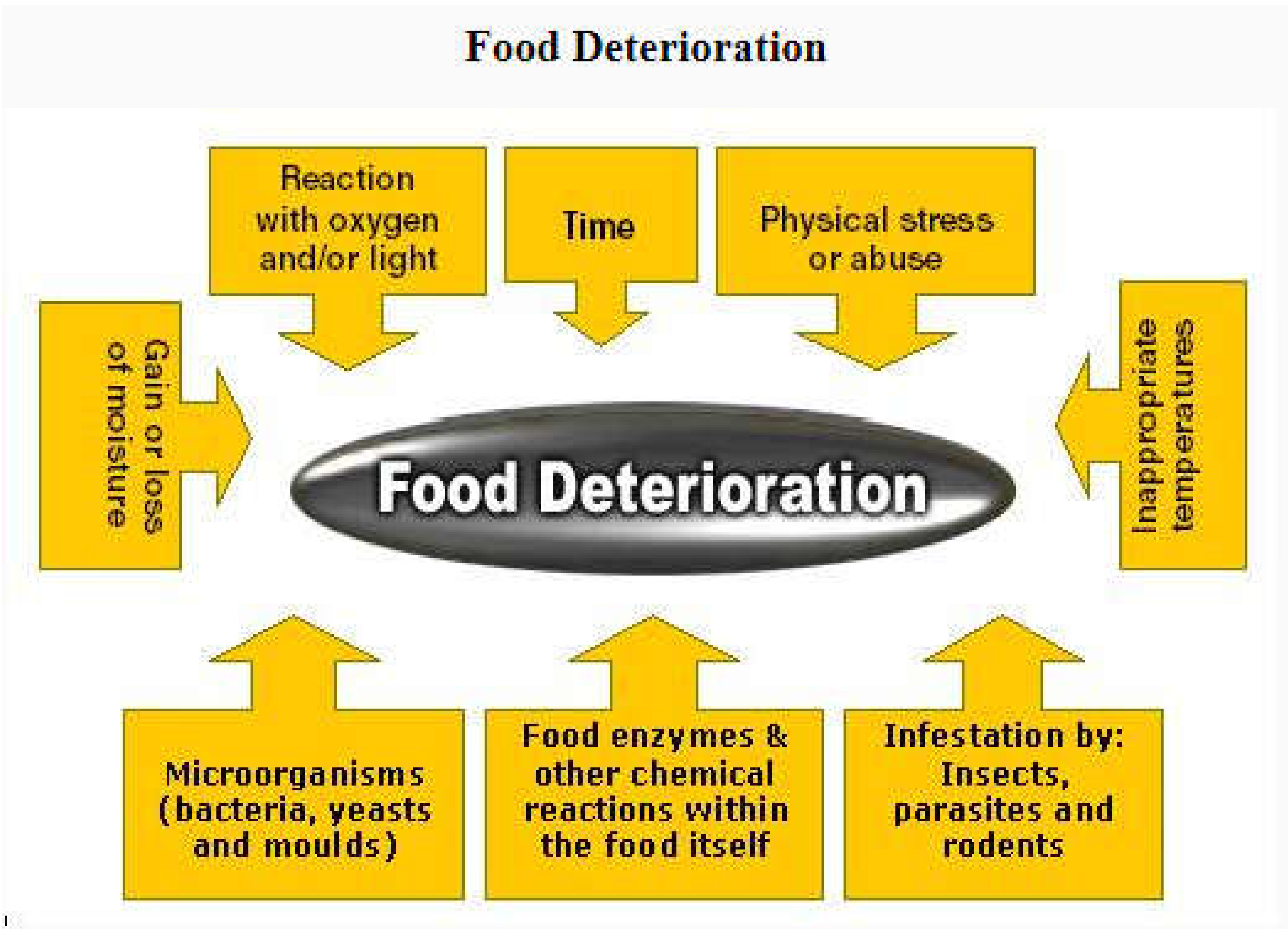
Food Product	Generalized Storage Life 21°C (days)
Meat	1–2
Fish	1–2
Poultry	1–2
Dried, salted, smoked meat and fish	360 and more
Fruits	1–7
Dried fruits	360 and more
Leafy vegetables	1–2
Root crops	7–20
Dried seeds	360 and more

Food Deterioration

The major causes of food deterioration include the following:

1. Growth and activities of microorganisms, principally bacteria, yeasts, and Molds
2. Activities of natural food enzymes
3. Insects, parasites, and rodents
4. Temperature, both heat and cold
5. Moisture and dryness
6. Air, and more particularly oxygen
7. Light
8. Time

Food Deterioration



Food Deterioration

Control of Deteriorations in Food Products

Control by Heating

Control by Freezing

Control Techniques for Fruits

Chemical preservation

Control by drying/dehydration

Thank you

Muthayammal Engineering College (Autonomous) Rasipuram 637408

16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: General Engineering Aspects in Food Processing

Dr. N. Saravanan

Professor

General Engineering Aspects in Food Processing

- A physical entity, which can be observed and/or measured, is defined qualitatively by a dimension.
- For example, time, length, area, volume, mass, force, temperature, and energy are all considered dimensions like unit of length may be measured as a meter, centimeter, or millimeter.
- Primary dimensions, such as length, time, temperature, and mass, express a physical entity.

General Engineering Aspects in Food Processing

- Secondary dimensions involve a combination of primary dimensions (e.g., volume is length cubed; velocity is distance divided by time).
- Physical quantities are measured by variety of unit systems.
- The most common systems include the Imperial (English) system; the centimeter, gram, second (cgs) system; and the meter, kilogram, second (mks) system.

General Engineering Aspects in Food Processing

SI Base Units

Measurable attribute of phenomena or matter	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

General Engineering Aspects in Food Processing

Examples of SI-Derived Units Expressed in Terms of Base Units

Quantity	SI Unit	
	Name	Symbol
Area	square meter	m^2
Volume	cubic meter	m^3
Speed, velocity	meter per second	m/s
Acceleration	meter per second squared	m/s^2
Density, mass density	kilogram per cubic meter	kg/m^3
Current density	ampere per square meter	A/m^2
Magnetic field strength	ampere per meter	A/m
Concentration (of amount of substance)	mole per cubic meter	mol/m^3
Specific volume	cubic meter per kilogram	m^3/kg
Luminance	candela per square meter	cd/m^2

General Engineering Aspects in Food Processing

Physical properties

•Food engineering is related to the analysis of equipment and systems used to process food on a commercial production scale.

•Design of food equipment and processes to insure food quality and safety we should know the response of the food materials to physical and chemical treatments.

•Raw food materials are biological in nature and as such have certain unique characteristics which distinguish them from other manufactured products.

General Engineering Aspects in Food Processing

Rheological properties

- The majority of industrial food processes involve fluid movement.
- Liquid foods such as milk and juices have to be pumped through processing equipment or from one container to another.
- A number of important unit operations such as filtration, pressing and mixing are, particular applications of fluid flow.
- The mechanism and rate of energy and mass transfer are strongly dependent on flow characteristics.

General Engineering Aspects in Food Processing

Mechanical Properties

•Mechanical properties are those properties that determine the behavior of food materials when subjected to external forces.

•Mechanical properties are important in processing (conveying, size reduction) and consumption (texture, mouth feel).

•The forces acting on the material are usually expressed as *stress*, i.e. intensity of the force per unit area ($N.m^2$ or Pa.). The dimensions and units of stress are like those of pressure

General Engineering Aspects in Food Processing

The response of materials to stress is deformation, expressed as *strain*.

• *Elastic deformation:* deformation appears instantly with the application of stress and disappears instantly with the removal of stress.

• *Plastic deformation:* deformation does not occur as long as the stress is below a limit value known as *yield stress*. Deformation is permanent, i.e. the body does not return to its original size and shape when the stress is removed.

• *Viscous deformation:* deformation (flow) occurs instantly with the application of stress and it is permanent. The *rate* of strain is proportional to the stress

General Engineering Aspects in Food Processing

Thermal Properties

- In the food industry every process involves thermal effects such as heating, cooling or phase transition.
- The thermal properties of foods are important in food process engineering.
- The following properties are of particular importance: thermal conductivity, thermal diffusivity, specific heat, latent heat of phase transition and emissivity

General Engineering Aspects in Food Processing

Electrical Properties

•The electrical properties of foods are particularly relevant to microwave and ohmic heating of foods and to the effect of electrostatic forces on the behavior of powders.

•The most important properties are electrical conductivity and the dielectric properties.

•Ohmic heating is a technique whereby a material is heated by passing an electric current through it.

General Engineering Aspects in Food Processing

Size and Shape

•The size and shape of a raw food material can vary widely.

• The variation in shape of a product may require additional parameters to define its size.

•The size of spherical particles like peas or cantaloupes is easily defined by a single characteristic such as its diameter.

•The size of non-spherical objects like wheat kernels, bananas, pears, or potatoes may be described by multiple length measurements.

General Engineering Aspects in Food Processing

Colour

•Colour is an important quality parameter because colour and colour uniformity are vital components of visual quality of fresh foods and play a major role in consumer choice.

• Automatic measurement of color is essential in many process control applications, such as sorting of fruits and vegetables in packing houses, control of roasting of coffee and nuts, control of frying of potato chips

General Engineering Aspects in Food Processing

Density

•Density is defined as objects mass per unit volume. Mass is a property.

•The symbol most often used for density is ρ (the lower case Greek letter rho). Mathematically, density is defined as mass divided by volume.

•It is an indication of how matter is composed in the body material with more compact density has higher density

General Engineering Aspects in Food Processing

Bulk Density

•It is the weight of the food material in a unit volume. It is of importance in the packaging, handling and other operations.

•**Bulk density** is defined as the mass of many particles of the material divided by the total volume they occupy

General Engineering Aspects in Food Processing

Porosity

- The void space can be describing the porosity which is expressed as volume not occupied as good material.
- **Porosity** is the percentage of air between the particles compared to a unit volume of particles.
- **Porosity** is that portion of the material volume occupied by pore spaces.

General Engineering Aspects in Food Processing

Specific gravity

- The Specific Gravity - *SG* - is a dimensionless unit defined as the ratio of density of the substance to the density of water at a specified temperature.
- ***Apparent* specific gravity** is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance.

General Engineering Aspects in Food Processing

Thermal Conductivity

- Thermal conductivity *is a measure of the ability of a material to transfer heat.*
- It may be define as the rate of heat flow through unit thickness of material per unit area normal to direction of heat flow and per unit time per unit temperature difference is called thermal conductivity.

General Engineering Aspects in Food Processing

Viscosity

- Viscosity is a resistance of a fluid which is being deformed by either shear stress or tensile stress.
- In the other word we can say viscosity is the property of fluid by virtue of which is opposing its flow.
- Viscosity is resistance to flow.

General Engineering Aspects in Food Processing

Thermal Diffusivity

•It is defined as *the ratio of thermal conductivity to the 'volumetric heat capacity' of the material.*

•Volumetric heat capacity is obtained by multiplying the mass specific heat c p by the density ρ.

•It may be calculated by dividing thermal conductivity with the specific heat and density.

•In heat transfer analysis, thermal diffusivity usually denoted *α* but *a*, *κ*, *k*, and *D* are also used. It has the SI unit of m^2/s

General Engineering Aspects in Food Processing

Heat

•In physics, **heat** is energy in transfer other than as work or by transfer of matter.

•When there is a suitable physical pathway, heat flows from a hotter body to a colder one.

•A form of energy associated with the motion of atoms or molecules and capable of being transmitted through solid and fluid media by conduction, through fluid media by convection, and through empty space by radiation

General Engineering Aspects in Food Processing

Specific Heat

The specific heat is the amount of heat per unit mass required to raise the temperature by one degree Celsius without change in surface.

General Engineering Aspects in Food Processing

Latent heat

The quantity of heat absorbed or released by a substance undergoing a change of state, such as ice changing to water or water to steam, at constant temperature and pressure.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Preliminary methods

Dr. N. Saravanan
Professor

Preliminary methods

The preliminary preparative operations in food processing include:

- Cleaning,
- Sorting and
- Grading of food raw material.

These may be considered as separation operation.

Preliminary methods

- Cleaning involves the separation of contaminants from the desired raw materials.
- Sorting involves the separation of the raw materials into different categories based on their physical characteristics such as size, shape and colour.
- Grading involves the separation of the raw materials into categories based on the differences in their overall quality

Preliminary methods

Cleaning of food raw materials

Different food raw materials are associated with different types of contaminants.

These include

- Mineral contaminants- soil, sand, stone metallic particles, grease and oil.
- Plant part- stalks, pits, husks and rope,
- Animal parts and contaminants—excreta, hair, insects eggs and body part
- Chemical contamination- sprayed residues of pesticides, insecticides and fertilizers
- Microbial contaminants—microorganisms and their metabolites.

Preliminary methods

The chosen cleaning process must satisfy the following requirements in order to achieve the aforesaid objective:-

1. The separation efficiency of the process must be high and consistent and should produce minimum wastage of good material
2. Damage of cleaned raw material must be avoided
3. Recontamination of the cleaned food should be avoided by complete removal of the contaminants.

Preliminary methods

4. The design of the process equipment should be such that recontamination of the cleaned food due to flying dust or wash water is prevented.

5. The cleaning process must leave the cleaned surface in acceptable condition,

6. The volume and concentration of liquid effluents must be kept be minimum and the effluents should be disposed off effectively.

Preliminary methods

Cleaning Methods

The cleaning methods can be classified into two groups, namely

- Dry cleaning methods which include screening, brushing, aspiration, abrasion and magnetic separation
- Wet cleaning methods which include soaking, spraying, flotation, ultrasonic cleaning, filtration and settling.

Preliminary methods

Screening

Screens are primarily size separators or sorting machines but may be used as cleaning equipment for removing contaminants of different size from that of the raw material.

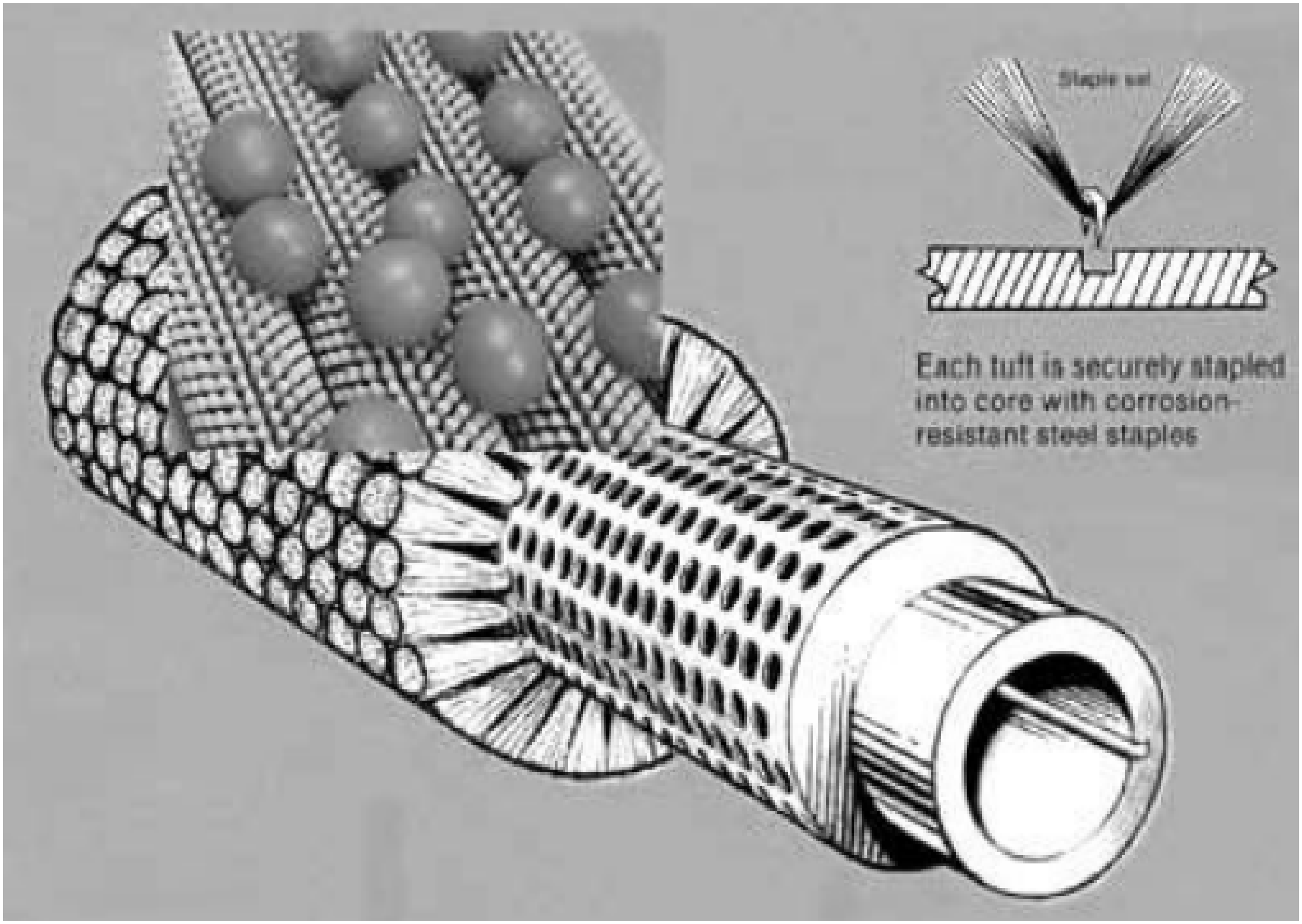
These machines are useful in cleaning fine materials such as flour and ground spices but must be frequently cleaned to remove oversized contaminants

Preliminary methods

Abrasion cleaning

Abrasion between food particles or between the food and moving parts of cleaning machinery is used to loosen and remove adhering contaminants. Vibrators, abrasive discs and rotating brushes are used for this purpose.

Preliminary methods



Preliminary methods

Aspiration cleaning

Aspiration (or winnowing) is based on the differences in the aerodynamic properties of materials.

The raw material to be cleaned is fed into a stream of air flowing at controlled velocity to separate the raw materials into two or more streams (e.g. light and heavy streams).

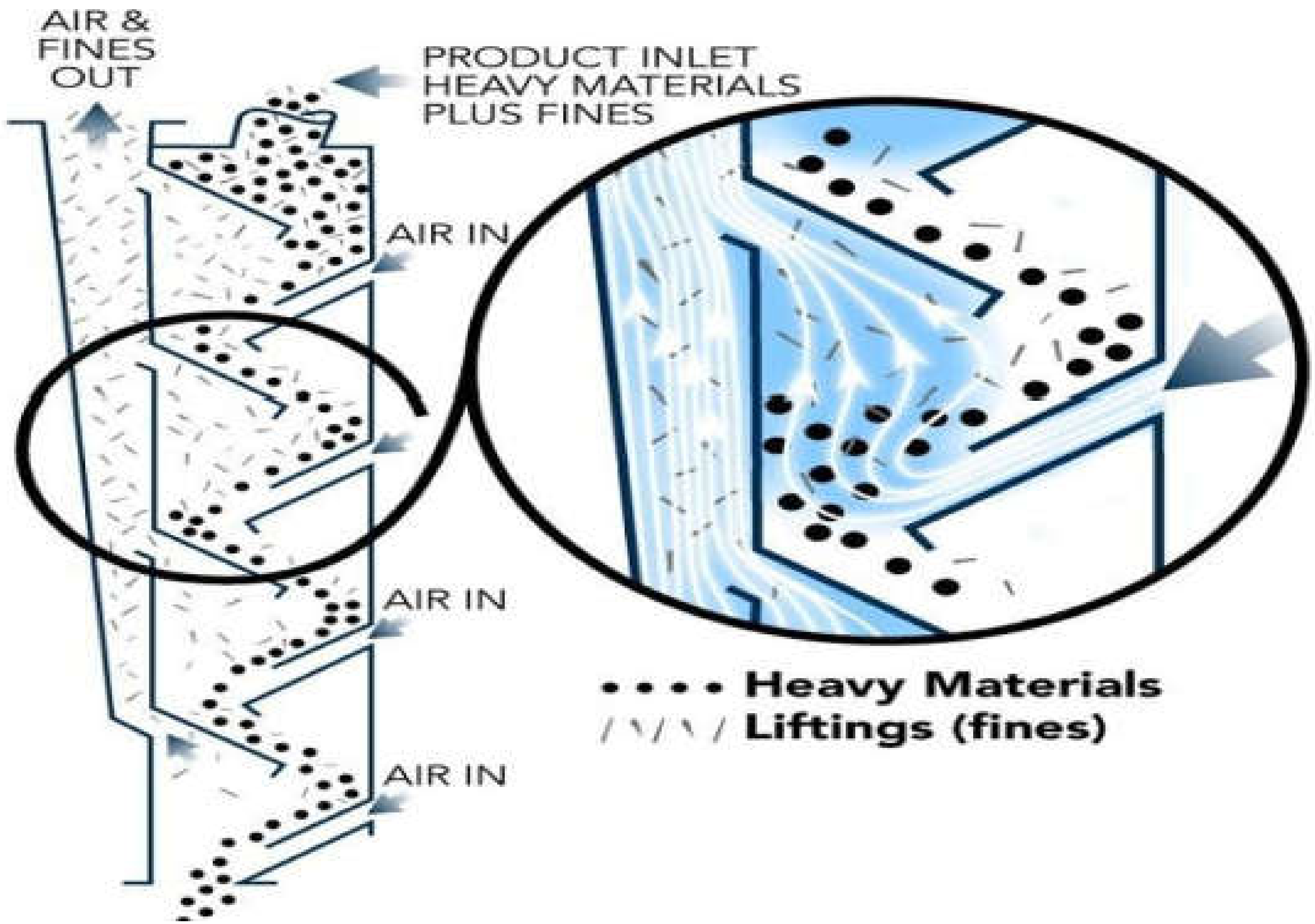
Preliminary methods

Aspiration cleaning

The cleaned products are usually discharged as the middle stream leaving the heavy debris (stones, pieces of metal or wood) behind while floating off the light debris such as stalks, husks and hairs.

This method is used in cleaning cereals, nuts, beans, onions, melon, eggs.

Preliminary methods

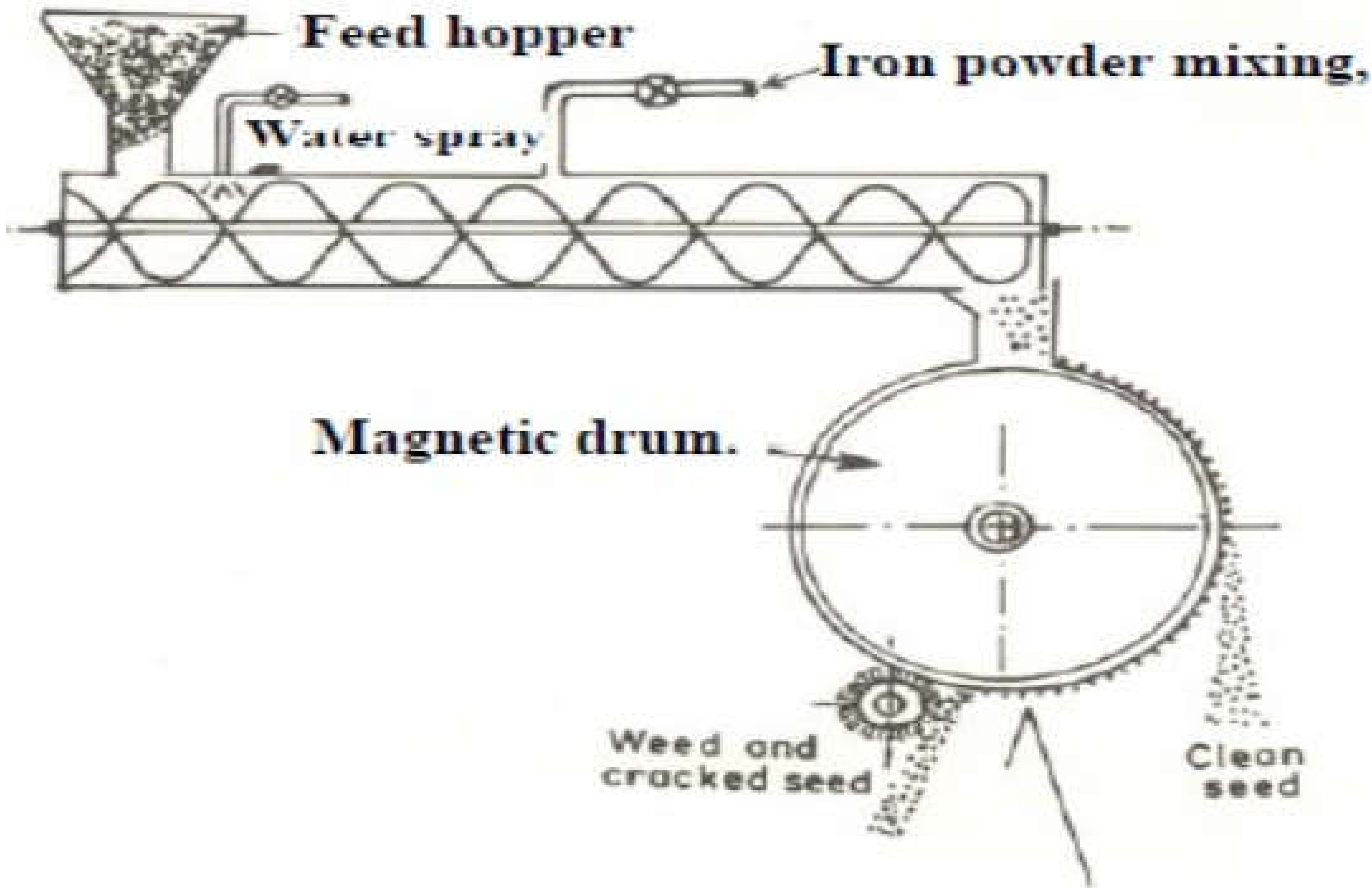


Preliminary methods

Magnetic cleaning

This type of cleaning involves where the food contaminated with high amount of metallic material. Magnetic separators used for this type of cleaning include rotating or stationary magnetic drums, magnetized belts, magnets located over belts carrying the food or staggered magnetized grids through which the food is passed

Preliminary methods



Magnetic Cleaner

Preliminary methods

Miscellaneous dry cleaning methods

Such cleaning methods include:

1. Electrostatic cleaning
2. Radio isotope separation
3. X-ray separation.

Preliminary methods

Electrostatic cleaning

Electrostatic cleaning can be used in a limited number of cases where the surface charge on raw materials differs from contaminating particles.

The principle can be used to distinguish grains from other seeds of similar geometry but differences in electrostatic charging of materials under controlled humidity conditions.

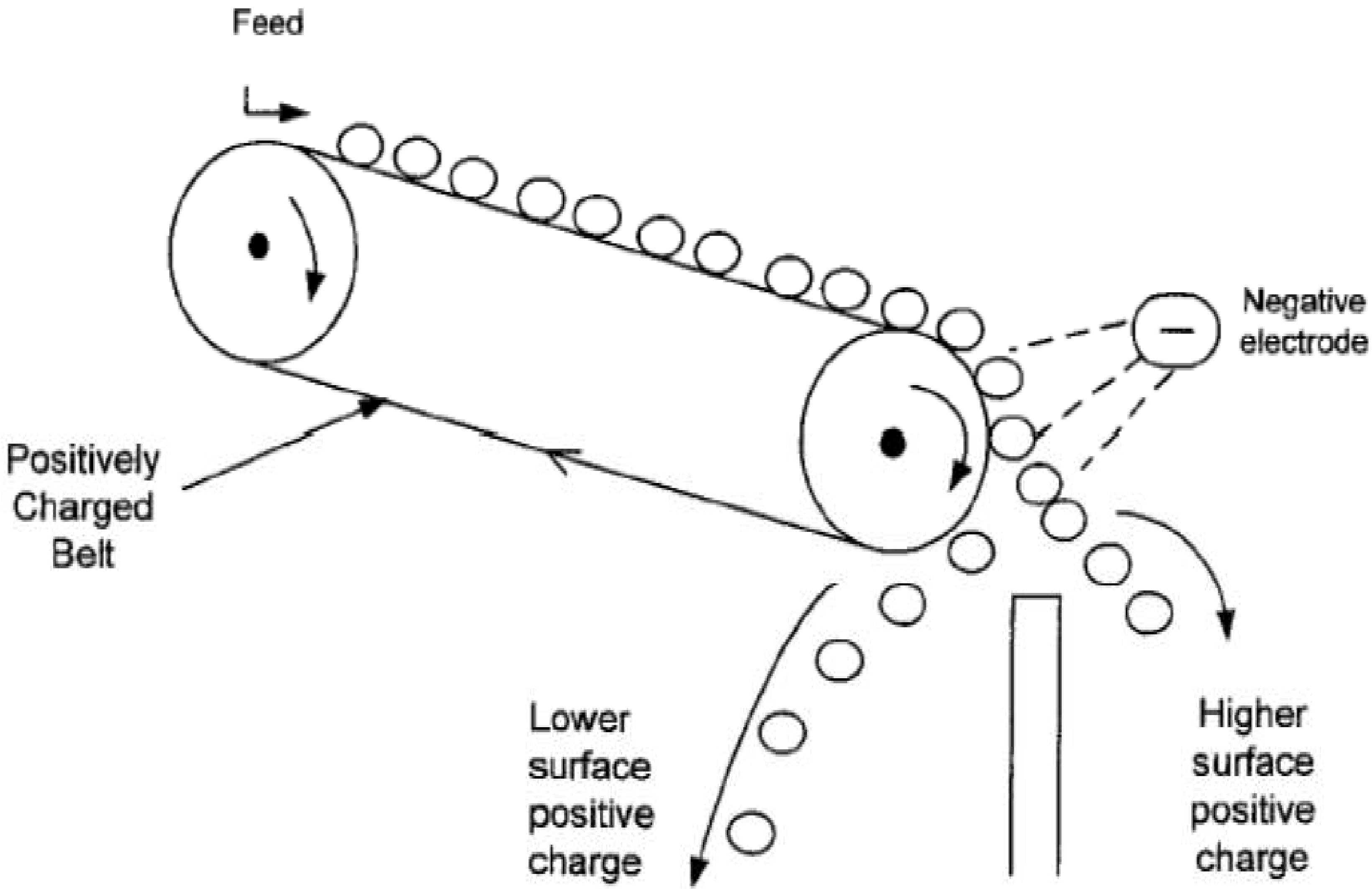
Preliminary methods

Electrostatic cleaning

Charged particles being removed by oppositely charged or earthed rollers, grids, etc. and it has also been described for cleaning tea.

The feed is conveyed on a charged belt and charged particles are attracted to an oppositely charged electrode according to their surface charge.

Preliminary methods



electrostatic cleaning.

Preliminary methods

Radio isotope separation

Clods of earths and stones may be separated from the potatoes.

X-ray separation

Stones, glass and metal fragments in foods such as confectionery can be separated by this method

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Preliminary methods

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Preliminary methods

Wet cleaning methods

Wet cleaning has the advantage of removing firmly adherent soils and owing the use of detergents and sanitizers.

Wet cleaning methods include:

- Soaking,
- Spray washing,
- Flotation washing

Preliminary methods

Soaking

This is the simplest method and is often used as preliminary stage in the cleaning of heavily contaminated root vegetables and other foods. Soaking softens adhering soil and also facilitates the removal of sand, stone, and ether abrasive material.

Preliminary methods

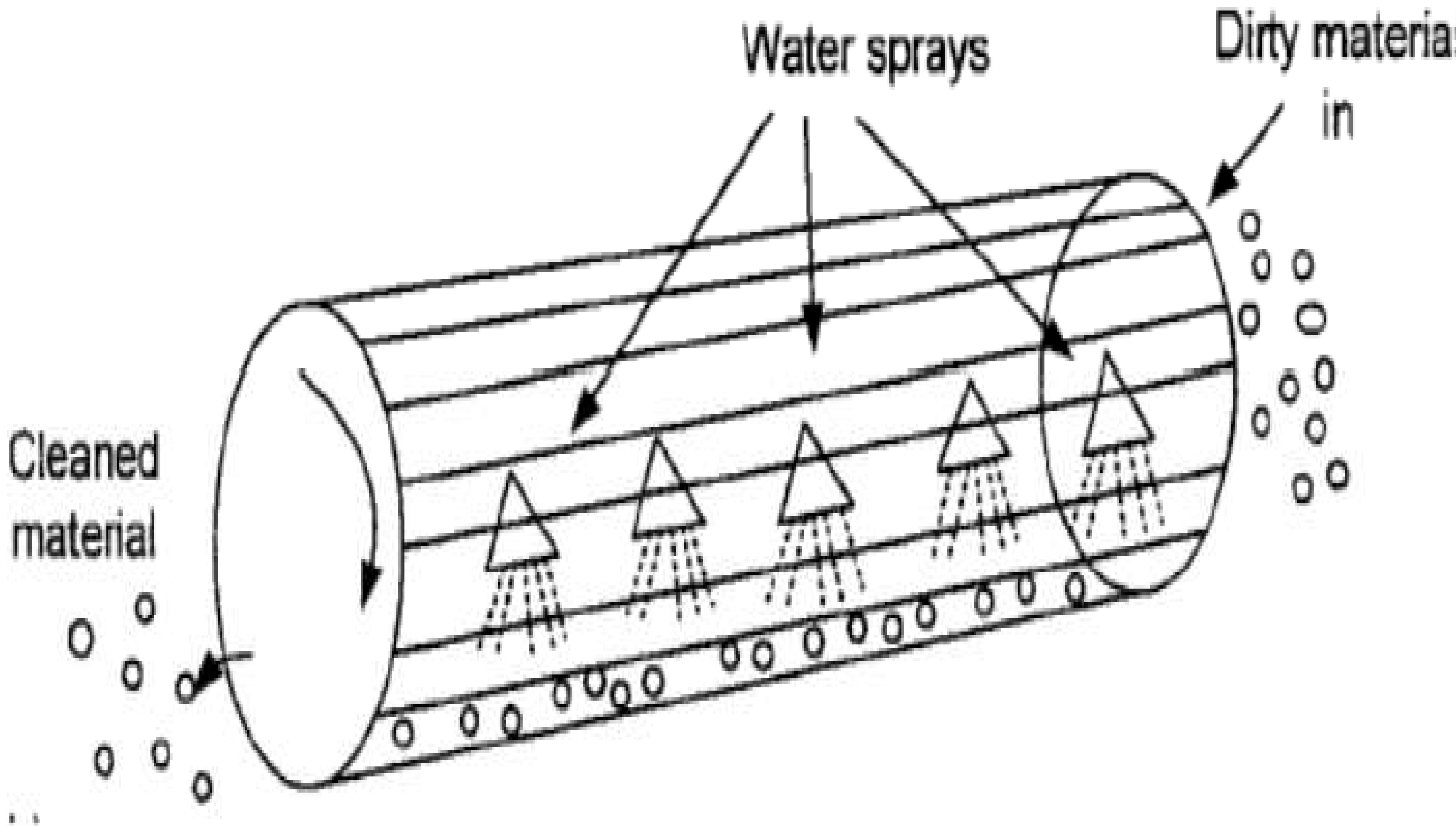
Spray washing

This is the most widely used method for wet cleaning of fruits and vegetables.

The surface of the food is subjected to water sprays.

The efficiency of spray washing depends on several parameters such as water pressure, volume of water, temperature, the distance of the food from jets, the time of spraying and number of spray jets used.

Preliminary methods



spray washer.

Preliminary methods

Flotation washing

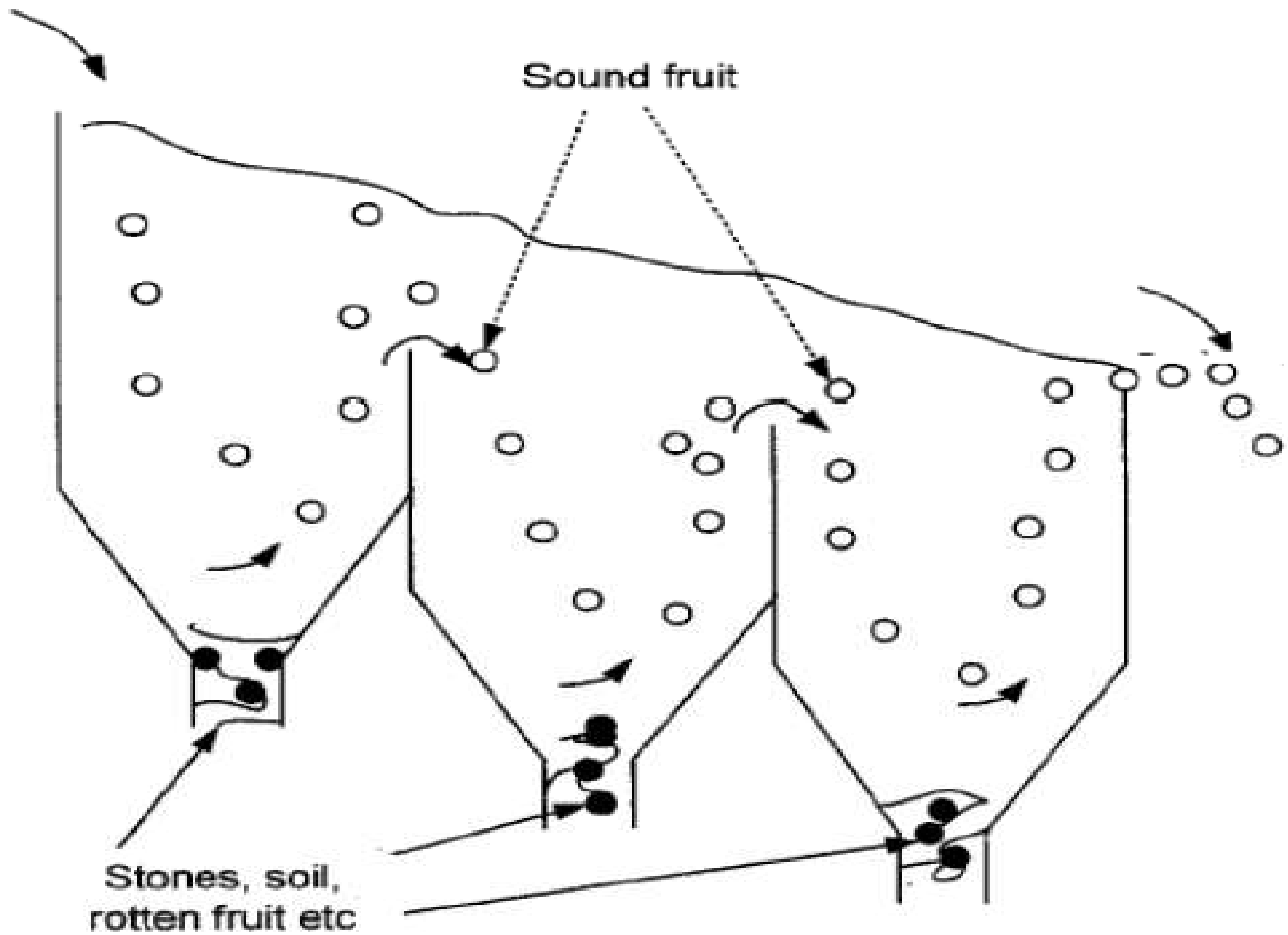
The method depends on the differences in buoyancy of the desired and undesired parts of the food raw material to be cleaned.

For example, bruised or rotten apples sink in water and can be removed at the base of tank and the good fruit can be collected as overflow.

Preliminary methods

Froth flotation has been used to separate peas from weed seeds by immersing the peas in dilute mineral oil-detergent emulsion through which air is blown, the contaminants float on foam and are removed. The cleaned peas are given a final wash to remove the emulsion.

Preliminary methods



flotation washing.

Preliminary methods

Dewatering

Wet cleaning results in a cleaned product that may have some excess water adhering to it.

Dewatering may be effected by passing the food over vibratory screens or specially designed rotary screens.

In the case of cleaned peas for freezing, or washed wheat for milling, centrifuges may be used.

Preliminary methods

The two main objectives of cleaning food raw materials are:

1. Removal of contaminants which constitute a health hazard or which are aesthetically unacceptable.
2. Control of microbiological loads and biochemical reactions which impair subsequent process effectiveness and product quality.

Preliminary methods

Sorting of foods

Sorting and grading are terms which are frequently used interchangeably in the food processing industry, but strictly speaking they are distinct operations.

Sorting is a separation based cm a single measurable property of raw material units, while grading is the assessment of the overall quality of a food using a number of attributes.

Preliminary methods

Sorting and grading can both damage the food raw material or product because of improper handling by human operators (operator damage), dumping (dumping damage) or dropping of material (drop damage).

Such damages can be eliminated or minimized by choosing effective food process.

Preliminary methods

Sorting methods include:

- Weight sorting,
- Shape sorting,
- Size sorting and
- Photometric or colour sorting.

Preliminary methods

Weight sorting

Weight is usually the most precise method of sorting.

The weight of a food unit is proportional to the cube of its characteristic dimension and hence weight sorting is more precise compared to dimensional sorting.

Preliminary methods

Preliminary methods

Size sorting

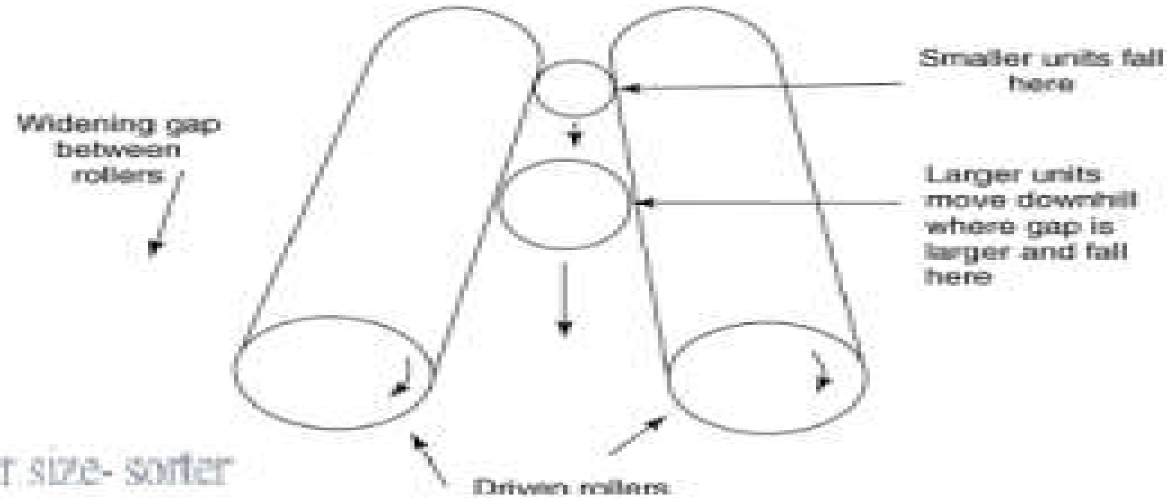
Different types of screens are used for size separation of foods

The screen designs commonly used in food industry may be grouped into two types:

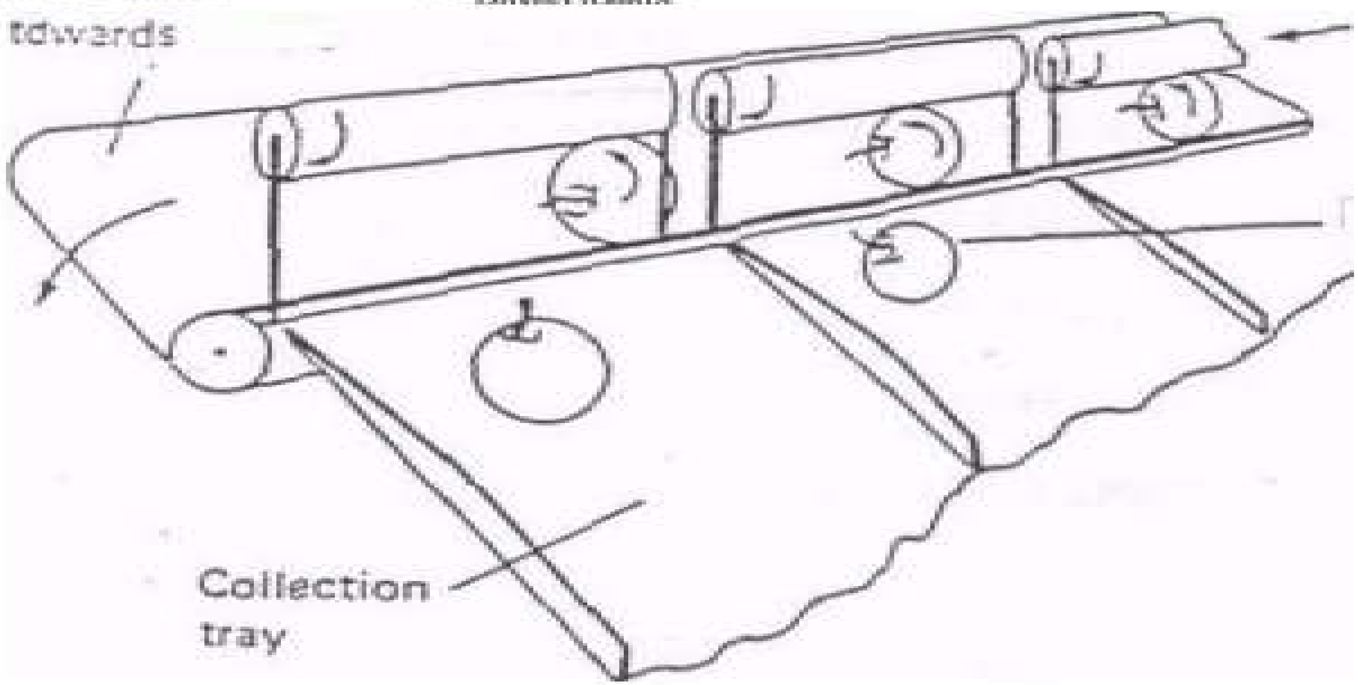
(i) Variable aperture screens using cable, belt, roller or screw sorters and

(ii) Fixed aperture screens using stationary, vibratory, rotary, gyratory or reciprocating screens.

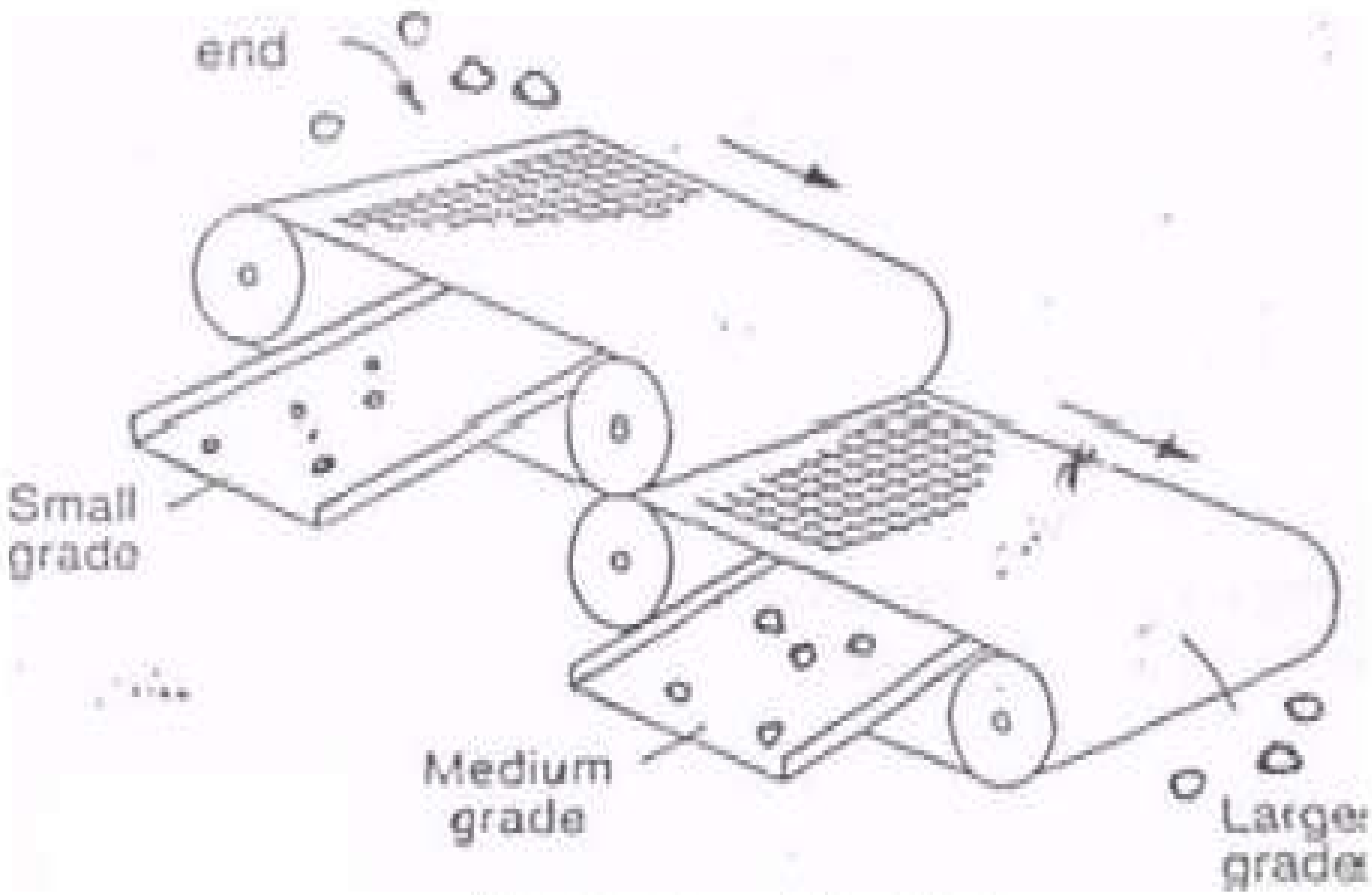
Preliminary methods



roller size- sorter



Preliminary methods



Screen Sorter

Preliminary methods

Shape sorting

Shape sorting is adopted when food raw materials contain undesirable material even after size or weight sorting and cleaning.

For example, cleaned and size or weight sorted wheat may still contain weed seeds of similar size and weight compared to wheat.

Preliminary methods

Preliminary methods

Photometric/Color sorting

Photometric sorting uses optical properties of foods to effect separation of desired material from contaminants.

The goal is the separation of items that are discolored, toxic, not as ripe as required, or still with hull.

The color separator separates the fruits, vegetables or grains due to difference in color or brightness.

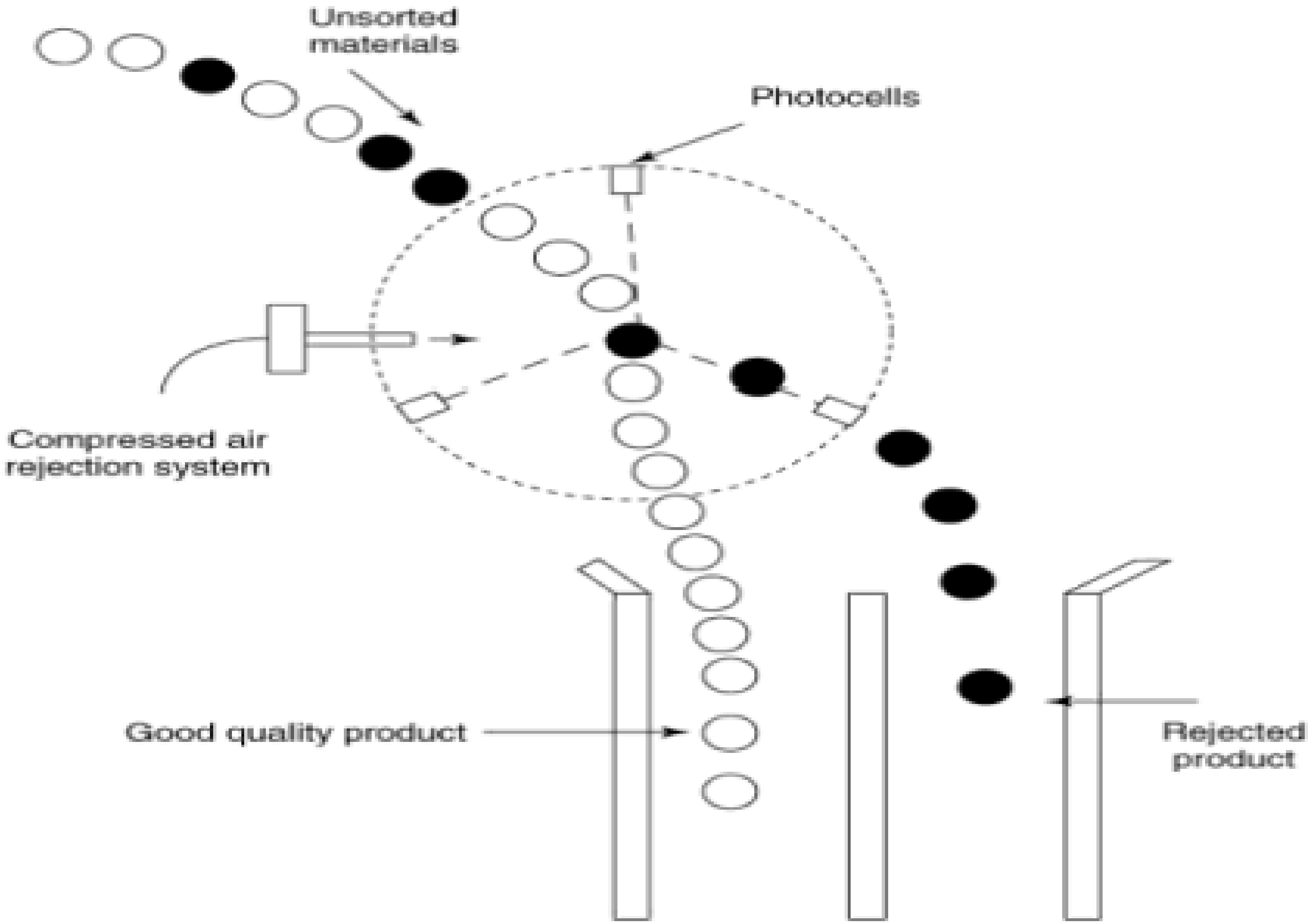
The color separators are generally used for larger crop seeds like peas and beans.

Preliminary methods

Reflectance properties are used to indicate:

1. Raw material maturity (e.g. color of fruit, vegetables and meat indicates ripeness and freshness characterize)
2. The presence of surface defects (e.g. worm holed cereals or nuts and bruised fruits)
3. The extent of heat processing (e.g. in manufacture of bread and potato chips or crisps)

Preliminary methods



Preliminary methods

Other sorting methods

Sorting on the basis of surface roughness or stickiness may be used for separating seeds.

In Surface Texture/Roughness Separator the mixture to be separated is fed over the centre of an inclined draper belt moving in upward direction.

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Preliminary methods

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Preliminary methods

Grading

This term is often used interchangeably with sorting but strictly means the assessment of overall quality of a food using a number of attributes.

Sorting (that is separation on the basis of one characteristic) may therefore be used as part of a grading operation but not vice versa.

Preliminary methods

Grading methods may be classified into two types:

- Quality control procedures in which the quality of the food is determined by laboratory tests on samples drawn statistically from a batch of food.
- Procedures in which the total quantity of food is subjected to physical separation in quality categories. This grading may be carried out manually or by specialized machines.

Preliminary methods

Peeling is used in the processing of many fruits and vegetables to remove unwanted or inedible material, and to improve the appearance of the final product. The main consideration is to minimise costs by removing as little of the underlying food as possible and reducing energy, labour and material costs to a minimum.

Preliminary methods

There are five main methods of peeling:

1. flash steam peeling
2. knife peeling
3. abrasion peeling
4. caustic peeling

Preliminary methods

Flash steam peeling

Foods (for example root crops) are fed in batches into a pressure vessel which is rotated at 4–6 rpm. High-pressure steam (1500×10^3 Pa) is introduced and all food surfaces are exposed to the steam by the rotation of the vessel for a predetermined time, which differs according to the type of food.

Preliminary methods

Knife peeling

Stationary blades are pressed against the surface of rotating fruits or vegetables to remove the skin. Alternatively the blades may rotate against stationary foods.

Preliminary methods

Abrasion peeling

Food is fed onto carborundum rollers or placed into a rotating bowl which is lined with carborundum.

The abrasive surface removes the skin and it is washed away by a copious supply of water.

Preliminary methods

Caustic peeling

A dilute solution of sodium hydroxide (named lye) is heated to 100–120°C.

In the older method of lye peeling, food is passed through a bath of 1–2% lye which softens the skin and the skin is then removed by high-pressure water sprays.

Product losses are of the order of 17%.

Conversion and Preservation operations

Size reduction

Size reduction is a process of reducing large solid unit masses-vegetables or chemical substances into small unit masses, coarse particles or fine particles.

The term size reduction is applied to all the ways in which particles of the food materials is reduced into smaller size.

The size reduction is done for different purpose and by different methods.

Conversion and Preservation operations

In the food industry, raw materials (solid) and intermediate products must often be submitted to size reduction operations such as cutting, chopping, grinding, milling and so on.

In the case of liquids and semi-solids, size reduction operations include mashing, atomizing, homogenizing etc.

Conversion and Preservation operations

The following are some important applications of size reduction in the food industry:

- Milling of cereal grains to obtain flour
- Fine grinding (refining) of chocolate mass
- Flaking of soybeans prior to solvent extraction
- Cutting of vegetables and fruits to desired shapes (cubes, strips, slices…)
- Fine mashing of baby food
- Homogenization of milk and cream.

Conversion and Preservation operations

Size reduction is a widespread, multipurpose operation. Its may serve a number of different objectives, such as:

● Accelerating heat and mass transfer (flaking of soybeans or grinding coffee in preparation to extraction, atomization of milk as a fi ne spray into hot air in spray-drying)

● Facilitating separation of different parts of a material (milling wheat to obtain flour and bran separately, filleting of fish

Conversion and Preservation operations

Obtaining a desirable product texture (refining of chocolate mass, meat grinding)

- Facilitating mixing and dispersion (milling or crushing ingredients for dry mixing, homogenization of liquids to obtain stable emulsions)
- Portion control (slicing cold-cuts, bread, cakes)
- Obtaining pieces and particles of defined shapes (cubing meat for stew, cutting pineapple to obtain the familiar wheel-shaped slices, cutting dough to make cookies)

Conversion and Preservation operations

Different methods of size reduction are classified according to the size range of particles produced:

1. Chopping, cutting, slicing and dicing:

(a) large to medium (stewing steak, cheese and sliced fruit for canning)

(b) medium to small (bacon, sliced green beans and diced carrot)

(c) small to granular (minced or shredded meat, flaked fish or nuts and shredded vegetables)

Conversion and Preservation operations

2. Milling to powders or pastes of increasing fineness (grated products > spices > flours > fruit nectars > powdered sugar > starches > smooth pastes)

3. Emulsification and homogenisation (mayonnaise, milk, essential oils, butter, ice cream and margarine)

Conversion and Preservation operations

In all types of size reduction there are three types of force used to reduce the size of foods:

1. compression forces
2. impact forces
3. shearing (or attrition) forces.

Conversion and Preservation operations

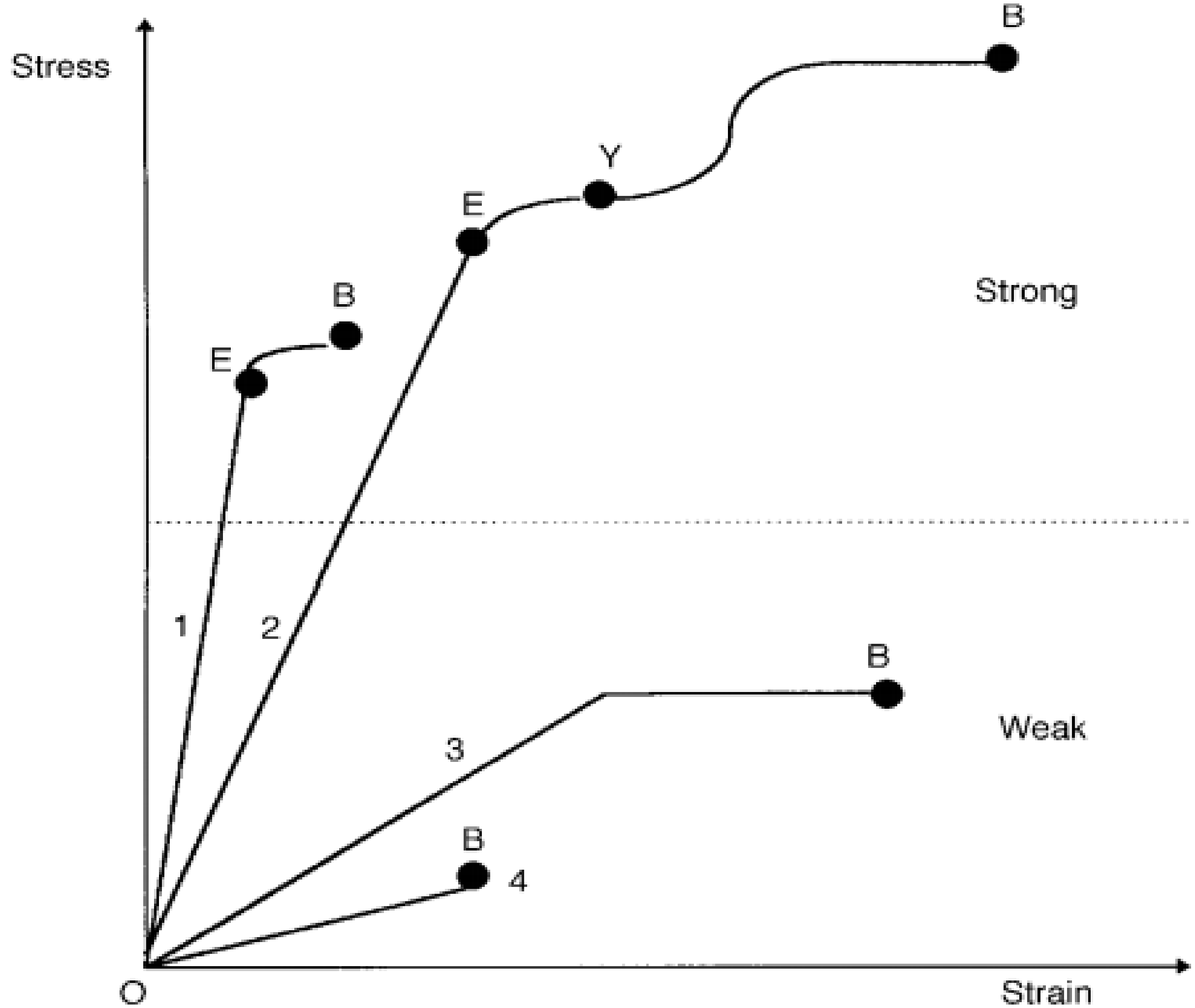

Fig. 4.1 Stess-strain diagram for various foods.
(E = elastic limit; Y = yield point; B = breaking point; O–E = elastic region; E–Y = inelastic deformation; Y–B = region of ductility; (1) = hard, strong, brittle material; (2) = hard, strong, ductile material; (3) = soft, weak, ductile material and (4) = soft, weak brittle material.) (After Loncin and Merson (1979).)

Conversion and Preservation operations

The energy required to reduce the size of solid foods is calculated using one of three equations, as follows:

1. Kick's law
2. Rittinger's law
3. Bond's law

Conversion and Preservation operations

Kick's law states that the energy required to reduce the size of particles is proportional to the ratio of the initial size of a typical dimension (for example the diameter of the pieces) to the final size of that dimension:

$$E = K_K \ln\left(\frac{d_1}{d_2}\right)$$

Where E(J) = the energy required per mass of feed, K_K=Kick's constant,d_1= the average initial size of pieces, and d_2 =the average size of ground particles.

Conversion and Preservation operations

Rittinger's law states that the energy required for size reduction is proportional to the change in surface area of the pieces of food (instead of a change in dimension described in Kick's law):

$$E = K_R\left(\frac{1}{d_2} - \frac{1}{d_1}\right)$$

Where K_R = Rittinger's constant.

Conversion and Preservation operations

Bond's law is used to calculate the energy required for size reduction from

$$\frac{E}{W} = \sqrt{\left(\frac{100}{d_2}\right)} - \sqrt{\left(\frac{100}{d_1}\right)}$$

Where W(J kg^{-1}) = the Bond Work Index (40000–80000 J $kg^{-1}$for hard foods such as sugar or grain), d_1= diameter of sieve aperture that allows 80% of the mass of the feed to pass and d_2=diameter of sieve aperture that allows 80% of the mass of the ground material to pass.

Conversion and Preservation operations

Kick's law gives reasonably good results for coarse grinding in which there is a relatively small increase in surface area per unit mass.

Rittinger's law gives better results with fine grinding where there is a much larger increase in surface area

Bond's law is intermediate between these two

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FOOD TECHNOLOGY

Topic: Conversion and Preservation operations

Dr. N. Saravanan
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Conversion and Preservation operations

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Conversion and Preservation operations

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3. Emulsification and homogenisation (mayonnaise, milk, essential oils, butter, ice cream and margarine)

Conversion and Preservation operations

Benefits in size reduction:

- Increase in the surface-area-to-volume ratio of the food.
- Increases the rate of drying,
- Increases the rate heating or cooling
- Improves the efficiency and rate of extraction
- Facilitating mixing and blending
- Facilitates heat exchange, chemical and biological reactions

Conversion and Preservation operations

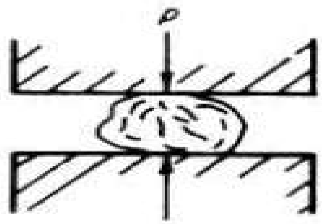
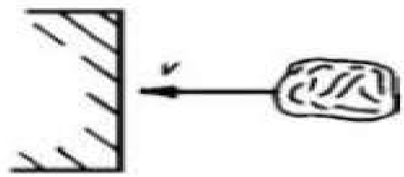
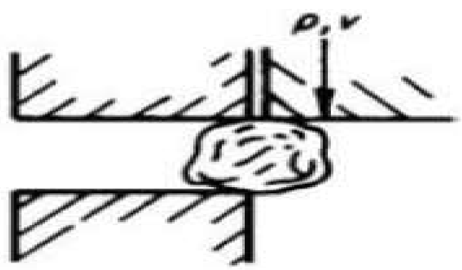
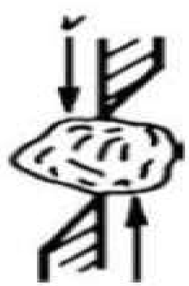
Forces Used in Size Reduction

The types of forces commonly used in food processes are compressive, impact, attrition or shear and cutting.

In a combination operation, more than one type of force is usually acting.

For example, crushing, grinding, and milling take place in powdered sugar, flour, mustard, and cocoa production.

Conversion and Preservation operations

Force	Schematic diagram	Principle	Example of equipmen
Compressive		Nutcracker	Crushing rolls
Impact		Hammer	Hammer mill
Attrition		File	Disc attrition mill
Cut		Scissors	Rotary knife cutter

Conversion and Preservation operations

The Mechanism of Size Reduction

In the grinding process, materials are reduced in size by fracturing them.

In the process, the material is stressed by the action of mechanical moving parts in the grinding machine and Initially the stress is absorbed internally by the material as strain energy.

Stress → Strain → Fracture in lines of Weakness → Released Heat

Some of the energy is taken up in the creation of new surface, but the greater part of it is dissipated as heat.

Conversion and Preservation operations

Energy for Size reduction

Energy required depends upon:

1. The hardness of the material
2. The tendency of the material to crack (friability).

The minimum energy needed to rupture the material.

Excess energy is lost as heat.

This loss should be kept as low as practicable

Conversion and Preservation operations

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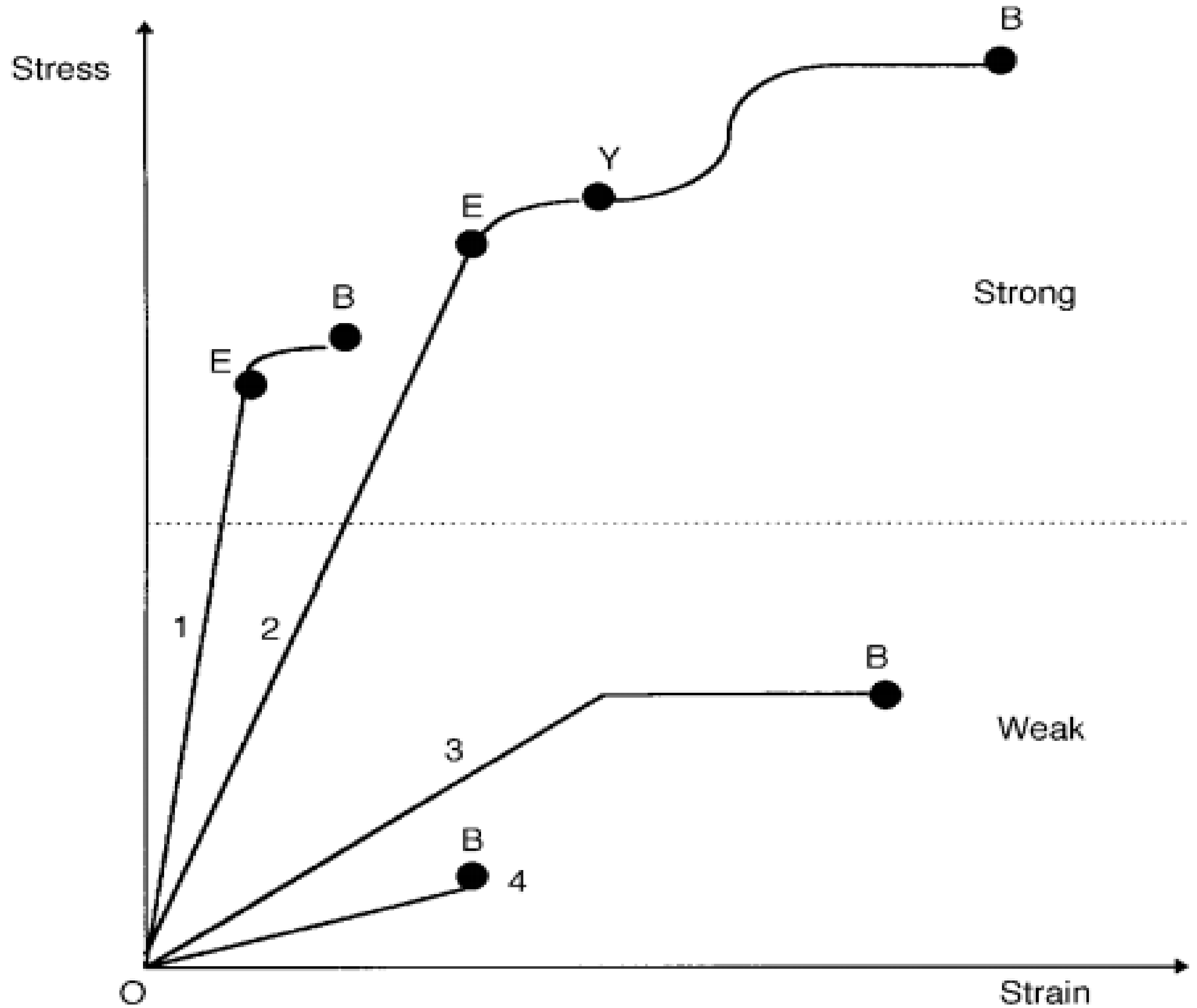
Conversion and Preservation operations



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Conversion and Preservation operations

Size reduction equipment

The principal types of size-reduction machines are as follows:

A. Crushers (coarse and fine)

1. Jaw crushers 2. Gyratory crushers 3. Crushing rolls

B. Grinders (intermediate and fine)

1. Hammer mills and impactors 2. Rolling–compression mills 3. Attrition mills

C. Ultrafine grinders

1. Hammer mills with internal classification 2. Fluid–energy mills 3. Agitated mills 4. Ball mills

D. Cutting machines

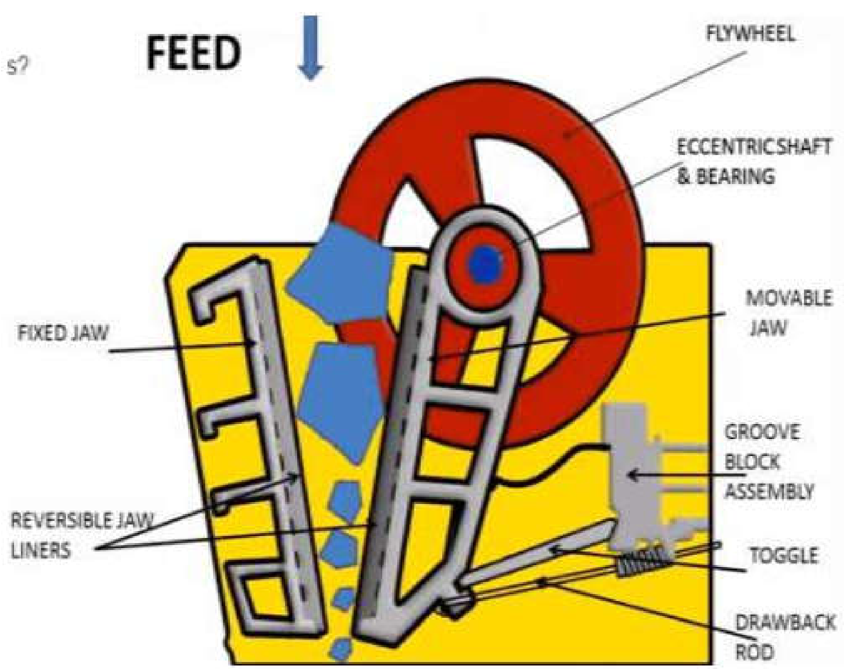
1. Knife cutters, dicers and slitters

Conversion and Preservation operations

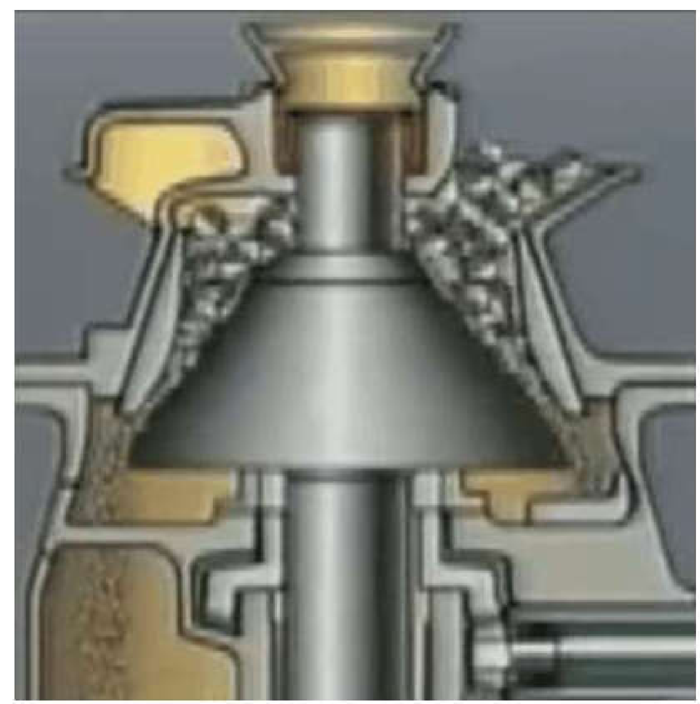
Crushers

Jaw and gyratory crushers draw material down into a progressively narrower space resulting in size reduction.

1. Jaw crushers



2. Gyratory crushers



Conversion and Preservation operations

Hammer Mills

Hammer mill, which contains a high-speed rotor turning inside a cylindrical case.

The rotor carries a collar bearing a number of hammers around its periphery.

By the rotating action, the hammers swing through a circular path inside the casing containing a toughened breaker plate.

Feed passes into the action zone with the hammers driving the material against the breaker plate and forcing it to pas through a bottom mounted screen by gravity when the particles attain a proper size

Conversion and Preservation operations

Reduction is mainly due to impact forces.

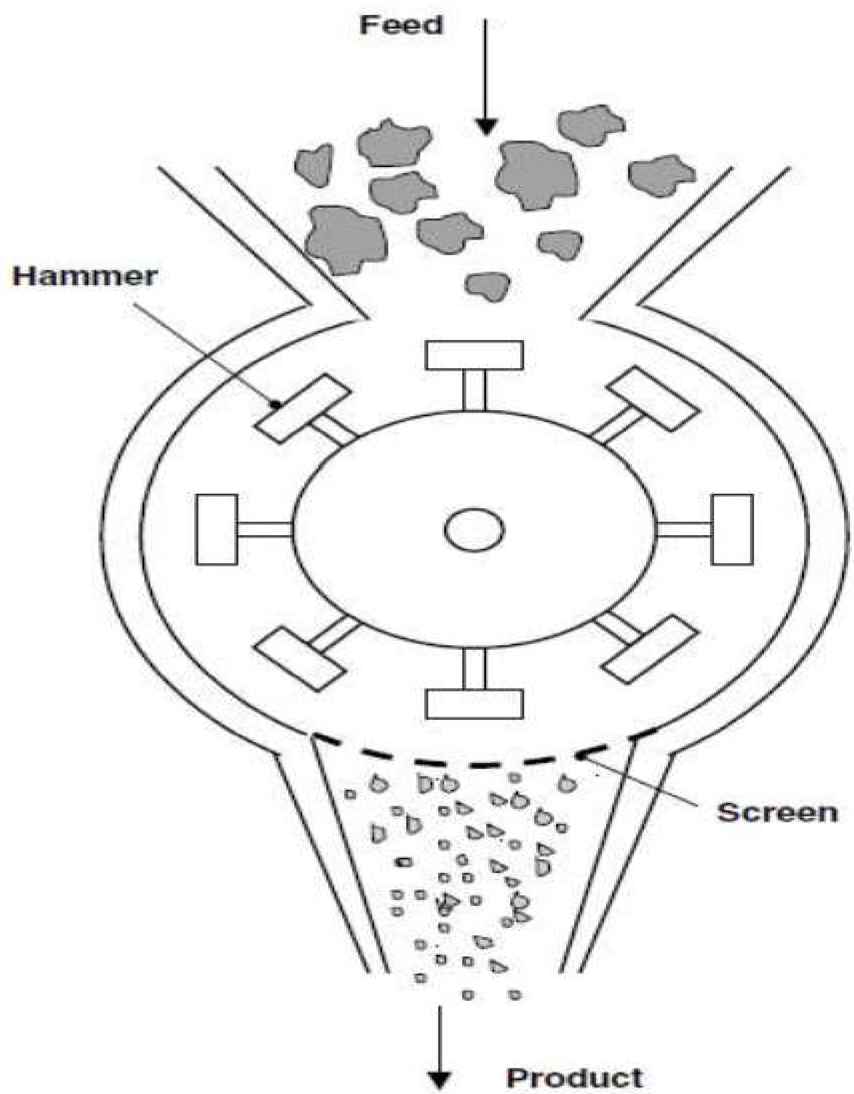
The hammers may be replaced by knives or other devices to give the mill the possibility of handling tough, ductile or fibrous materials.

The hammer mill is a versatile piece of equipment that gives high reduction ratios.

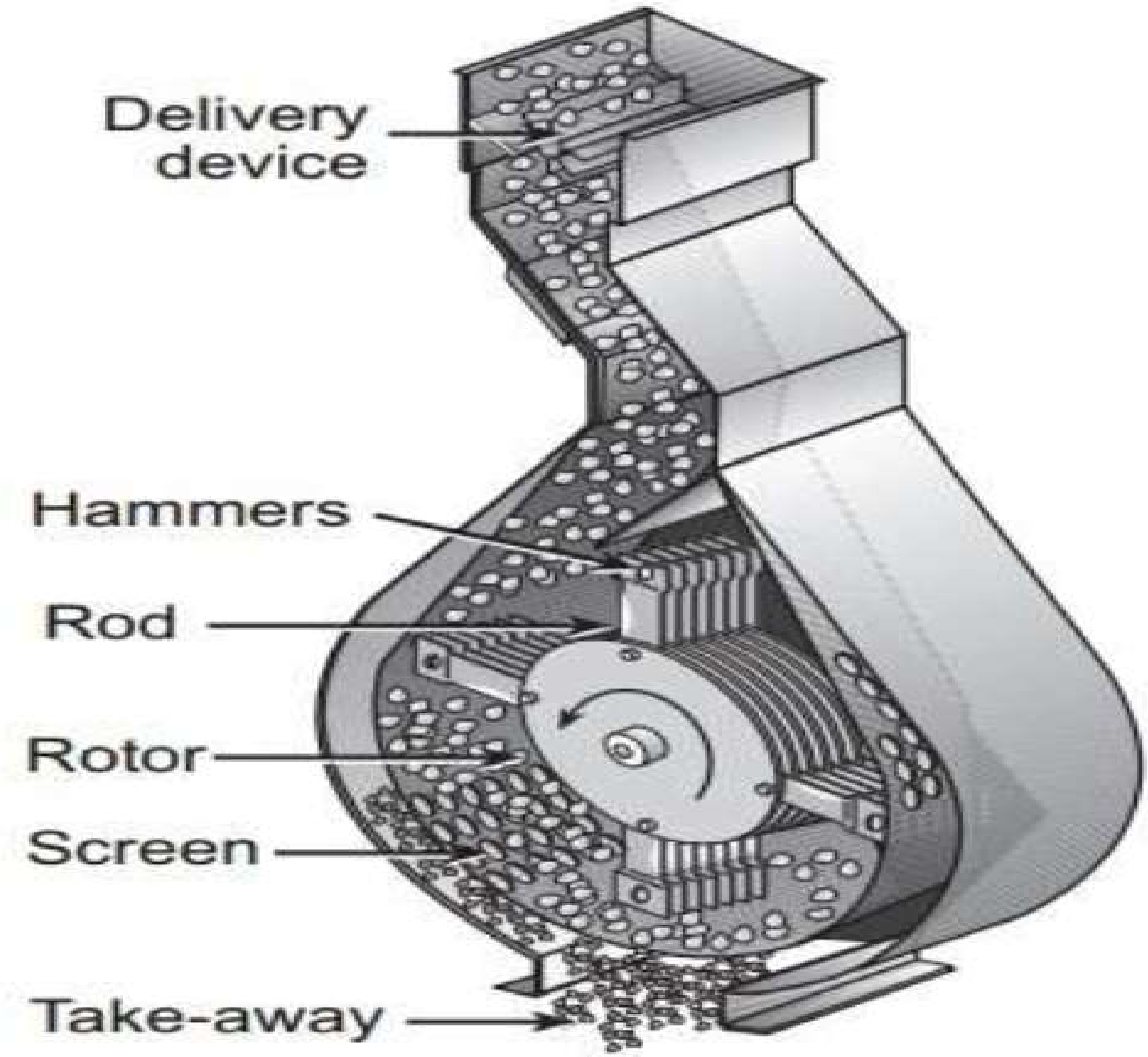
It handle a wide variety of materials from hard and abrasive to fibrous and sticky.

In the food industry extensive use for grinding spices, sugar agglomerate, dry fruits, dry vegetables

Conversion and Preservation operations



Conversion and Preservation operations



Conversion and Preservation operations

Attrition mill

Attrition mills are also known as plate mills or disc pulverizes and are widely used for small-scale milling.

These mills use the working principle of a the shearing and cutting actions.

The material is fed in between two circular plates with the flute or roughened surface.

One of the plates is fixed while the other one has a rotation facility.

Normally, the material is fed near the axis of the rotation and is sheared and crushed.

Conversion and Preservation operations

These mills produce a narrow range of particle sizes.

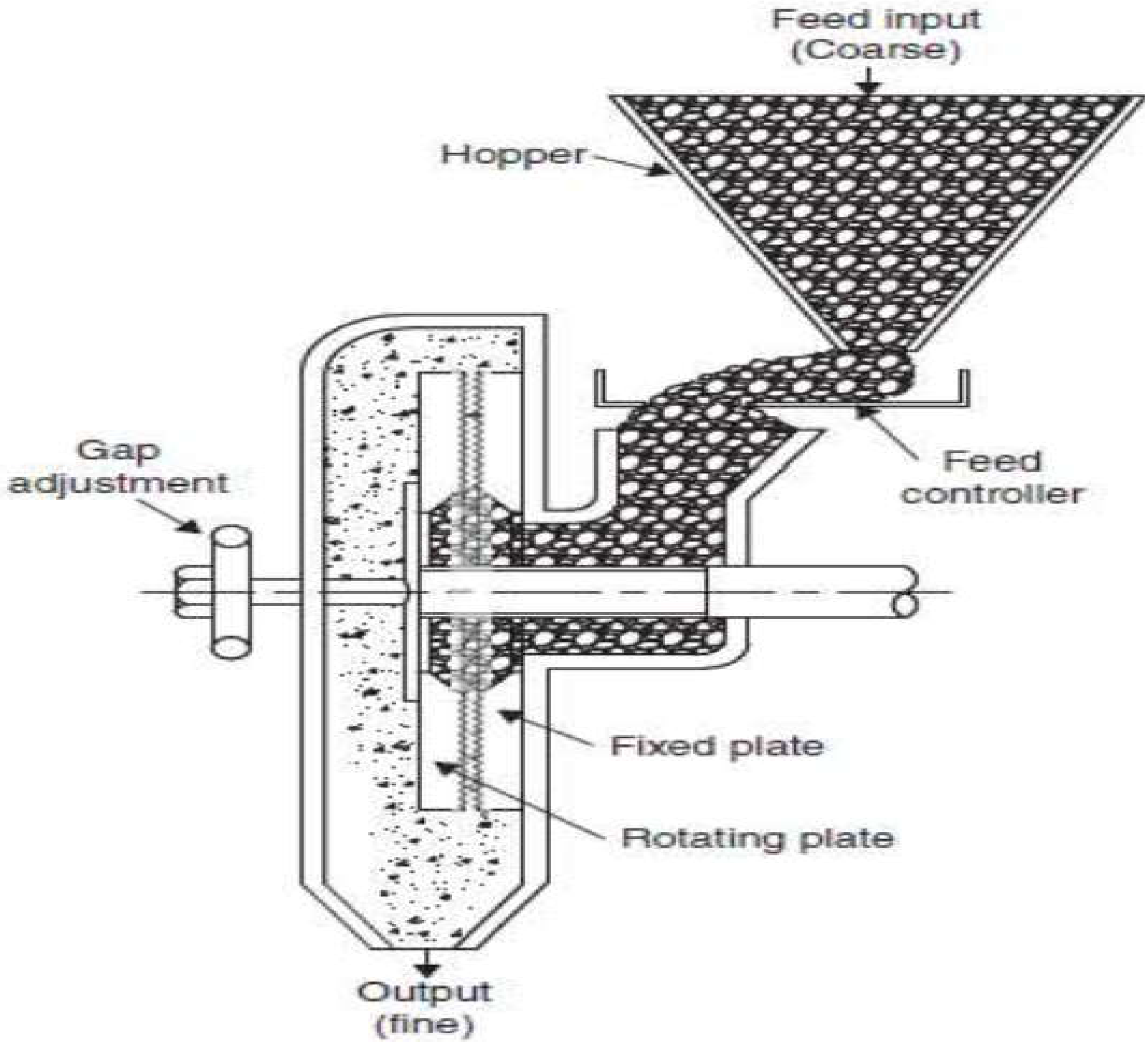
The low clearance and higher speed facilitate the production of finer size particles.

The plate mills led to the development of the colloid mill.

The main difference between them is clearance between the plates and the speed of rotation.

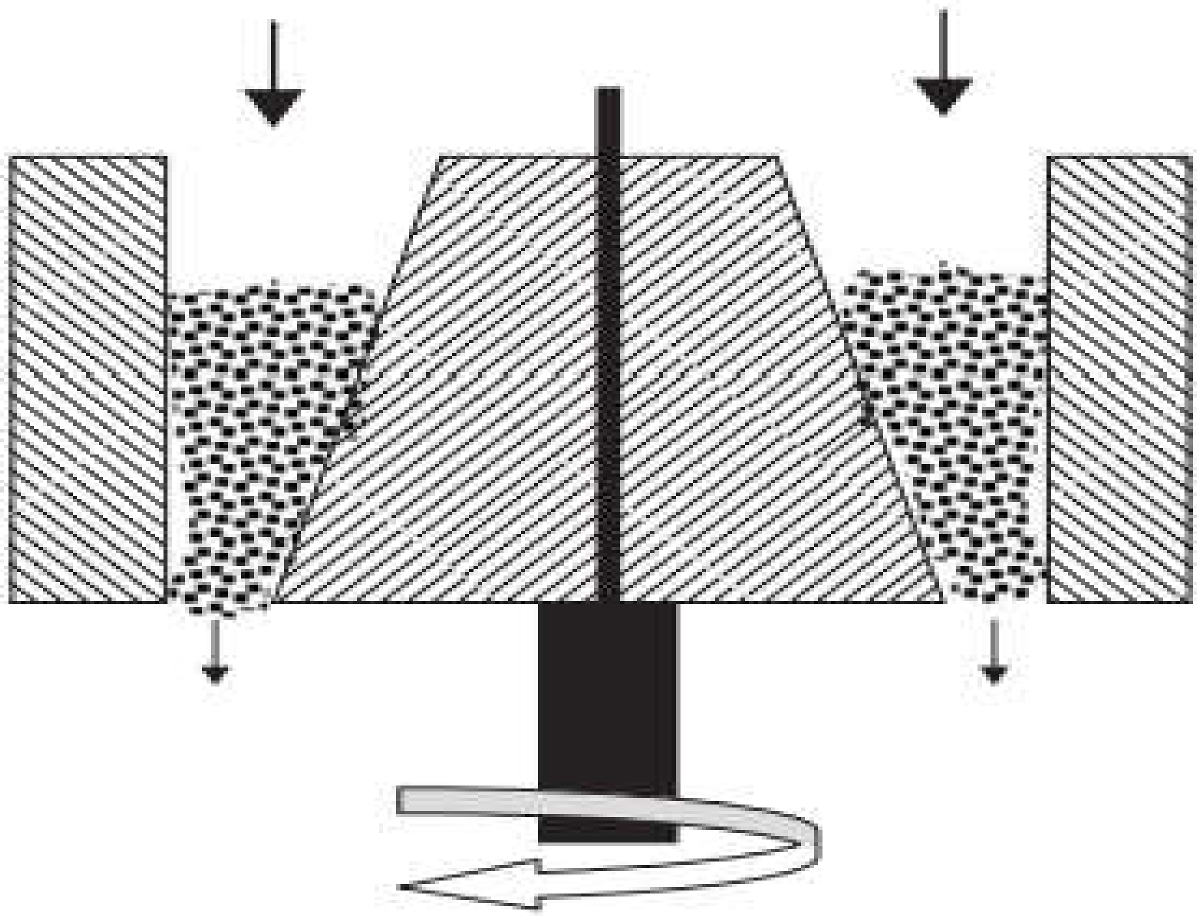
These mills are extremely used like shred, curl, granulate, grind, shear, twist, blend, rub

Conversion and Preservation operations



Conversion and Preservation operations

Attrition mill with conical grinding surface



Conversion and Preservation operations

Tumbling mill or ball mill

A tumbling mill is used in many industries for fine grinding.

It basically consists of a horizontal, slow speed, rotating cylinder that is partially filled with either balls or rods.

The cylinder shell is usually made of steel, lined with carbon-steel plate, porcelain, silica rock, or rubber.

The balls are normally made out of steel or flint stones, while the rods are usually manufactured with high carbon steel.

Conversion and Preservation operations

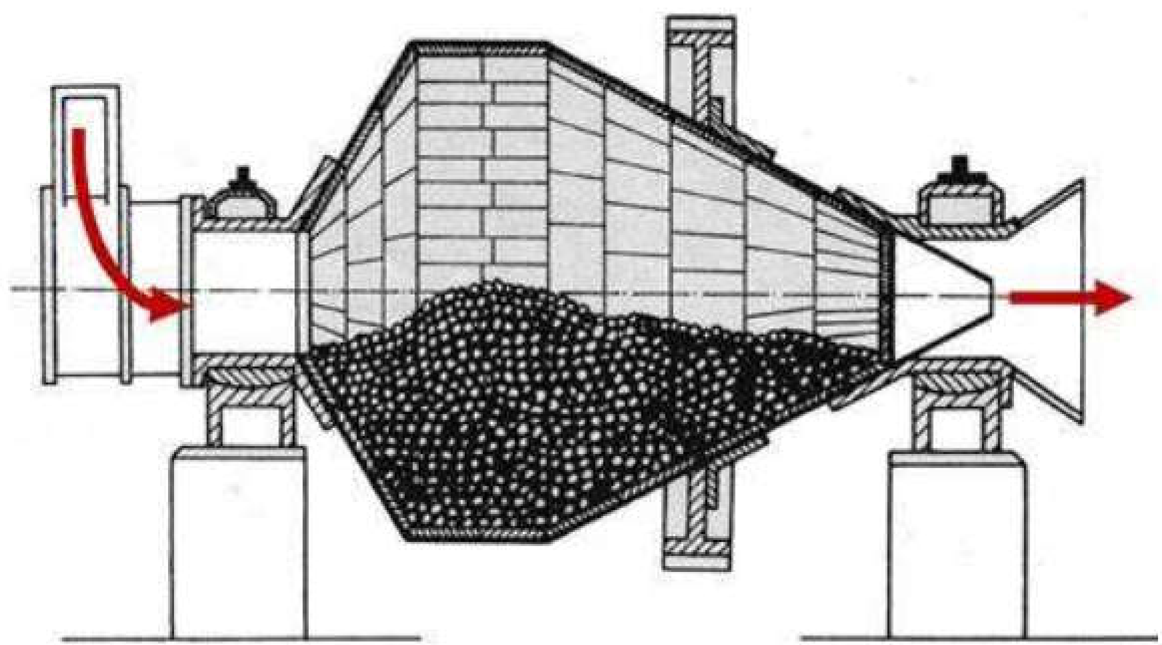
The cylinder rotates, the grinding medium is lifted up the sides of the cylinder and dropped onto the material being comminuted, filling the void spaces between the medium.

The grinding medium components also tumble over each other, exerting a shearing action on the feed material.

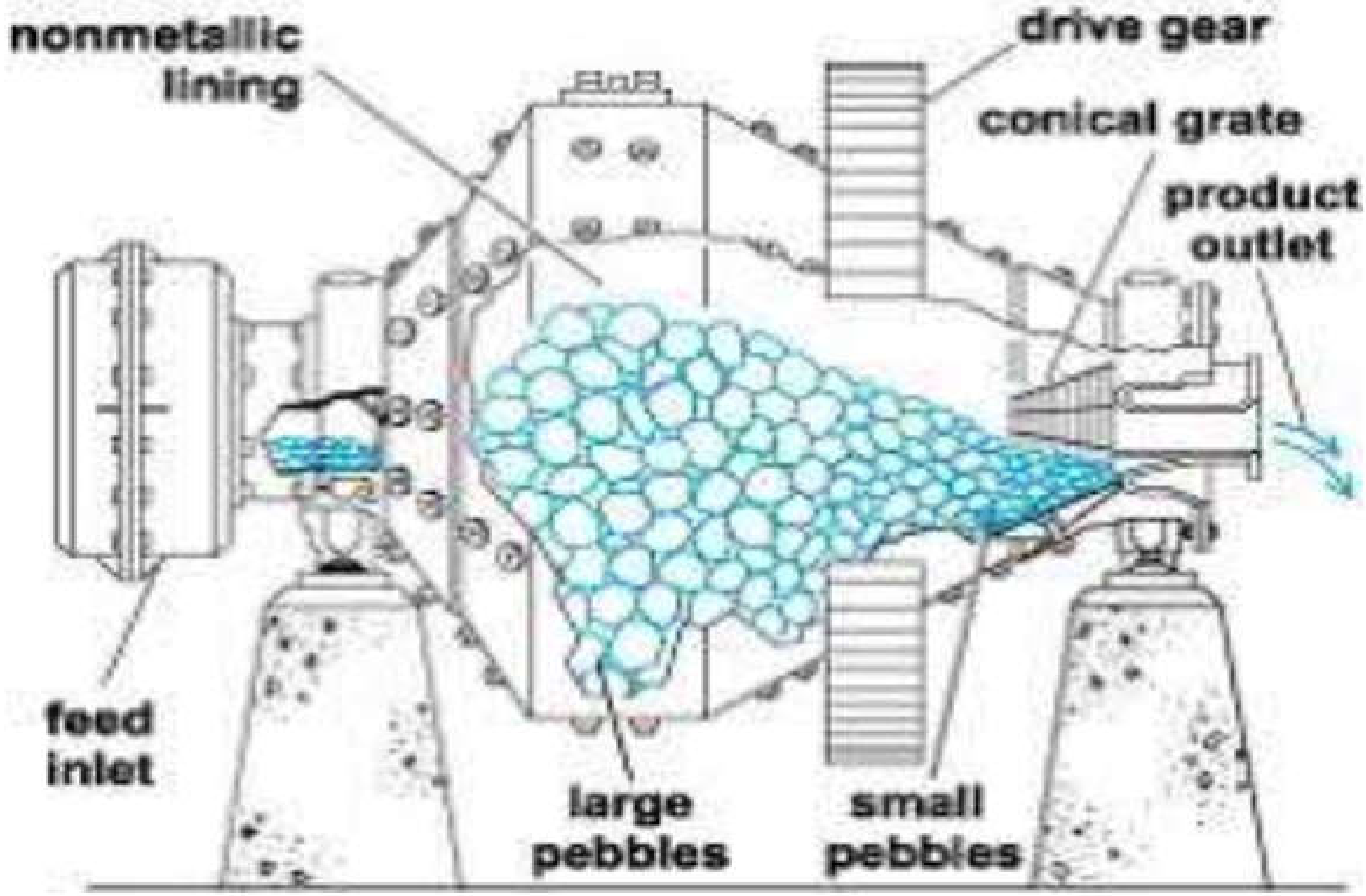
This combination of impact and shearing forces brings about a very effective size reduction.

As a tumbling mill basically operates in a batch manner.

Conversion and Preservation operations



Conversion and Preservation operations



Conversion and Preservation operations

Cutting machine

slicing and flaking equipment

dicing equipment

shredding equipment

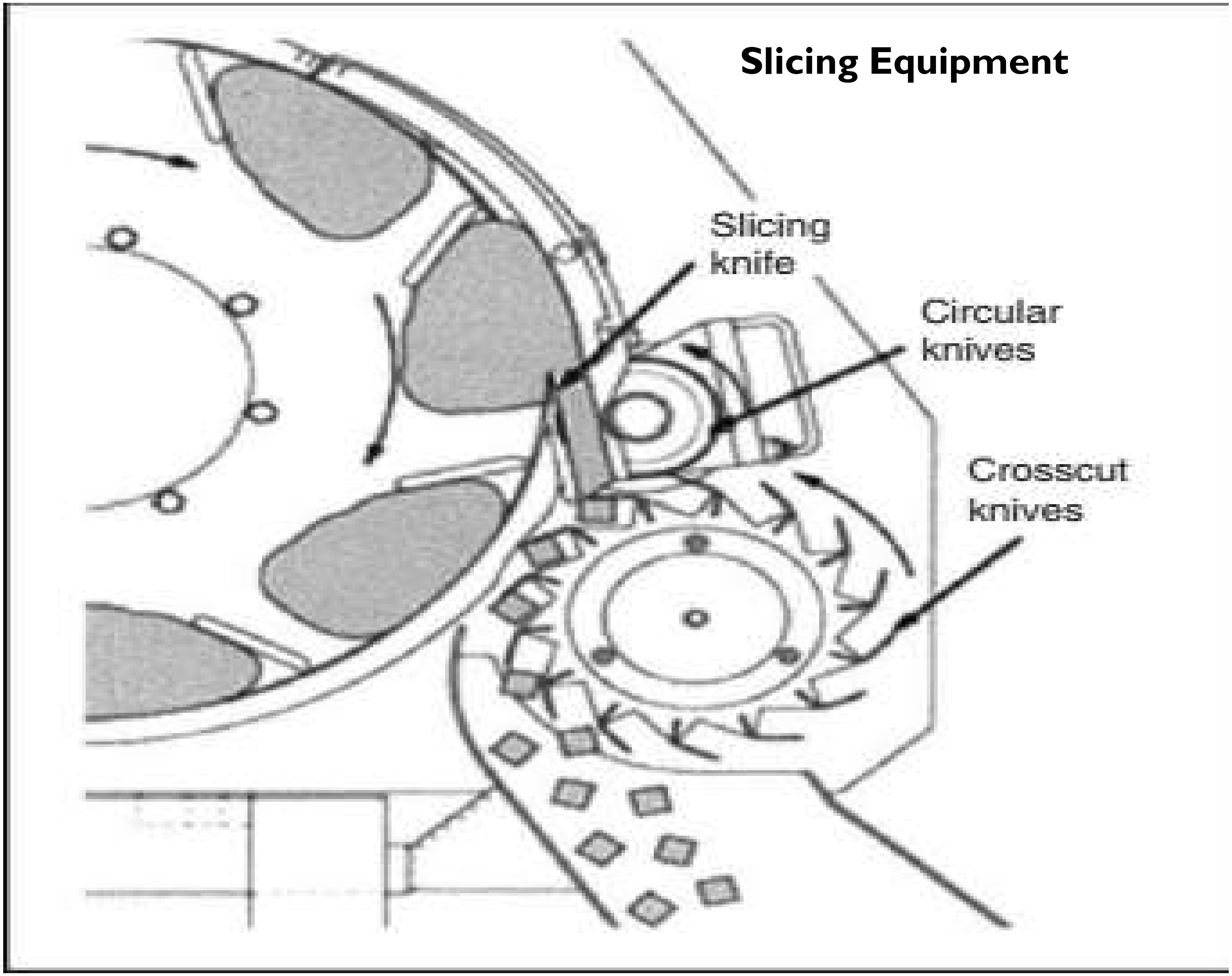
pulping equipment.

Conversion and Preservation operations

Different cutting operations

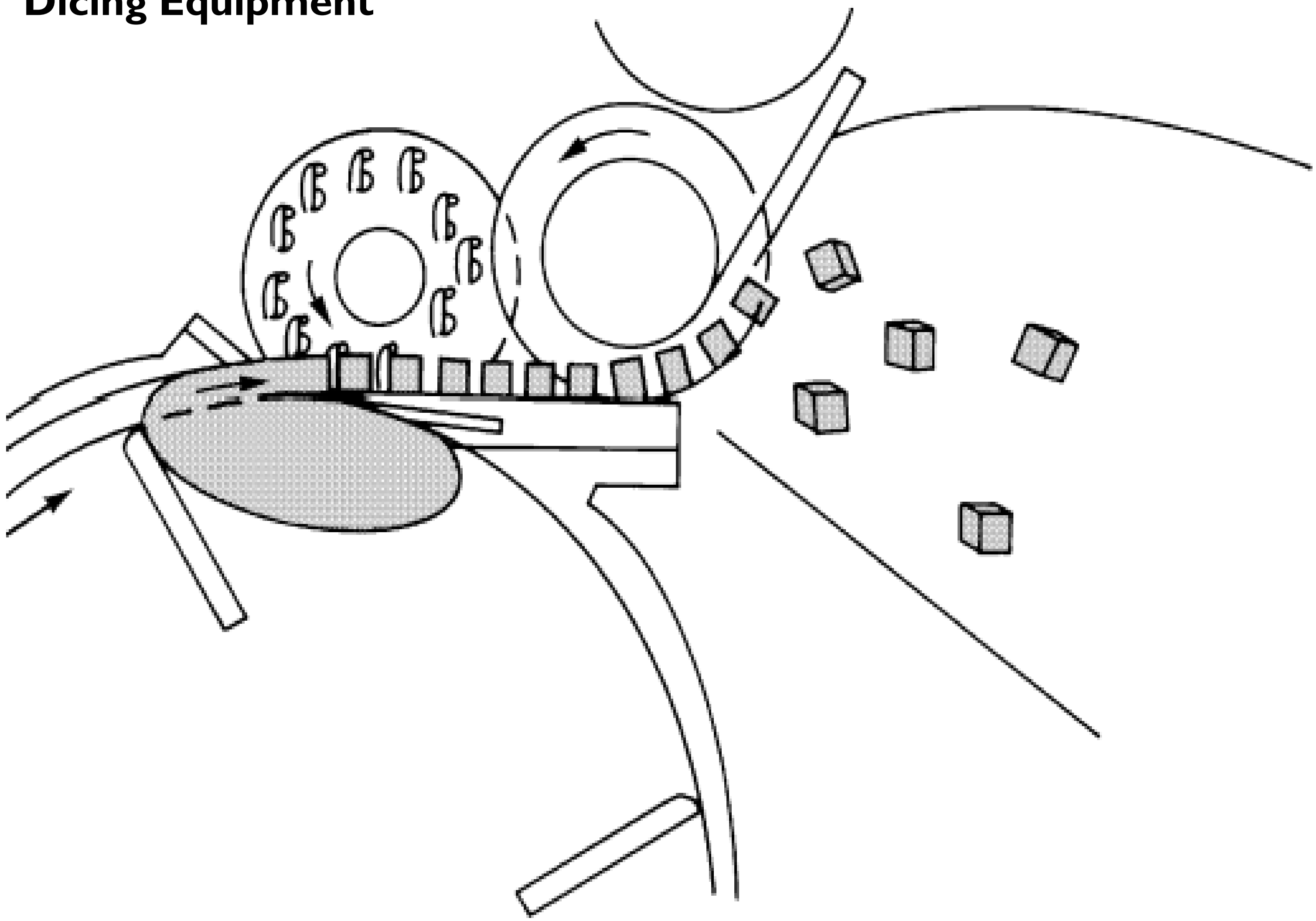
Cutting operations	Description
Slicing	Blade slices by centrifugal force and each slice falls away freely
Dicing	Vegetables, fruits and meats are first sliced and then cut into strips by rotating blades. The strips are then fed to a second set of rotating knives that operate at right angles to the first set and cut the strips into cubes
Shredding	Commonly they are the modified form of a hammer mill in which knives are used instead of hammers to produce a cutting action. A second type of shredder, known as the squirrel cage disintegrator, has two concentric cylindrical cages inside a casing. They are fitted with knife blades along their length and the two cages rotate in opposite directions. Food is subjected to powerful shearing and cutting forces as it passes between them
Pulping	A combination of compression and shearing forces are used for juice/pulp extraction from fruits or vegetables and for producing pureed and pulped meats

Conversion and Preservation operations



Conversion and Preservation operations

Dicing Equipment



Conversion and Preservation operations

Homogenization

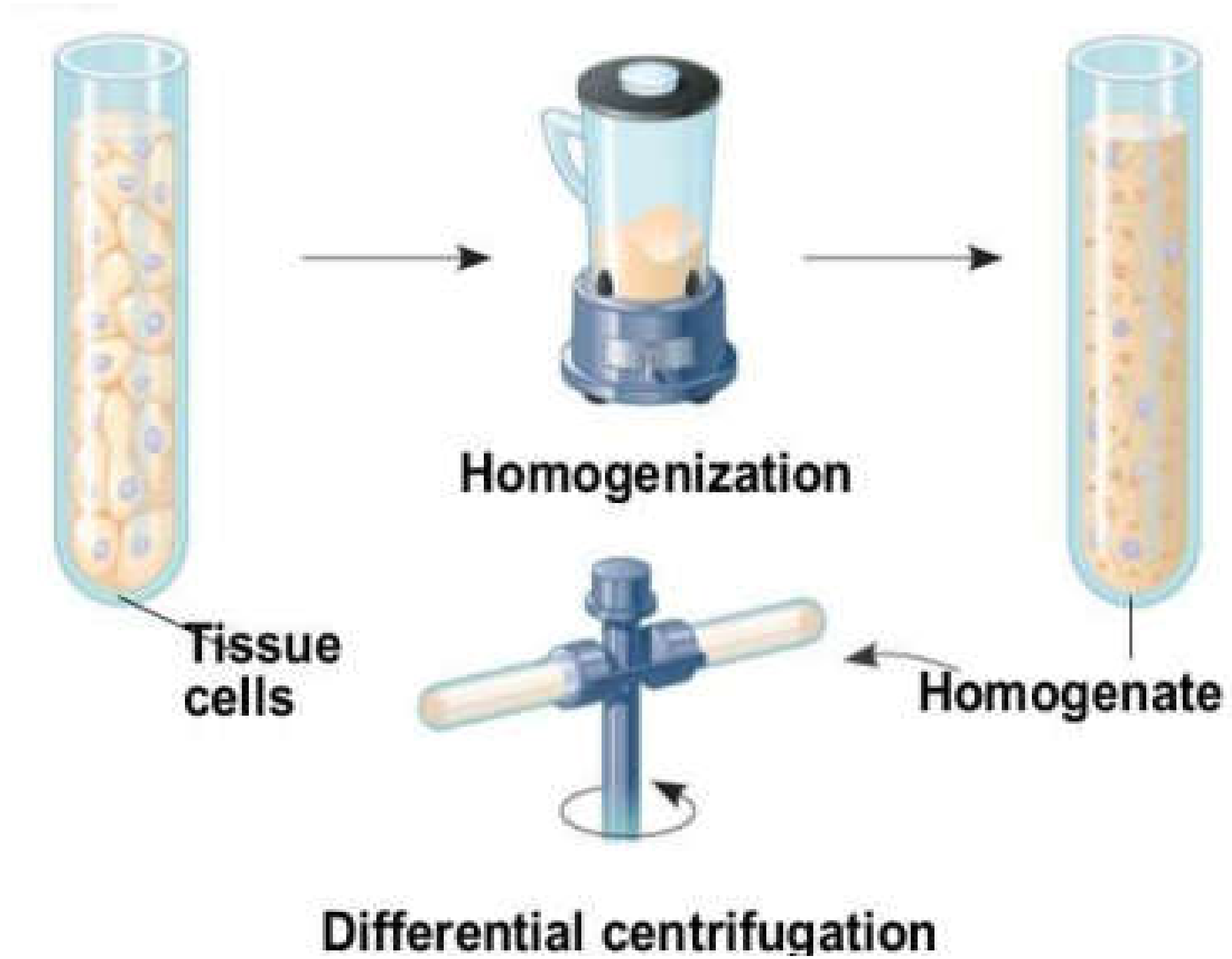
The unit operation that prevents fat globules from coalescing into cream is called homogenization.

Which is also a way of size reduction in liquids.

The liquid formulation is forced through a small opening at higher speeds.

Breaking down the fat or other globules into smaller ones.

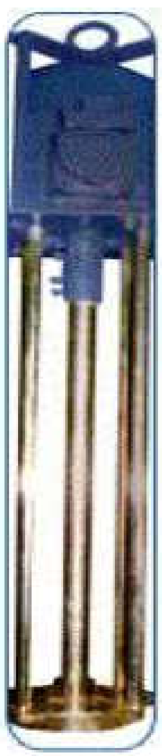
Conversion and Preservation operations



Conversion and Preservation operations

High-speed mixers

Edges and tips of the blades in high-speed turbine/ propeller type mixers impart a shearing action on the low viscous food formulations to homogenize into a smooth homogeneous emulsion.



Conversion and Preservation operations

Pressure homogenizers

Pressure homogenization is conventionally done prior to pasteurization and ultra-high temperature (UHT) sterilization.

Pressure homogenizers use a high pressure pump, operating at 100–700 bar, Which is fitted with a homogenizing valve(s) (two-stage homogenization) on the discharge side.

When liquid is pumped through the small adjustable gap (< 300 μm) between the valve and the valve seat.

The high pressure produces a high liquid velocity (80–150 m/s).

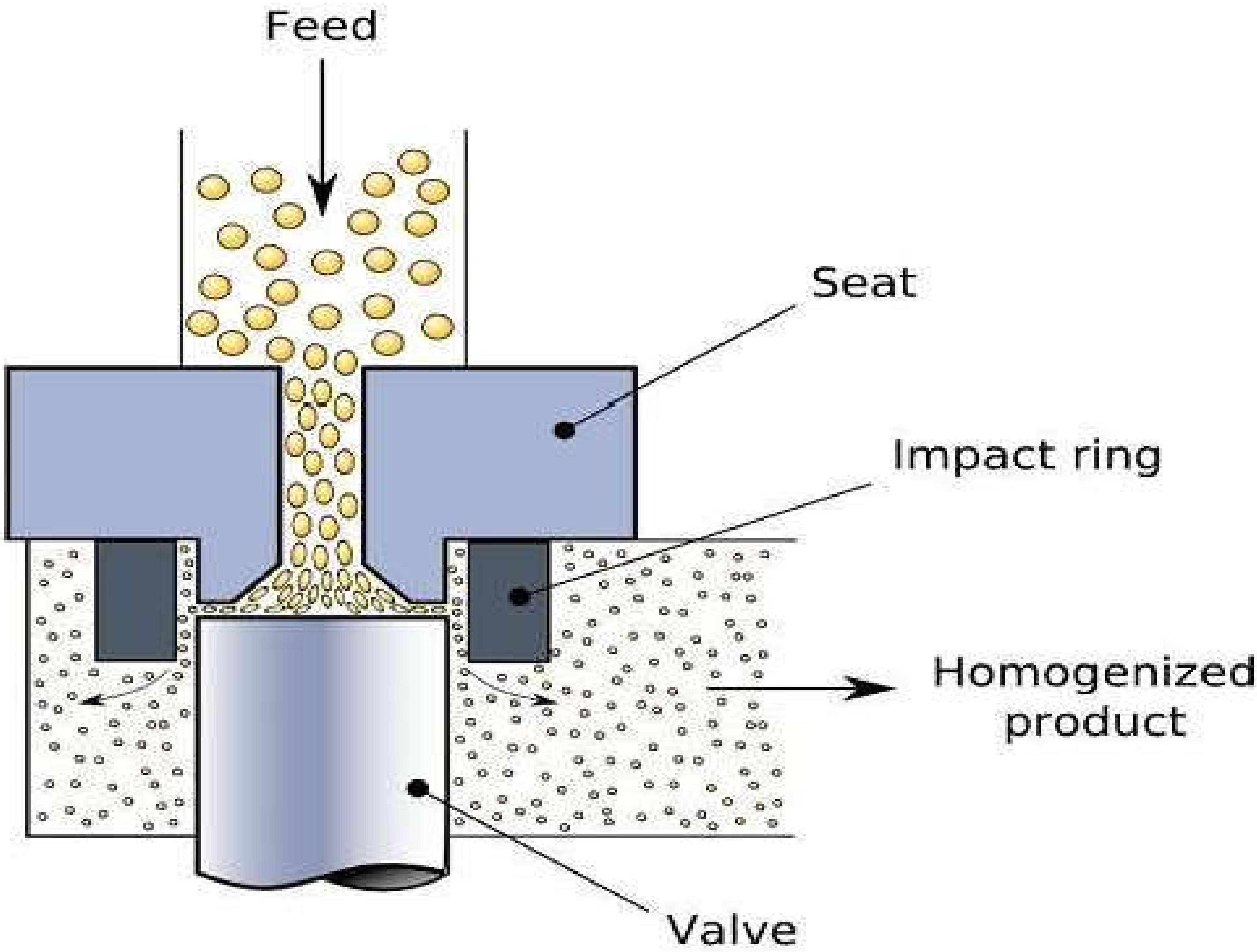
Conversion and Preservation operations

An instantaneous drop in velocity occurs as the liquid emerges from the valve.

This extreme turbulence produces powerful shearing forces and the droplets in the dispersed phase become disrupted.

The collapse of air bubbles (termed 'cavitation') and impact forces created in some valves by placing a hard surface (a breaker ring) in the path of the liquid further reduces the globule size

Conversion and Preservation operations



Conversion and Preservation operations

Colloid mills

Colloid mills are more effective than pressure homogenizers in creating high shear and are meant for high viscous liquids.

They are essentially vertical disc mills with a narrow gap between stationary and rotating discs in the range of 0.05–1.3mm and rotate at 3000–15000 rpm.

Numerous designs of disc including flat, corrugated, conical shapes and even carborundum are available for different applications.

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Conversion and Preservation operations

The greater friction created during size reduction of high-viscous foods may require these mills to be cooled by circulating water in the water jacket

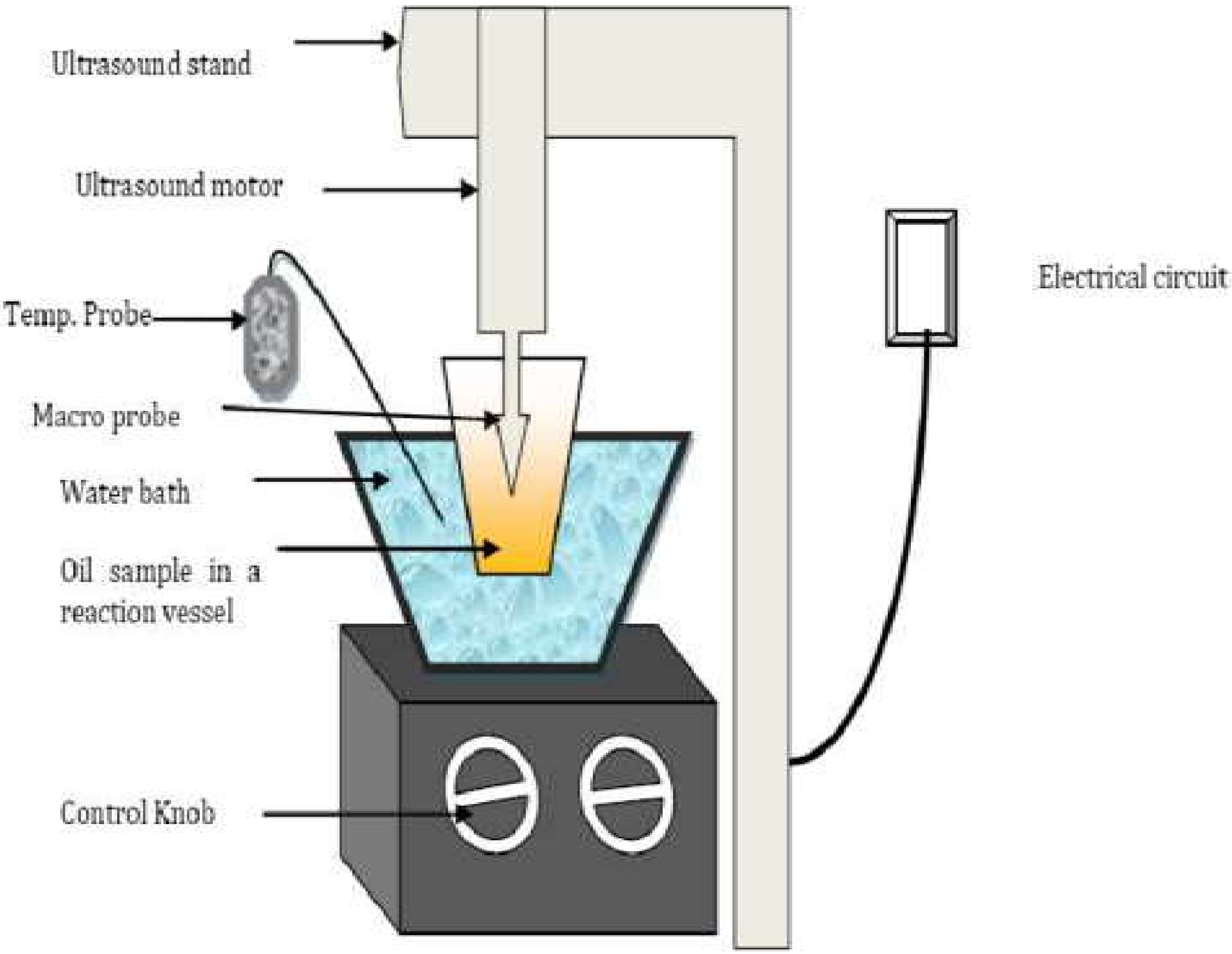
Conversion and Preservation operations

Ultrasonic homogenizers

A high-frequency sound wave in the range of 18–30 kHz is used in ultrasonic homogenizers. Cause alternate cycles of compression and tension in low-viscosity liquids.

It is also responsible for cavitation of air bubbles to form emulsions with droplet sizes of 1–2 μm.

Conversion and Preservation operations



Conversion and Preservation operations

This type of homogenizer is used for the production of salad creams, ice cream, synthetic creams, baby foods and essential oil and emulsions.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Preservation operations

Dr. N. Saravanan
Professor

Preservation operations

Food preservation prevents the growth of microorganisms (such as yeasts), or other microorganisms (although some methods work by introducing benign bacteria or fungi to the food), and slowing the oxidation of fats.

Food preservation may also include processes that inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut during food preparation.

Preservation operations

Many processes designed to preserve food involve more than one food preservation method.

Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination).

Preservation operations

Methods of preservation:

- Traditional Techniques
- Modern Industrial Techniques

Preservation operations

Curing

Preservation operations

Cooling / Freezing

Preservation operations

Boiling / Heating

Preservation operations

sugaring

Preservation operations

Pickling

Preservation operations

canning

Preservation operations

Jellying

Preservation operations

Confit

Preservation operations

Modern industrial techniques

Pasteurization

Preservation operations

Vacuum Packing

Preservation operations

Artificial food additives

Preservation operations

Irradiation

Preservation operations

Modified atmosphere packing

Preservation operations

Hurdle technology

Parameter	Symbol	Application
High temperature	F	Heating
Low temperature	T	Chilling, freezing
Reduced water activity	a_w	Drying, curing, conserving
Increased acidity	pH	Acid addition or formation
Reduced redox potential	E_h	Removal of oxygen or addition of ascorbate
Biopreservatives		Competitive flora such as microbial fermentation
Other preservatives		Sorbates, sulfites, nitrites

Preservation operations

Freeze drying

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Cereal grains

Dr. N. Saravanan
Professor

Cereal grains

A cereal is any grass cultivated (grown) for the edible components of its grain (botanically, a type of fruit called a caryopsis), composed of the endosperm, germ, and bran. The term may also refer to the resulting grain itself (specifically "cereal grain").

Cereal grains

Cereal grain crops are grown in greater quantities and provide more food energy worldwide than any other type of crop and are therefore staple crops.

Edible grains from other plant families, such as buckwheat (Polygonaceae), quinoa (Amaranthaceae) and chia (Lamiaceae), are referred to as pseudocereals.

Cereal grains

In their natural, unprocessed, whole grain form, cereals are a rich source of vitamins, minerals, carbohydrates, fats, oils, and protein.

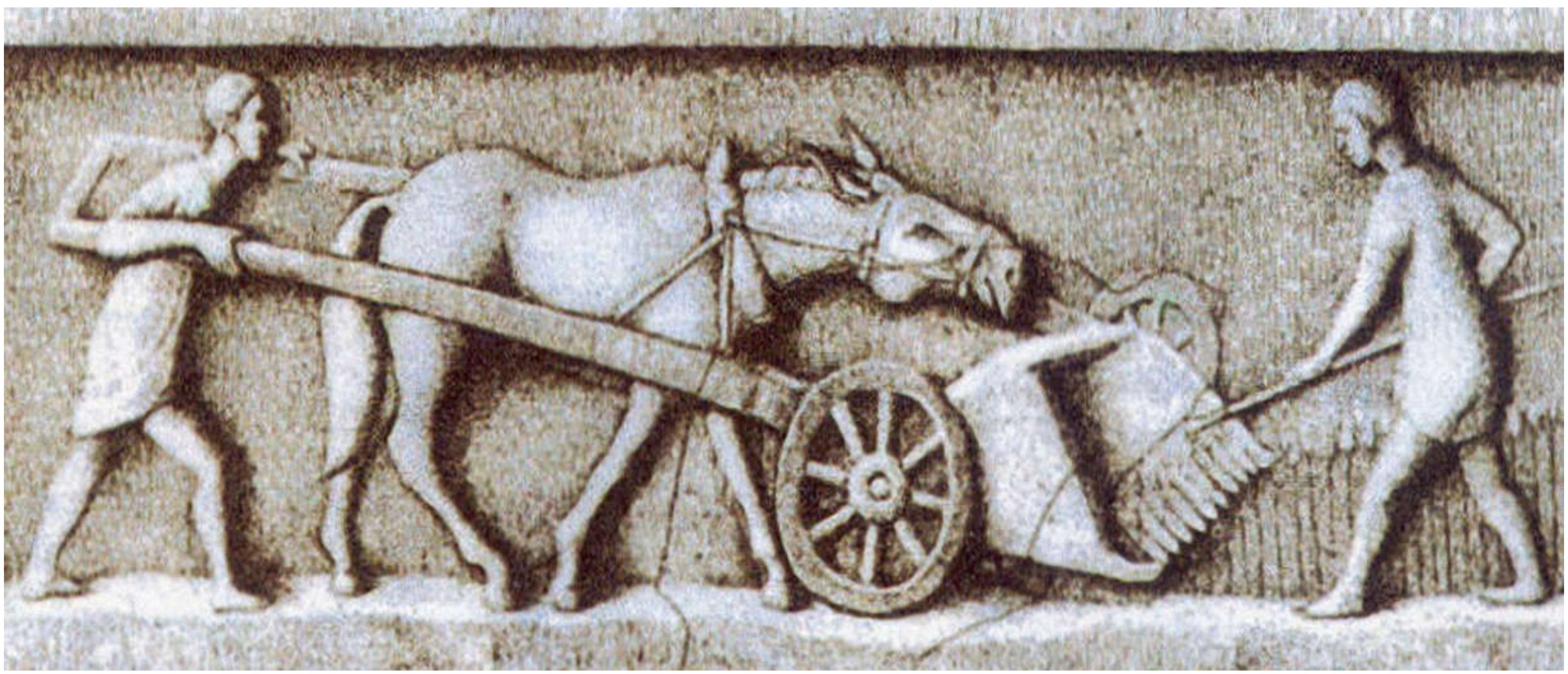
When processed by the removal of the bran, and germ, the remaining endosperm is mostly carbohydrate.

In some developing countries, grain in the form of rice, wheat, millet, or maize constitutes a majority of daily sustenance.

Cereal grains

In developed countries, cereal consumption is moderate and varied but still substantial.

The word cereal is derived from Ceres, the Roman goddess of harvest and agriculture



Cereal grains

Ancient Egypt Food cultivation

Cereal grains

The Green Revolution

During the second half of the 20th century there was a significant increase in the production of high-yield cereal crops worldwide, especially wheat and rice, due to an initiative known as the Green Revolution.

The strategies developed by the Green Revolution focused on fending off starvation and increasing yield-per-plant, and were very successful in raising overall yields of cereal grains, but did not give sufficient relevance to nutritional quality

Cereal grains

Important cereals are wheat, rice, maize, oat, barley, rye, millet and sorghum.

All cereals belong to the Gramineae family – other important crops included in this family are bamboo and sugar cane.

Cereals are cultivated in huge amounts, and are used as a staple food in most of the developing countries as they provide more energy.

Cereal grains

There is a long list of benefits for cereals grain, and they are an important part of our daily diet. Cereals can grow in adverse environmental and bad soil conditions, and the yield of cereal grains is not compromised due to harsh environmental conditions.

Cereal grains

Cereals are nutritionally important sources of dietary protein, iron, vitamin B complex, vitamin E, carbohydrates, niacin, riboflavin, thiamine, fibre and traces of minerals important for both humans and animals.

Soluble bran in cereals is also helpful for lowering blood cholesterol levels and also prevent cardiovascular diseases.

Cereal grains

Maize also known as corn, is a cereal grain first domesticated by indigenous peoples in southern Mexico about 10,000 years ago.

Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice

Cereal grains

Raw, yellow, sweet maize kernels are composed of 76% water, 19% carbohydrates, 3% protein, and 1% fat.

In a 100-gram serving, maize kernels provide 86 calories and are a good source (10–19% of the Daily Value) of the B vitamins, thiamin, niacin (but see Pellagra warning below), pantothenic acid (B5)

Cereal grains

Nutritional value per 100 g (3.5 oz)		
Energy	360 kJ (86 kcal)	
Carbohydrates	18.7 g	
Starch	5.7 g	
Sugars	6.26 g	
Dietary fiber	2 g	
Fat	1.35 g	
Protein	3.27 g	
Tryptophan	0.023 g	
Threonine	0.129 g	
Isoleucine	0.129 g	
Leucine	0.348 g	
Lysine	0.137 g	
Methionine	0.067 g	
Cystine	0.026 g	
Phenylalanine	0.150 g	
Tyrosine	0.123 g	
Valine	0.185 g	
Arginine	0.131 g	
Histidine	0.089 g	
Alanine	0.295 g	
Aspartic acid	0.244 g	
Glutamic acid	0.636 g	
Glycine	0.127 g	
Proline	0.292 g	
Serine	0.153 g	
Vitamins	**Quantity**	**%DV†**
Vitamin A equiv.	9 μg	1%
lutein zeaxanthin	644 μg	
Thiamine (B_1)	0.155 mg	13%
Riboflavin (B_2)	0.055 mg	5%
Niacin (B_3)	1.77 mg	12%

Cereal grains

Rice is the seed of the grass species Oryza glaberrima (African rice) or Oryza sativa (Asian rice).

As a cereal grain, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia and Africa.

It is the agricultural commodity with the third-highest worldwide production

Cereal grains

Rice, a monocot, is normally grown as an annual plant, although in tropical areas it can survive as a perennial and can produce a ratoon crop for up to 30 years.

Rice cultivation is well-suited to countries and regions with low labor costs and high rainfall, as it is labor-intensive to cultivate and requires ample water

Cereal grains

Cooked unenriched long-grain white rice is composed of 68% water, 28% carbohydrates, 3% protein, and negligible fat

A 100-gram (3 1⁄2-ounce) reference serving of it provides 540 kilojoules (130 kilocalories) of food energy and contains no micronutrients

Cereal grains

Nutritional value per 100 g (3.5 oz)		
Energy	544 kJ (130 kcal)	
Carbohydrates	28.73 g	
Sugars	0 g	
Dietary fiber	0 g	
Fat	0.19 g	
Protein	2.36 g	
Vitamins	**Quantity**	**%DV†**
Thiamine (B_1)	0.02 mg	2%
Riboflavin (B_2)	0.016 mg	1%
Niacin (B_3)	0.4 mg	3%
Pantothenic acid (B_5)	0.4 mg	8%
Vitamin B_6	0.164 mg	13%
Minerals	**Quantity**	**%DV†**
Calcium	1 mg	0%
Iron	0.20 mg	2%
Magnesium	8 mg	2%
Manganese	0.4 mg	19%
Phosphorus	33 mg	5%
Potassium	26 mg	1%
Zinc	0.4 mg	4%

Cereal grains

Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food.

The many species of wheat together make up the genus Triticum; the most widely grown is common wheat

Cereal grains

Wheat is an important source of carbohydrates.

Globally, it is the leading source of vegetable protein in human food, having a protein content of about 13%, which is relatively high compared to other major cereals but relatively low in protein quality for supplying essential amino acids.

Nutritional value per 100 g (3.5 oz)		
Energy	1,368 kJ (327 kcal)	
Carbohydrates	71.18 g	
Sugars	0.41	
Dietary fiber	12.2 g	
Fat	1.54 g	
Protein	12.61 g	
Vitamins	**Quantity**	**%DV†**
Thiamine (B_1)	0.383 mg	33%
Riboflavin (B_2)	0.115 mg	10%
Niacin (B_3)	5.464 mg	36%
Pantothenic acid (B_5)	0.954 mg	19%
Vitamin B_6	0.3 mg	23%
Folate (B_9)	38 μg	10%
Choline	31.2 mg	6%
Vitamin E	1.01 mg	7%
Vitamin K	1.9 μg	2%
Minerals	**Quantity**	**%DV†**
Calcium	29 mg	3%
Iron	3.19 mg	25%
Magnesium	126 mg	35%
Manganese	3.985 mg	190%
Phosphorus	288 mg	41%
Potassium	363 mg	8%
Sodium	2 mg	0%
Zinc	2.65 mg	28%

Cereal grains

Barley, a member of the grass family, is a major cereal grain grown in temperate climates globally.

It was one of the first cultivated grains, particularly in Eurasia as early as 10,000 years ago.

Barley has been used as animal fodder, as a source of fermentable material for beer and certain distilled beverages.

Cereal grains

Nutritional value per 100 g (3.5 oz)		
Energy	515 kJ (123 kcal)	
Carbohydrates	28.2 g	
Sugars	0.3 g	
Dietary fiber	3.8 g	
Fat	0.4 g	
Protein	2.3 g	
Vitamins	**Quantity**	**%DV†**
Vitamin A equiv.	0 μg	0%
beta-Carotene	5 μg	0%
lutein zeaxanthin	56 μg	
Thiamine (B_1)	0.083 mg	7%
Riboflavin (B_2)	0.062 mg	5%
Niacin (B_3)	2.063 mg	14%
Pantothenic acid (B_5)	0.135 mg	3%
Vitamin B_6	0.115 mg	9%
Folate (B_9)	16 μg	4%
Vitamin B_{12}	0 μg	0%
Choline	13.4 mg	3%
Vitamin C	0 mg	0%
Vitamin D	0 IU	0%
Vitamin E	0.01 mg	0%
Vitamin K	0.8 μg	1%
Minerals	**Quantity**	**%DV†**
Calcium	11 mg	1%
Copper	0.105 mg	5%
Iron	1.3 mg	10%

Cereal grains

Sorghum is the cultivation and commercial exploitation of species of grasses within the genus Sorghum (often S. bicolor).

These plants are used for grain, fibre and fodder.

The plants are cultivated in warmer climates worldwide.

Cereal grains

Nutrient	Sorghum[H]
Water (g)	9
Energy (kJ)	1,419
Protein (g)	11.3
Fat (g)	3.3
Carbohydrates (g)	75
Fiber (g)	6.3
Sugar (g)	0
Minerals	[H]
Calcium (mg)	28
Iron (mg)	4.4
Magnesium (mg)	0
Phosphorus (mg)	287
Potassium (mg)	350
Sodium (mg)	6
Zinc (mg)	0
Copper (mg)	–
Manganese (mg)	–
Selenium (μg)	0

Cereal grains

The oat (Avena sativa), sometimes called the common oat, is a species of cereal grain grown for its seed, which is known by the same name (usually in the plural, unlike other cereals and pseudocereals).

While oats are suitable for human consumption as oatmeal and oat milk, one of the most common uses is as livestock feed.

Oats are associated with lower blood cholesterol when consumed regularly

Cereal grains

Oats are best grown in temperate regions.
They have a lower summer heat requirement and greater tolerance of rain than other cereals, such as wheat, rye or barley

Cereal grains

Nutritional value per 100 g (3.5 oz)		
Energy	1,628 kJ (389 kcal)	
Carbohydrates	66.3 g	
Dietary fiber	11.6 g	
Fat	6.9 g	
Saturated	1.21 g	
Monounsaturated	2.18 g	
Polyunsaturated	2.54 g	
Protein	16.9 g	
Vitamins	**Quantity**	**%DV†**
Thiamine (B_1)	0.763 mg	66%
Riboflavin (B_2)	0.139 mg	12%
Niacin (B_3)	0.961 mg	6%
Pantothenic acid (B_5)	1.349 mg	27%
Vitamin B_6	0.12 mg	9%
Folate (B_9)	56 μg	14%
Minerals	**Quantity**	**%DV†**
Calcium	54 mg	5%
Iron	5 mg	38%
Magnesium	177 mg	50%
Manganese	4.9 mg	233%
Phosphorus	523 mg	75%
Potassium	429 mg	9%
Sodium	2 mg	0%
Zinc	4 mg	42%

Cereal grains

Rye (Secale cereale) is a grass grown extensively as a grain, a cover crop and a forage crop.

It is a member of the wheat tribe (Triticeae) and is closely related to barley (genus Hordeum) and wheat (Triticum).

Rye grain is used for flour, bread, beer, crisp bread, some whiskeys, some vodkas, and animal fodder.

Cereal grains

Nutritional value per 100 g (3.5 oz)		
Energy	1,414 kJ (338 kcal)	
Carbohydrates	75.86 g	
Sugars	0.98 g	
Dietary fiber	15.1 g	
Fat	1.63 g	
Protein	10.34 g	
Vitamins	**Quantity**	**%DV†**
Thiamine (B_1)	0.3 mg	26%
Riboflavin (B_2)	0.3 mg	25%
Niacin (B_3)	4 mg	27%
Pantothenic acid (B_5)	1 mg	20%
Vitamin B_6	0.3 mg	23%
Folate (B_9)	38 µg	10%
Choline	30 mg	6%
Vitamin E	1 mg	7%
Vitamin K	6 µg	6%
Minerals	**Quantity**	**%DV†**
Calcium	24 mg	2%
Iron	3 mg	23%
Magnesium	110 mg	31%
Manganese	3 mg	143%
Phosphorus	332 mg	47%
Potassium	510 mg	11%
Sodium	2 mg	0%
Zinc	3 mg	32%

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Preservation – Pasteurization

Dr. N. Saravanan

Professor

Food Preservation – Pasteurization

Pasteurisation is a process in which packaged and non-packaged foods (such as milk and fruit juice) are treated with mild heat, usually to less than 100°C (212°F), to eliminate pathogens and extend shelf life.

The process is intended to destroy or deactivate organisms and enzymes that contribute to spoilage or risk of disease, including vegetative bacteria, but not bacterial spores.

Since pasteurization is not sterilization, and does not kill spores, a second "double" pasteurization will extend the quality by killing spores that have germinated.

Food Preservation – Pasteurization

The process was named after the French microbiologist, Louis Pasteur, whose research in the 1880s demonstrated that thermal processing would inactivate unwanted microorganisms in wine.

Spoilage enzymes are also inactivated during pasteurization.

Today, pasteurization is used widely in the dairy industry and other food processing industries to achieve food preservation and food safety

Food Preservation – Pasteurization

- Pasteurisation is a relatively mild heat treatment, in which food is heated to below 100ºC.
- In **low acid foods (pH>4.5**, for example milk) it is used to minimize the hazards from pathogenic micro-organisms and to extend the shelf life of foods for **severaldays**.
- In **acidic foods (pH< 4.5**, for example bottled fruit) it is used to extend the shelf life for **several months** by destruction of pathogenic micro organism and enzyme inactivation.
- In this method minimal changes are caused to sensory characteristics or nutritive value.

Food Preservation – Pasteurization

Different Methods of Pasteurization

- Low-temperature hold method (LTH):
  - conditions of 63°C for 30 min before cooled to 7°C
- High-temperature short-time (HTST):
  - conditions of 71.5°C for at least 15sec before cooled to 10°C
- Ultrahigh-temperature (UHT):
  - 138°C for at least 2 seconds
  - extreme pasteurization
  - kills all microorganisms
  - keeping milk in a closed, sterile container at room temperature

Food Preservation – Pasteurization

Estimation of Pathogenic Micro Organism in Pasteurization

- Phosphatase activity test is simple test. Specially for milk pasteurization.
  - If phosphatase activity is found, it is assumed that the heat treatment was inadequate to destroy the pathogenic bacteria **or**
  - Unpasteurized milk has contaminated the pasteurized product.
- A similar test for the effectiveness of liquid-egg pasteurization is based on residual -amylase activity.

Food Preservation – Pasteurization

Some examples of convention pasteurization treatments

Product	Temperature	Time	Remark
Milk	62.8°C	30 min	LTH
Milk	71.7°C	15 sec	HTST
Milk	137.8°C	2 sec	UHT
Ice-Cream	71.1°C	30 min	LTH
Ice-Cream	82.2°C	16-20 sec	HTST
Grape Wines*	82-85°C	1 min	in bulk
Fruit Wines*	62.8°C	depends	bottled hot
Beer	60°C	depends	bottled hot
Dried fruits	65.6-85°C	30-90 min	
Grape Juice*	76.7 °C	30 min	
Apple Juice*	85-87.8 °C	30-60sec	bottled in bulk
Carbonated Drinks*	65.6	30 min	in common
Vinegar*	60-65.6	30 min	in bulk

*depends on the acidity

Food Preservation – Pasteurization

Equipments

01. Pasteurization of Packaged Foods

- Some liquid foods are pasteurised after filling into containers.
  - Example => beers and fruit juices
- Hot water is normally used to packaged food.
- To reduce the risk of thermal shock of the container, (fracture caused by rapid changes in temperature).
  - Keep maximum temperature differences between the container and water are 20ºC for heating and 10ºC for cooling.

Food Preservation – Pasteurization

Packaged food …..

- Finally packaged food is cooled to approximately 40ºC
  - to evaporate surface water that help to minimize external corrosion to the container **and**
  - to accelerate the label adhesives.
- Hot-water pasteurizers may be **batch** or **continuous** operation.
- The batch equipment consists a water bath.
  - packaged food are heated to a set temperature and held this to required length of time.
  - Cold water is pumped in to cool the product.
- The continuous version consists a long narrow conveyor belt to carry containers through heating and cooling sections.

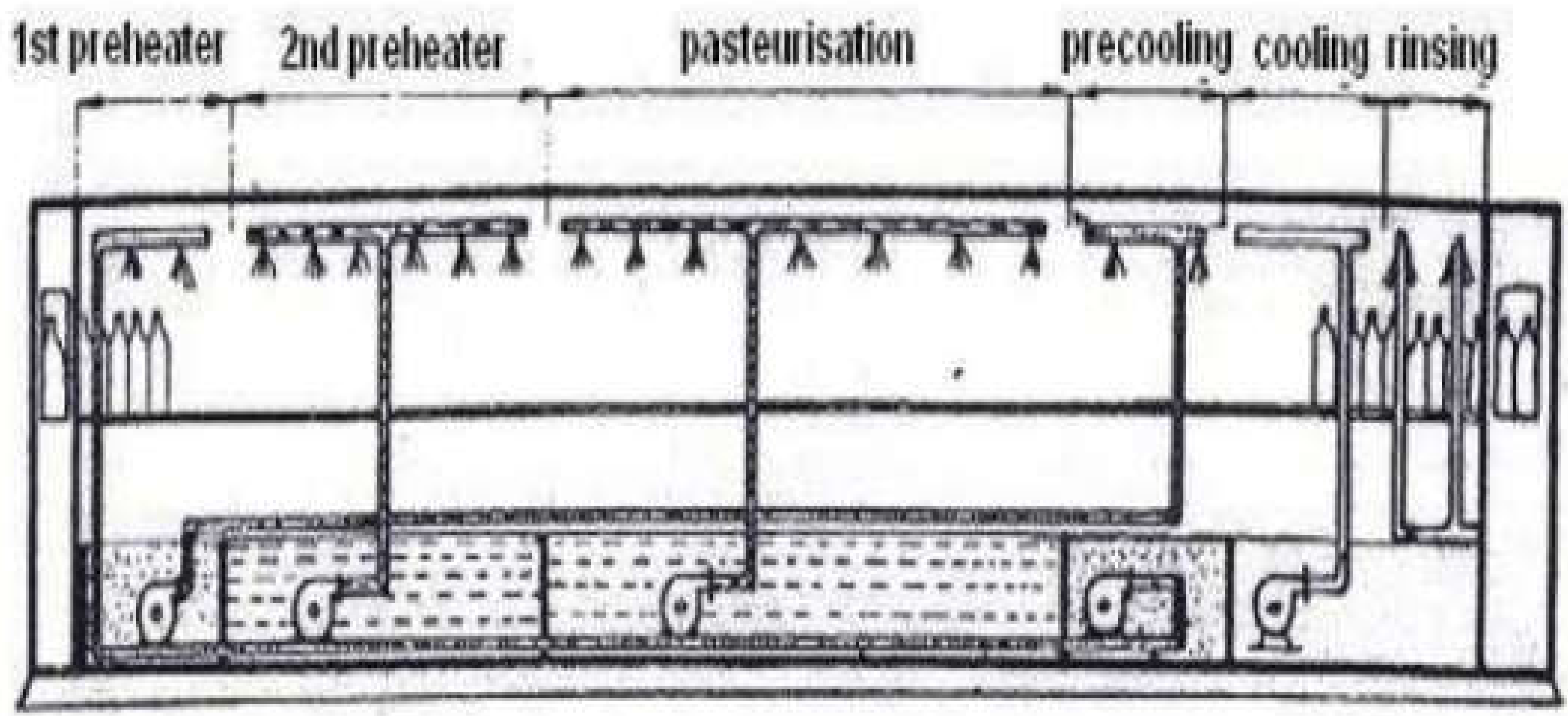
Food Preservation – Pasteurization

Packaged Food - Tunnel pasteurizer

- Tunnel divided into a number of heating zones.
- Very fine hot water sprays are used to heat the container
  - Packaged food pass through each zone of the conveyer. (1st & 2nd per heater, pasteurizer)
  - Incrementaly rises in temperature until pasteurization is achieved.
- Cool water spray is used to cool the containers through the tunnel.
- Temperatures in the heating zones are gradually increased by reducing the amount of air in the steam–air mixtures.

Food Preservation – Pasteurization

Tunnel pasteurizer



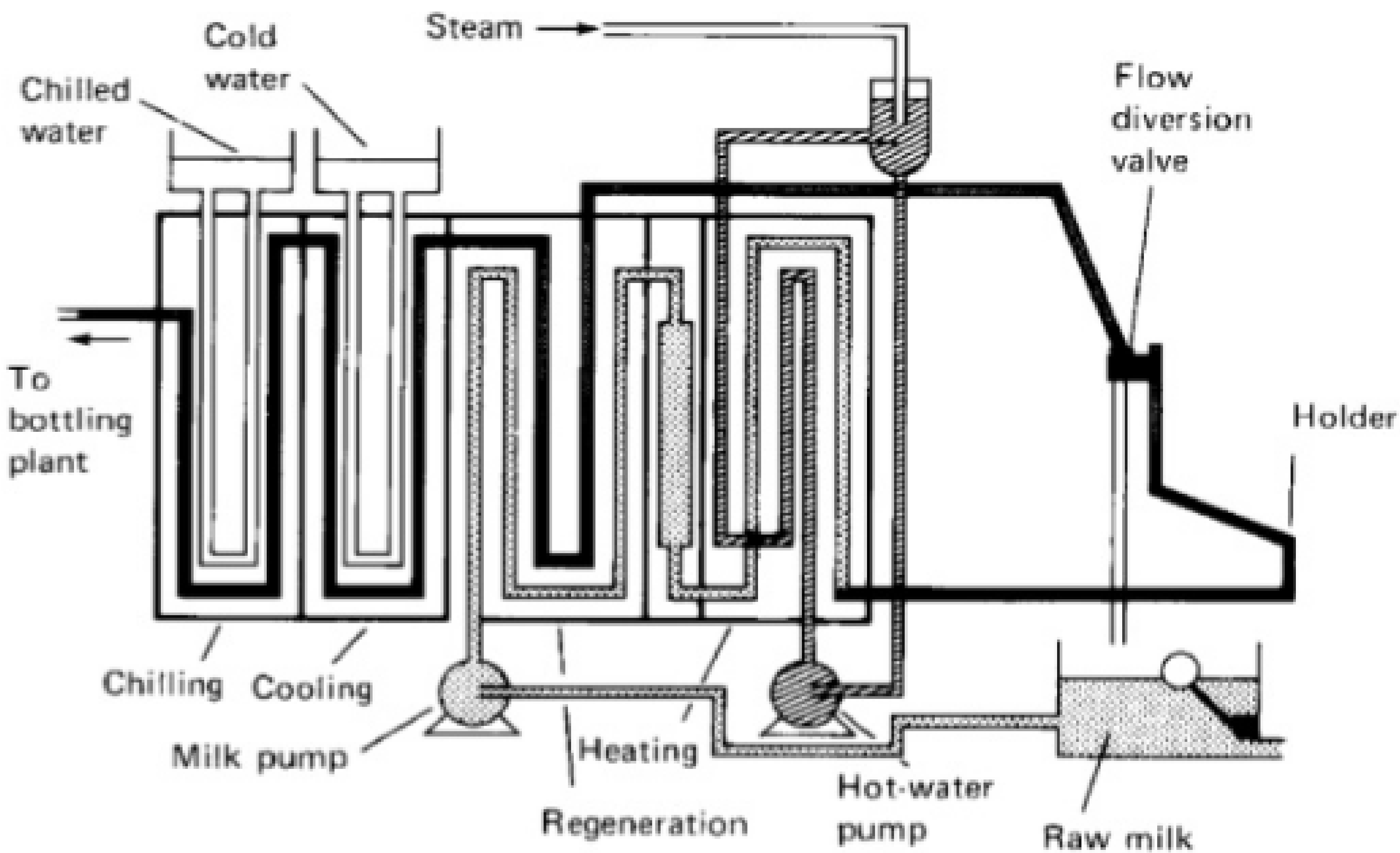
Food Preservation – Pasteurization

02. Pasteurization of Unpackaged Food

- Two main heat exchangers is commonly used for unpackaged food pasteurization.
  1. **Plate heat exchangers**
  2. **Tubular heat exchangers**
- Large scale pasteurization of low viscosity liquids,
  - milk, milk products, fruit juices, liquid egg, beers and wines
  - usually treated through **Plate heat exchangers**.
- Food is sprayed into a vacuum chamber and dissolved air is removed by a vacuum pump, prior to pasteurization.

Food Preservation – Pasteurization

01. Plate heat exchanger



Food Preservation – Pasteurization

Plate heat exchanger .....

- Food is pumped from a balance tank to a 'regeneration' section.
  - where it is pre-heated by food that has already been pasteurized.
- It is then heated to pasteurizing temperature in a heating section.
  - Hold until achieve the pasteurization temperature.
- If the pasteurizing temperature is not reached,
  - flow diversion valve automatically returns the food to the balance tank to be re-pasteurized.

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Food Preservation – Pasteurization

Plate heat exchanger .....

- The pasteurized product is then cooled in the regeneration section. And
  - then further cooled by cold water.
  - If necessary, chilled water also use in the cooling section.
- The regeneration of heat in this way leads to substantial savings in energy and up to 97% of the heat can be recovered.

Food Preservation – Pasteurization

Advantages of heat exchangers (HE)

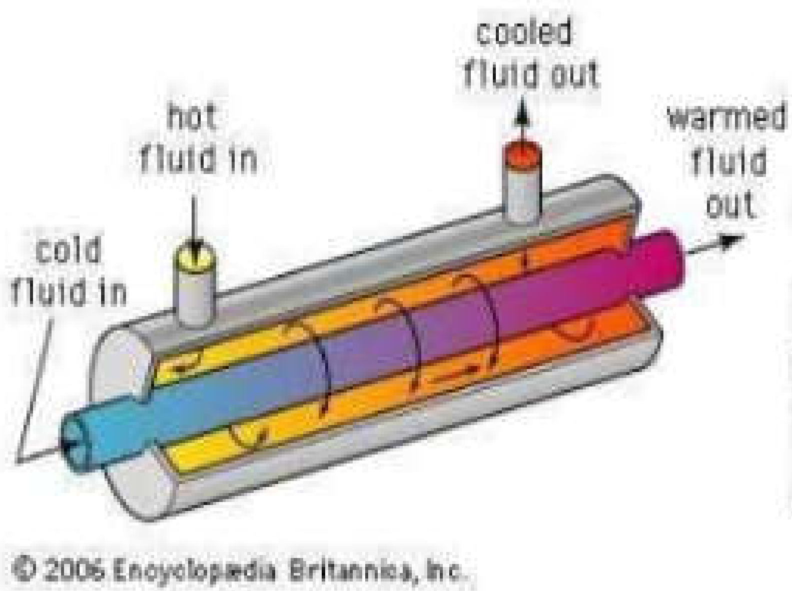
- Advantages of HEs over in-bottle processing:
  - more uniform heat treatment
  - simpler equipment & lower maintenance costs
  - lower space & labour costs
  - greater flexibility for different products
  - greater control over pasteurization conditions.

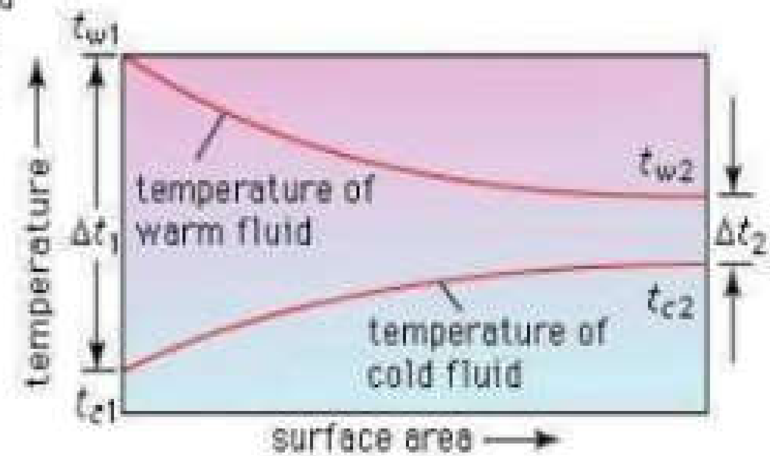
Food Preservation – Pasteurization

Concentric tube HE

- For more viscous foods;
  - dairy products, mayonnaise, tomato ketchup & baby foods.
- Number of concentric stainless steel coils
  - each made from double- or triple-walled tube.
- Food passes through the tube
  - heating or cooling water is re-circulated through the tube walls.
- Liquid food is passed from one coil to next for heating & cooling
  - heat is regenerated to reduce energy costs.
  - Pasteurised food is immediately filled into bottles& sealed.

Food Preservation – Pasteurization



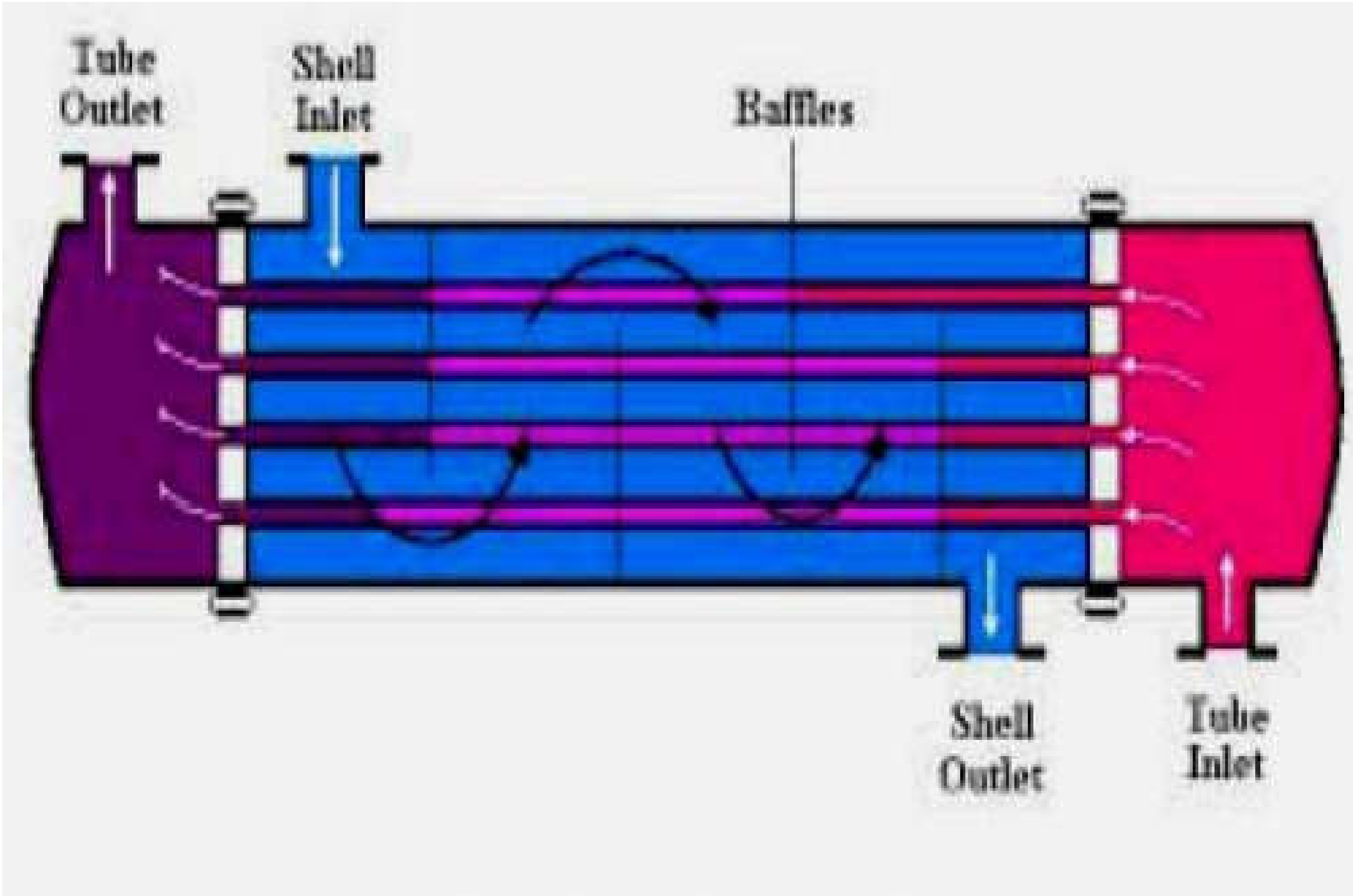


Food Preservation – Pasteurization

02. Shell and tubular or multi-tube heat exchanger

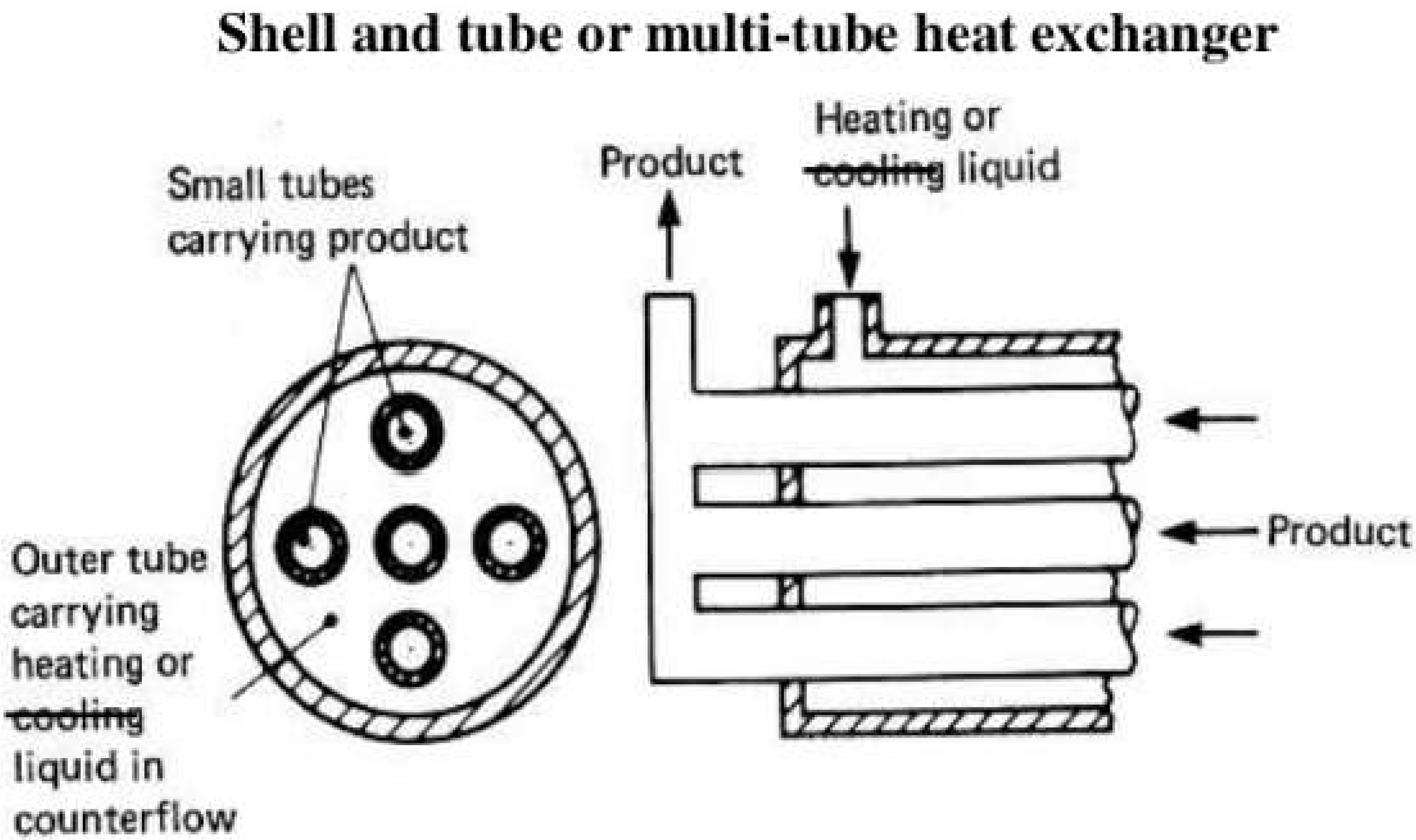
- Important and so widely used in modern food processing industries.
- Designed - various standards and codes,
  - Standards of the Tubular Exchanger Manufacturers Association (TEMA)
  - American Society of Mechanical Engineers.

Food Preservation – Pasteurization



Shell and tube Heat Exchanger

Food Preservation – Pasteurization



Food Preservation – Pasteurization

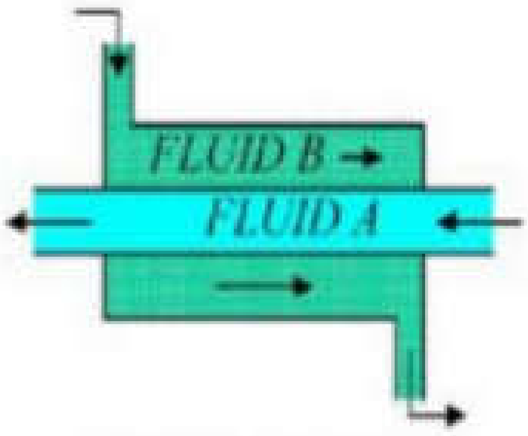
Multi-tubular heat exchanger

- Liquid food product pass through the multi tube chamber.
- Outer tube carrying heating liquid to opposite direction of liquid food.
  - Heating medium hot steam or hot water.
- This flow direction is called as " counter flow".
- Counter flow direction is more efficient method than parallel flow method.
- Cooling with chilled water or brine (counter flow)

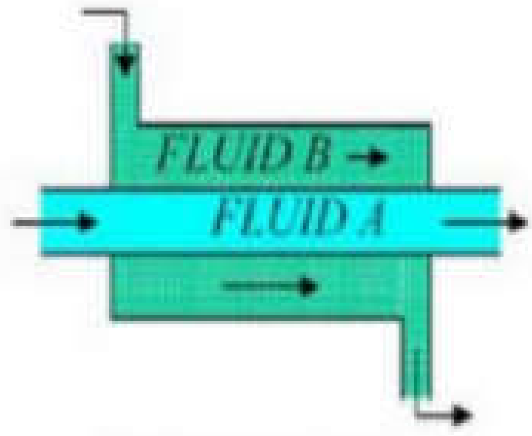
Food Preservation – Pasteurization

- Multi-tubular heat exchanger is well efficient method compare with single tubular heater.
  - Heating surface area of food is high
  - Complete and time efficiency pasteurization. (No cold point effect)
  - Retention of more sensory characters (aroma, flavour).
- To increase heat absorption efficient, the outer tubular chamber insulate with heat resistant materials.(reduce heat loss to environment)
- Tubular heat exchanger can be cleaned by through methods (usually 1 % HNO_3 and 1 % NaOH).
- Problem is deposits on the heating surfaces cannot be seen and hardly removable by mechanical.

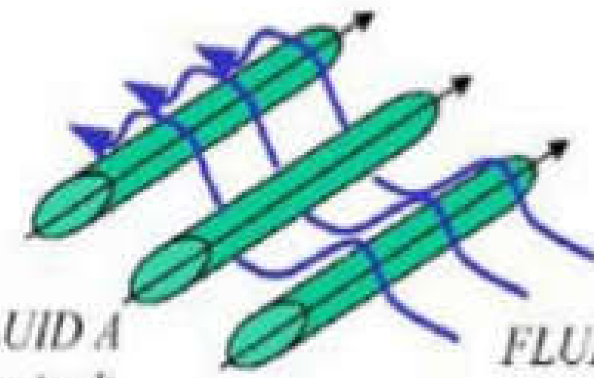
Food Preservation – Pasteurization



COUNTERFLOW



PARALLEL FLOW



FLUID A
(unmixed)

FLUID B
(mixed)

CROSSFLOW

Food Preservation – Pasteurization

Effect on foods

- Pasteurization is,
  - mild heat treatment
  - minor changes to nutritional and sensorial characteristics
- shelf life: few days or weeks

Effect: Colour, flavour and aroma

- Fruit juices
  - Main problem is colour deterioration by enzymic browning (poly phenol oxidase).
  - This browning reaction promoted by the presence of oxygen.
  - In fruit juice industries, fruits are involve to de-aerated prior to pasteurization process. There for retain natural fruit colour.

Food Preservation – Pasteurization

- Whiteness of raw milk & pasteurised milk differs
  – due to homogenisation
- Pasteurization has no measurable effect on
  – the colour of milk.
- Pigments in plant & animal products are mostly unaffected.
- Small loss of volatile aroma compounds during pasteurisation of juices.
- **Volatile recovery** used to produce high quality juices.

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Preservation – Pickling

Dr. N. Saravanan

Professor

Food Preservation – Pickling

Pickling is the process of preserving or extending the shelf life of food by either anaerobic fermentation in brine or immersion in vinegar.

The pickling procedure typically affects the food's texture, taste and flavor.

The resulting food is called a pickle, or, to prevent ambiguity, prefaced with pickled.

Foods that are pickled include vegetables, fruits, meats, fish, dairy and eggs.

Food Preservation – Pickling

A distinguishing characteristic is a pH of 4.6 or lower, which is sufficient to kill most bacteria.

Pickling can preserve perishable foods for months.

Antimicrobial herbs and spices, such as mustard seed, garlic, cinnamon or cloves, are often added.

If the food contains sufficient moisture, a pickling brine may be produced simply by adding dry salt.

For example, sauerkraut and Korean kimchi are produced by salting the vegetables to draw out excess water.

Food Preservation – Pickling

Natural fermentation at room temperature, by lactic acid bacteria, produces the required acidity. Other pickles are made by placing vegetables in vinegar.

Like the canning process, pickling (which includes fermentation) does not require that the food be completely sterile before it is sealed.

Food Preservation – Pickling

Pickles are aromatic and spicy food accessory which stimulate the sense of taste and act as appetizers.

They add variety and palatability in the meal and aid in digestion by stimulating the flow of gastric juices. Pickles are prepared from fruits and vegetables like cauliflower, carrot, radish, garlic, ginger, raw mango, amla, onion, lemon, green chilies etc.

Food Preservation – Pickling

Its is the process of preserving food by anaerobic fermentation in brine to produce lactic acid, or marinating and storing it in an acid solution, usually vinegar (acetic acid).

The resulting food is called a PICKLES

Pickling began 4000 years ago using cucumbers native to India. It is called " achar " in northern India. This was used as a way to preserve food for out-of-season use & for long journey, especially by sea

Food Preservation – Pickling

Salient Features

- Brining or coming.
- Food salty or sour taste.
- pH less than 4.6
- Preserve perishable foods.
- Antimicrobial herbs and spices.

Food Preservation – Pickling

Types Of Pickles

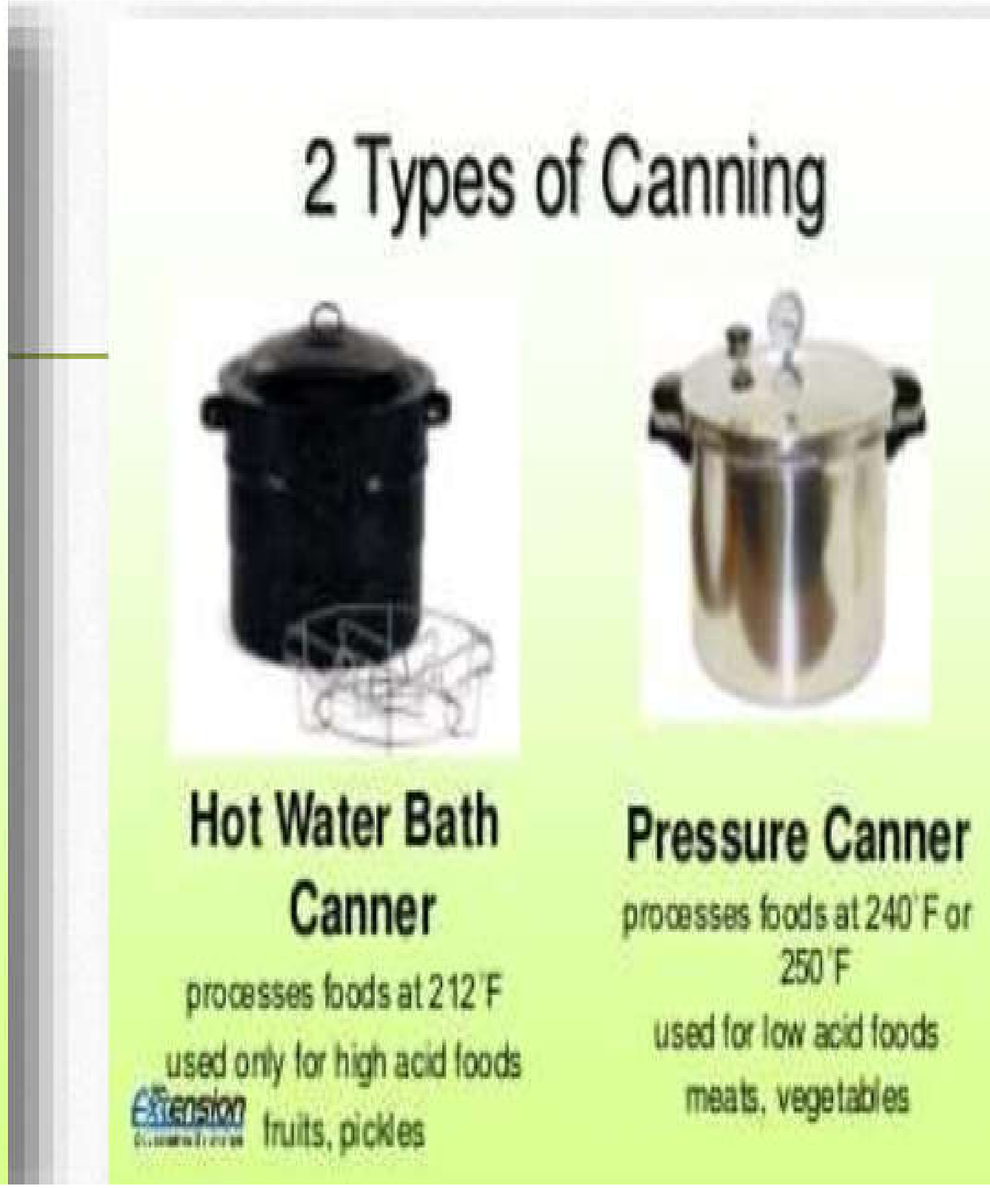
1. Brined dill pickles
2. Relishes
3. Fruit pickles

Food Preservation – Pickling

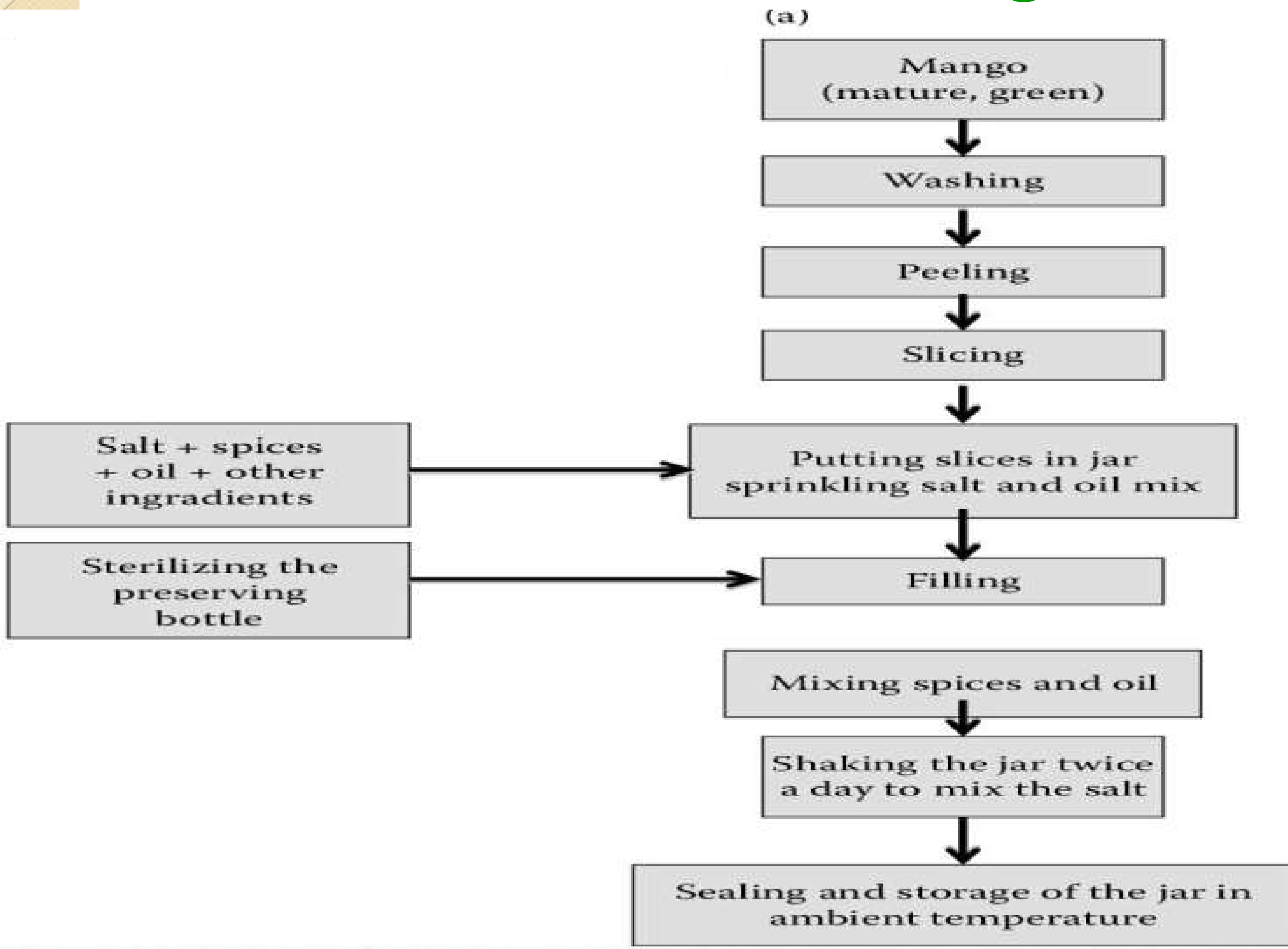
Pickling Equipment

- Utensils made of zinc, iron, brass, copper, or galvanized metal should **not** be used.
- For fresh-pack pickling large container made of stainless steel, glassware.
- For fermenting and brining, a crock or stone jar, an unchipped enamel-lined pan, a glass jar, a bowl, used for small quantities

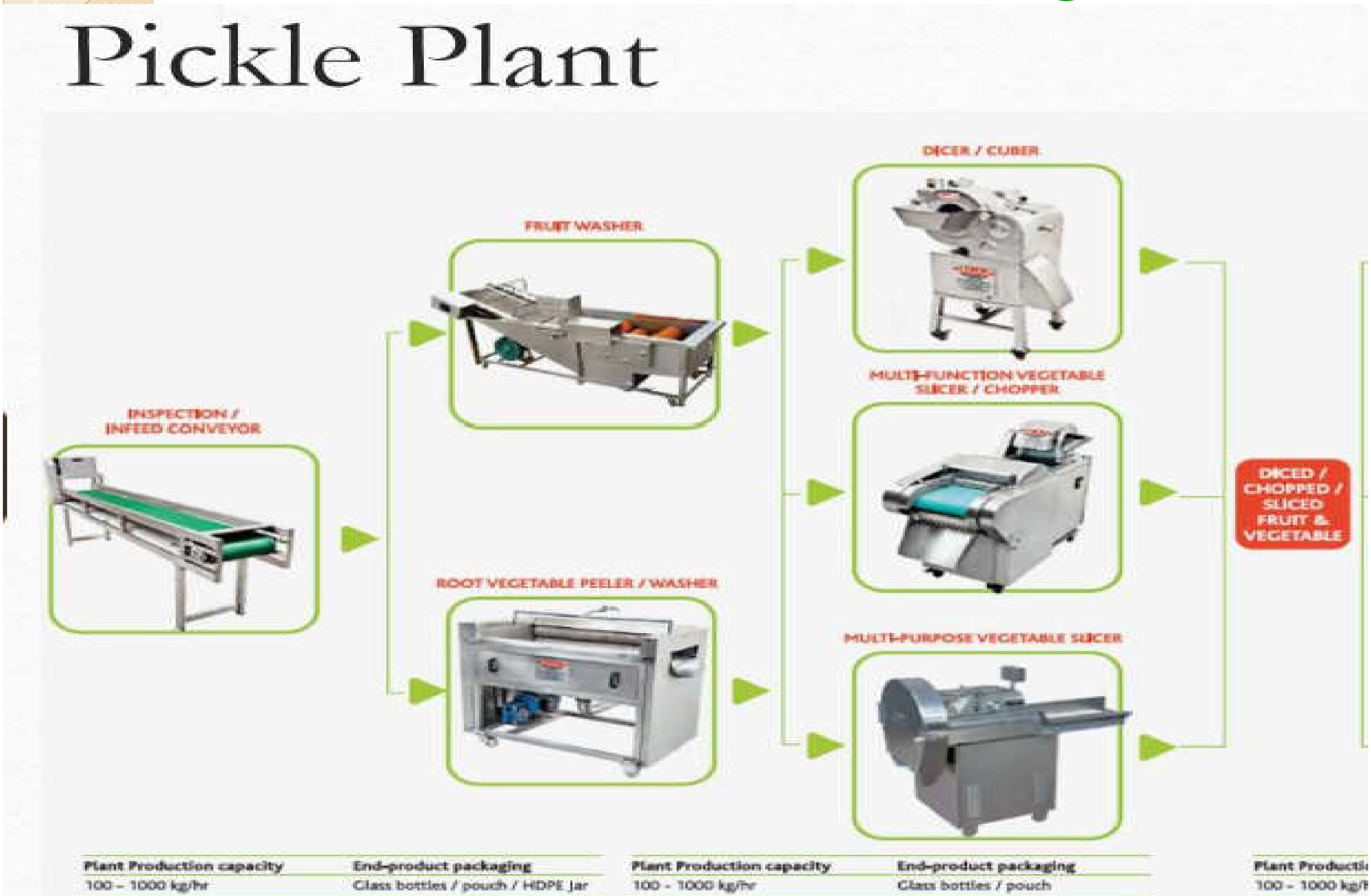
Food Preservation – Pickling



Food Preservation – Pickling



Food Preservation – Pickling



Food Preservation – Pickling

Food Preservation – Pickling

Key ingredients in pickling

- Salt – lactic acid, a preservative.
- Vinegar – Acts as a preservative due to the acidity of vinegar.
- Sugar – Sweetens taste; counteracts vinegar.
- Spices/herbs – Adds flavor.
- Water – Makes liquid portion of brine.
- Alum – Fermented pickle; does not improved firmness of quick-process pickle

Food Preservation – Pickling

Problem in the preparation of pickles

Shriveling – Shriveling occurs when vegetables like cucumber are placed directly in a very strong solution of salt, sugar, or vinegar.

Bitter taste – Its results when strong vinegar is used in pickling. This can also be caused by cooking for long time with spices or by over spicing.

Hollowness – It occurs due to lapse of too long period between pickling and brining from too rapid fermentation.

Softness & slipperiness – Soft pickles may result from exposure of pickles to air. Vegetables should be completely covered with brine which permits the development of undesirable micro-organism

Food Preservation – Pickling

Dark Pickles – Darkness of pickles may be caused by used of ground spices, too much spices, iodized salt, overcooking, used of iron container. It can also result from the growth of micro-organisms.

Dull or faded pickles – Pickles become dull or faded due to insufficient curing or use of inferior quality food material.

Formation of scum – When vegetables are placed in brine for curing, a while scum is formed on the surface due to the growth of wild yeast.

Food Preservation – Pickling

Cloudiness – Cloudiness results from use of inferior quality vinegar or by chemical action between the vinegar and chemical impurities such as calcium, magnesium and iron compounds present in salt or food itself

Food Preservation – Pickling

General method of preparing pickles-

1-Pickling by salt

Fruits and vegetables like raw mangoes, lemon, green chilies are preserved by using this method. Procedure of preparing pickle is as follows:

- Wash fruits or vegetable and peel if desired.
- Cut the fruits or vegetables into pieces.
- Fill the pieces into jar.
- Sprinkles salt at the rate of 15-20 g per kilogram of fruit.
- Keep in the sun for about 4-5 days. Shake the contents in between.
- Add spices as desired.
- Mix well.
- Label the jar and store at room temperature

Food Preservation – Pickling

2- Pickling by use of vinegar

Mango, garlic, onion, cauliflower, green chilies, etc. are pickled by used of vinegar. Care is taken that the final concentration of vinegar in finished pickle is not less than 2 % in terms of acetic acid. Procedure as follows-

- Select mature fruit or vegetable.
- Wash well with water.
- Remove cores, seeds or other inedible portions.
- Cut into pieces.
- Blanch in water.
- Dry in shade for 2-3 hrs.
- Repeat same procedure as pickling by salt

Food Preservation – Pickling

3- Pickling with oil

A layer of oil the top of pickle prevents the entry of atmospheric oxygen into the pickles and inhibits the growth of aerobic micro-organisms.

A mixture of spices and oil is prepared and vegetable pieces are added.

This mixture is filled into the jar and oil is poured on the top of it to cover up the mixture.

Food Preservation – Pickling

3- Pickling with oil

Raw mangoes, cauliflower, amla, turmeric, bitter gourd, garlic etc. are pickled using this method.

- Select mature and fresh fruit or vegetable.
- Wash fruit or vegetable, wipe off and cut into pieces.
- Remove inedible portions like seeds, cores, kernels etc.
- Repeat all procedure as above.

Food Preservation – Pickling

Green chilies pickles

Green chillies
↓
Washing
↓
Drying
↓
Making incision
↓
Mixing all spices in a little lime juice
↓
Mixing with chillies
↓
Filling into jar
↓
Adding lime juice and oil
↓
Keeping in sun for a week
↓
Storage

Food Preservation – Pickling

Thank you

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16BTE01 / 16CHE03 – FOOD TECHNOLOGY

Topic: Food Preservation – Irradiation

Dr. N. Saravanan

Professor

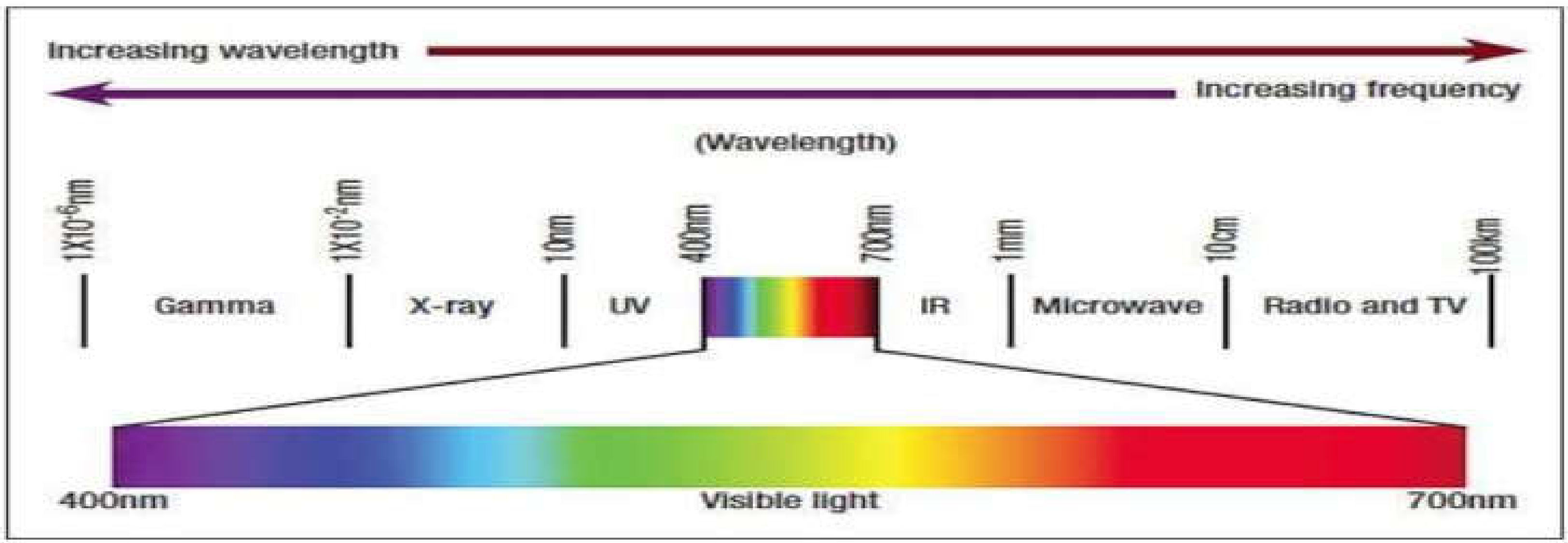
Food Preservation - Irradiation

- Food irradiation is the process of exposing food to a controlled source of irradiation for the purposes of reduction of microbial load, destruction of pathogens, extension of product shelf life, and disinfestations of produce.
- Similar to pasteurization of milk and pressure cooking of canned foods, treating food with irradiation can kill bacteria and parasites that would otherwise cause contamination and spoilage of food.
- Food irradiation process is often called cold pasteurization, because it kills harmful microbes without heat.

Food Preservation - Irradiation

TYPES OF RADIATIONS USED IN FOOD PRESERVATION.

1. Ultraviolet irradiation.
2. Ionizing radiation.
3. Electron beams.
4. Microwave processing.



Food Preservation - Irradiation

UV- IRRADIATION.

- Radiation with wavelength near 260nm is absorbed strongly by purines & pyrimidines, and is germicidal.
- Widely used in food industry.
- UV around 200nm is strongly absorbed by oxygen, may result in production of ozone and is ineffective against microorganisms.

Food Preservation - Irradiation

❖ Germicidal lamps.

- ❑ Quartz mercury lamp or low pressure mercury lamps are usual source of UV radiation in food industry . (254nm)
- ❑ Radiation range from rays in visible range to erythemic range.

Food Preservation - Irradiation

❖ Factors influencing effectiveness of UV radiation.

1.Time:

- ❑ Longer the time of exposure more effective the treatment.

2.Intensity: depends upon

- ❑ Power of the lamp.
- ❑ Distance from lamp to object.
- ❑ Kind and amount .
- ❑ Interfering material in the path.

3.Penetration:

- ❑ Depends on nature of the object or material being irradiated.
- ❑ Lamps also reduce the number of microorganisms in the air surrounding the food.

Food Preservation - Irradiation

❖Effects on Humans and Animals.

- ❑Gazing at UV lamps causes irritation of eyes within few minutes.
- ❑ Longer exposure of skin results in erythema and reddening.

❖Action on Microorganisms.

Resistance in microbes vary with

- ❑Location of organism (in air/ on surface)
- ❑ Phase of growth
- ❑ Physiological state of the cells

Food Preservation - Irradiation

IONIZING RADIATION.

Includes

- X- rays or gamma rays .
- Cathode rays or beta rays .
- Neutrons → Neutrons result in residual radioactivity in food
- Protons
- Alpha particles

Protons, Alpha particles → Have low penetration power → So these are not used in food preservation

Food Preservation - Irradiation

X-rays

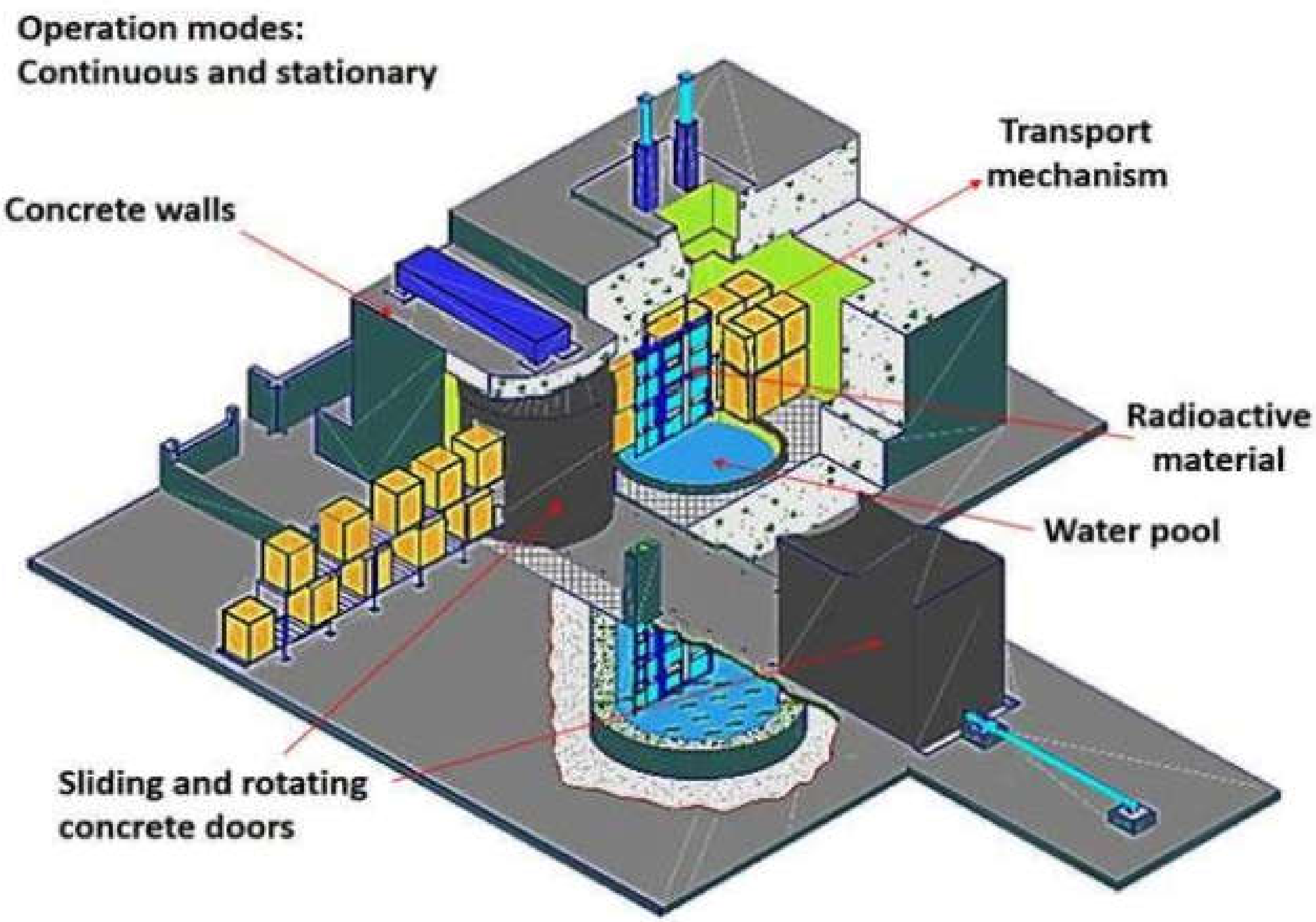
- These are penetrating electromagnetic waves which are produced by bombardment of heavy metal target with cathode rays within in evacuated tube
- They are not economical for industrial use.

Gamma rays

- Are like X-rays but emitted from by-products of atomic fission .
- Cobalt 60 & cesium 137 have been used as source of gamma rays.
- Cobalt 60 is more promising for commercial applications .
- Gamma rays have good penetration, it has been reported to be effective up to 20cm in most foods.

Food Preservation - Irradiation

Gamma irradiator for food processing.



Food Preservation - Irradiation

Beta rays

- These are streams of electrons (beta particles) emitted from radioactive material.
- They are deflected by magnetic and electric fields.
- Higher the charge of electrons , deeper its penetration.

Cathode rays

- Streams of electrons emitted from cathode of a evacuated tube.
- Have poor penetration power.

Food Preservation - Irradiation

❖ Effects on microorganisms.

- ➢ Bactericidal efficiency of a given dose of irradiation depends on following factors

- ❑ Kind and species of organism .
- ❑ Number of organisms originally present.
- ❑ Presence or absence of oxygen .
- ❑ Physical state of the food .
- ❑ Condition of organism .
- ❑ Composition of food.

Food Preservation - Irradiation

❖Effects on foods.

In meat

- pH of meat rises .
- Destruction of glutathione .
- Increase in carbonyl compounds, hydrogen sulphide & methyl mercaptan.

In fats and lipids

- Destruction of natural antioxidants and oxidation followed by partial polymerization.
- Increase in carbonyl compounds.

In vitamins

- Generally B-complex vitamins levels are reduced in food.

In enzymes.

- Some of the food enzymes are reduces.

Food Preservation - Irradiation

ELECTRON BEAMS.

- E-beams are propelled out of an electron gun .
- Used as sterilizers for more than 15 years , no radioactivity involved.
- Electrons can penetrate food only a little over an inch of thickness.

Food Preservation - Irradiation

MICROWAVE PROCESSING.

- Microwaves are electromagnetic waves between infrared and radio waves.
- The energy or heat produced by microwaves pass through the food results in microbial destruction.

Food Preservation - Irradiation

IRRADIATED FOODS.

The Radura is the international symbol indicating a food product has been irradiated. The Radura is usually green and resembles a plant in circle. The top half of the circle is dashed. Graphical details and colors vary between countries.

The FDA first approved the use of irradiation in 1963 to kill pests in wheat and flour. To date, the FDA and the USDA have approved food irradiation for use on fruits, vegetables, spices, raw poultry, and red meats.

Food Preservation - Irradiation

DOSIMETRY.

- The international unit for measurement of radiation is the Gray (Gy).
- One Gray represents one joule of energy absorbed per kilogram of irradiated product. One Gy is equivalent to 100 rad (radiation absorbed dose)
- Depending upon the mass and thickness of the food the desired dose is achieved by the time of exposure and by the location of the product relative to the source.

Food Preservation - Irradiation

❖**Levels of food irradiation.**

- Radurization (low) < 1 kGy
- Radicidation (medium) 1-10 kGy
- Rappertization (high) > 10kGy

Food Preservation - Irradiation

Levels of food irradiation.		
	Applications	Dose (kGy)
Low dose (up to 1 kGy) **Radurization**	Inhibit sprouting (potatoes, onions, yams, garlic)	0.06 - 0.2
	Delay in ripening (strawberries, potatoes)	0.5 - 1.0
	Prevent insect infestation (grains, cereals, coffee beans, spices, dried nuts, dried fruits, dried fish, mangoes, papayas)	0.15 - 1.0
	Parasite control and inactivation (tape worm, trichina)	0.3 - 1.0
Medium dose (1 kGy to 10 kGy) **Radicidation**	Extend shelf-life (raw and fresh fish, seafood, fresh produce, refrigerated and frozen meat products)	1.0 - 7.0
	Reduce risk of pathogenic and spoilage microbes (meat, seafood, spices, and poultry)	1.0 - 7.0
	Increased juice yield, reduction in cooking time of dried vegetables	3.0 - 7.0
High dose (above 10 kGy) **Rappertization**	Enzymes (dehydrated)	10.0
	Sterilization of spices, dry vegetable seasonings	30.0 max
	Sterilization of packaging material	10.0 - 25.0
	Sterilization of foods (for NASA and hospitals)	44.0

Food Preservation - Irradiation

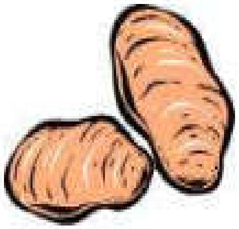
APPLICATIONS OF FOOD IRRADIATION.

Type of Food	Radiation Dose in kGy	Effect of Treatment
Meat, poultry, fish, shellfish, some vegetables, baked goods, prepared foods	20 to 71	Sterilization. Treated products can be stored at room temperature without spoilage. Treated products are safe for hospital patients who require microbiologically sterile diets.
Spices and other seasonings	Up to a maximum of 30	Reduces number of microorganisms and insects. Replaces chemicals used for this purpose.
Meat, poultry, fish	0.1 to 10	Delays spoilage by reducing the number of microorganisms in the fresh, refrigerated product. Kills some types of food poisoning bacteria and renders harmless disease-causing parasites (e.g., trichinae).
Strawberries and some other fruits	1 to 5	Extends shelf life by delaying mold growth.
Grain, fruit, vegetables, and other foods subject to insect infestation	0.1 to 2	Kills insects or prevents them from reproducing. Could partially replace post-harvest fumigants used for this purpose.
Bananas, avocados, mangoes, papayas, guavas, and certain other non-citrus fruits	1.0 maximum	Delays ripening.
Potatoes, onions, garlic, ginger	0.15 to 0.30	Inhibits sprouting.
Grain, dehydrated vegetables, other foods	Various doses	Desirable changes (e.g., reduced rehydration times).

Food Preservation - Irradiation

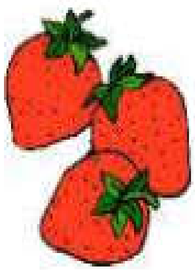
Which foods are irradiated?

- Wheat flour – control of mold



- White potatoes – inhibit sprouting

- Pork – kill Trichinia parasites



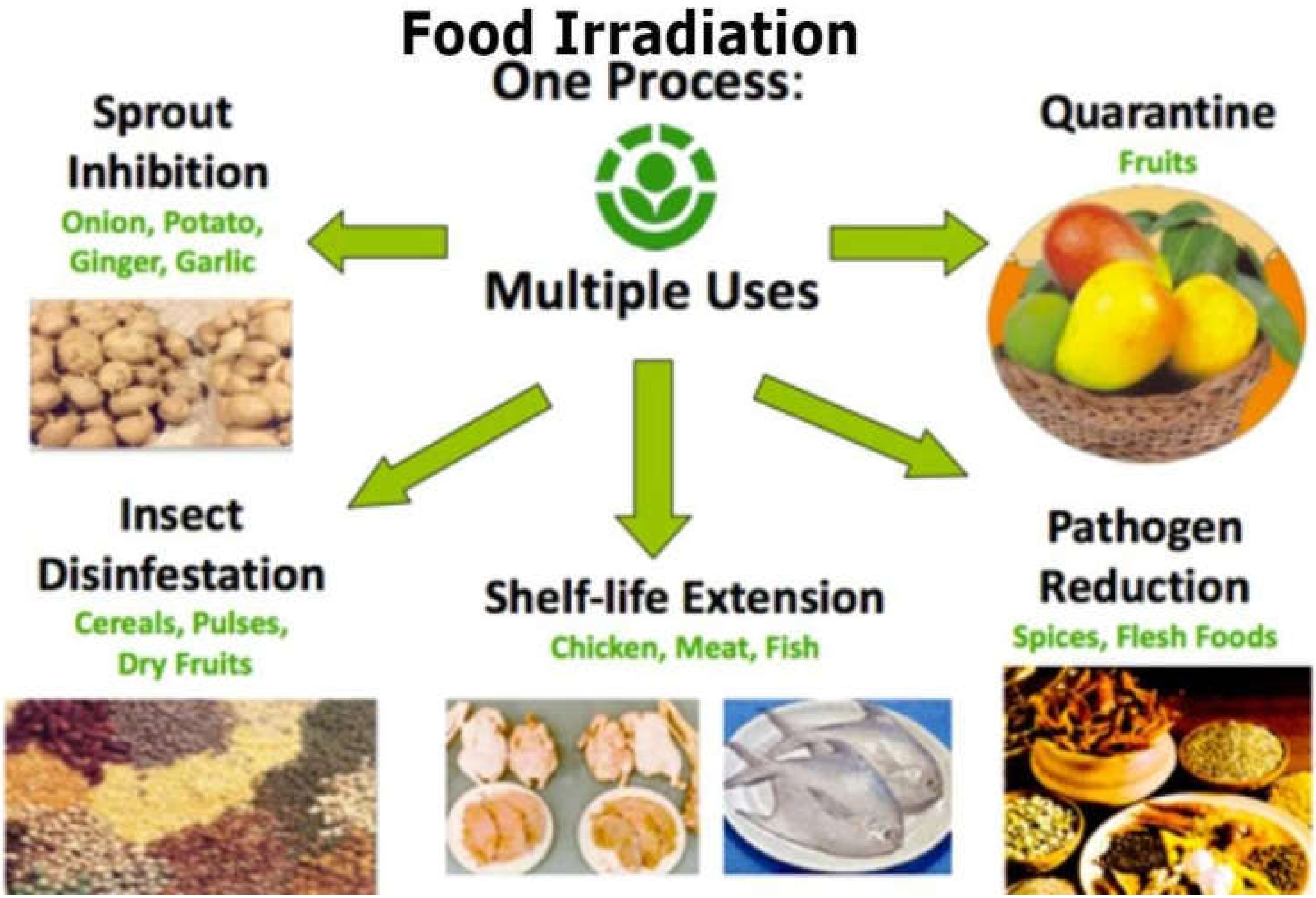
- Fruit and Vegetables – insect control; increase shelf life

- Herbs and Spices - sterilization
- Poultry – bacterial pathogen reduction

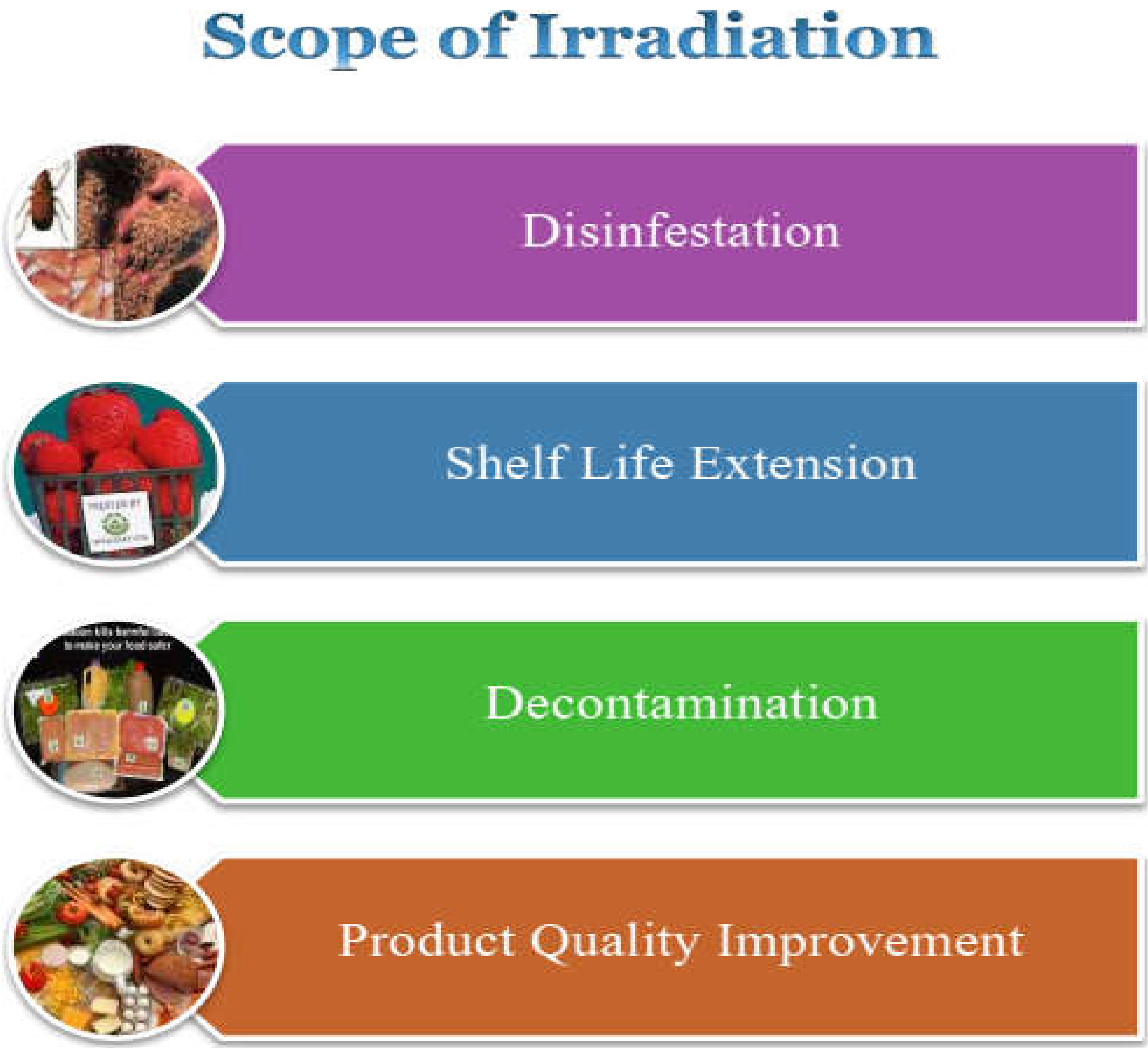
- Meat – bacterial pathogen reduction

Food Preservation - Irradiation

BENEFITS OF FOOD IRRADIATION



Food Preservation - Irradiation



Food Preservation - Irradiation

Product Quality Improvement

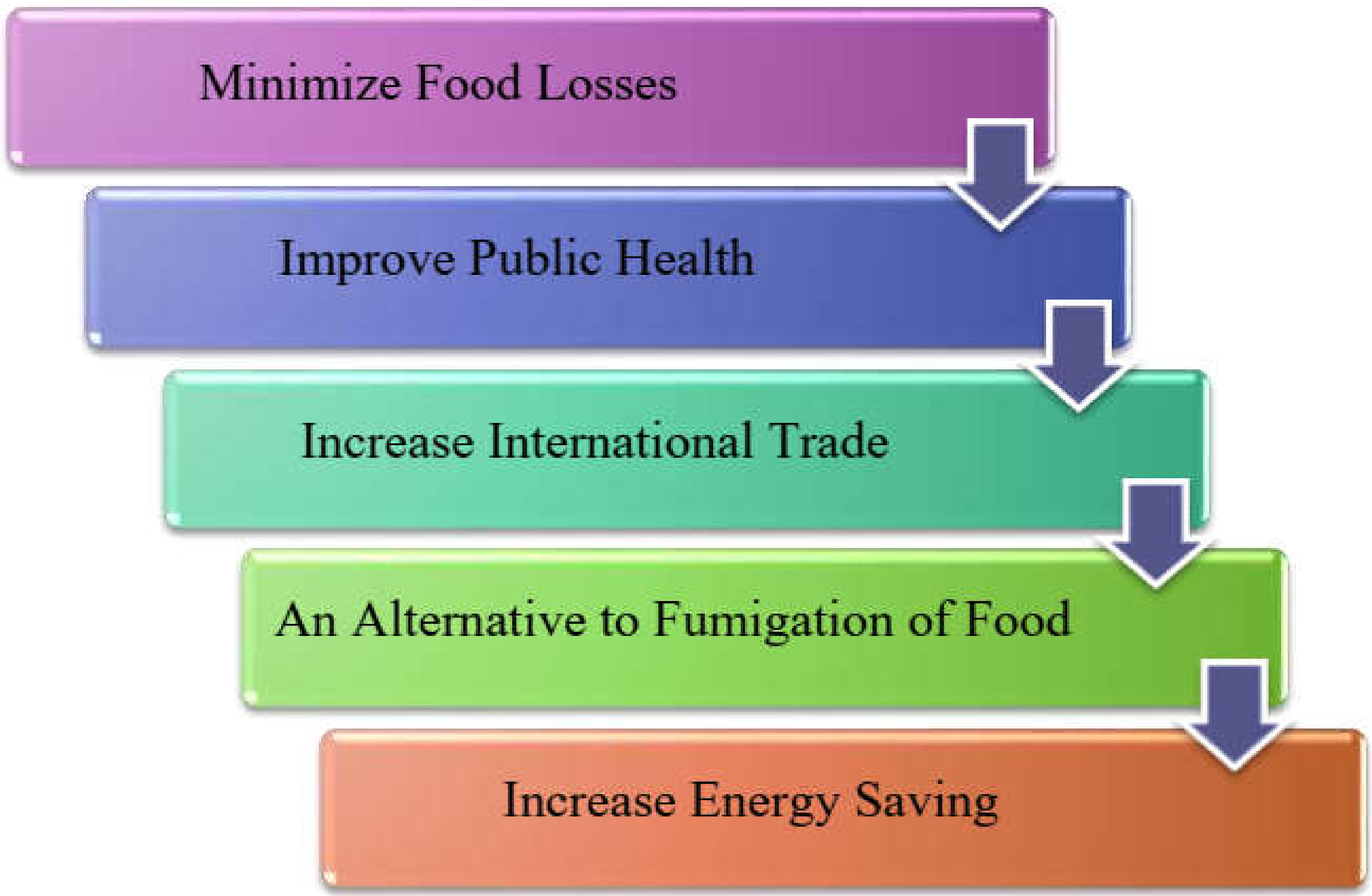
improving product recovery and higher juice yield in fruits

irradiation does not leave any chemical residues in foods

Increase shelf life and microbiological properties

Food Preservation - Irradiation

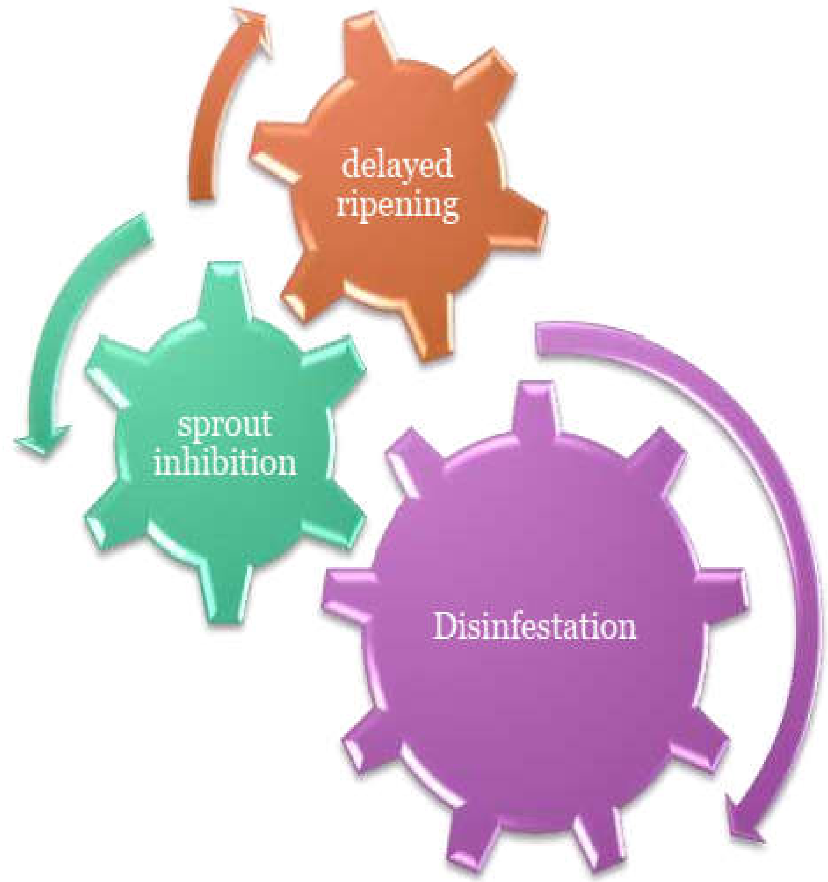
Advantages of Irradiation



Food Preservation - Irradiation

Minimize Food Losses

- Especially in the Third World, irradiation has high potential where in many cases food is spoiled during postharvest stage



Food Preservation - Irradiation

LIMITATIONS OF FOOD IRRADIATION

- Irradiation cannot be used with all foods. It can causes undesirable flavor and texture changes .
- Food irradiation can destroy bacterial spores but are ineffective against viruses.
- Irradiated foods may form chemical transformations forming radiolytic products.
- Increased consumer cost
- ✓ Irradiated meats cost approximately 3 to 5 cents more a pound than non-irradiated meat.
- Food irradiation reduces the nutritional content of foods.
- The microorganism present on the food may undergo mutation due to exposure to radiation.
- Irradiation cannot eliminate pesticides and other chemicals in food.

Thank you