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ONLINE COURSE WARE

SUBJECT NAME: FOOD PROCESS TECHNOLOGY – I
(cereals, fruits and vegetables, beverages)
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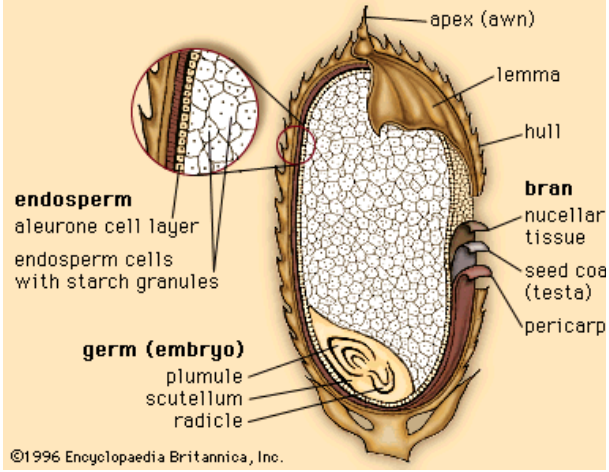
Module I 8L

Lecture 1

Basic Composition and Utilization of Cereals

1.1. Structure of cereal grains:

- Cereals are members of grass family
- Produce dry one Produce dry, one-seeded fruit called caryopsis seeded fruit, called caryopsis Caryopsis is also called kernel or grain
- Caryopsis consists of
  – Fruit coat or pericarp, which surrounds seed and is tightly adhered to seed coat
  – Seed, which consists of germ or embryo and endosperm enclosed by a nucellar epidermis and a seed coat
- All cereal grains have these same parts in approx. same relationship to each other



Structure and basic compositions of grains

1.2. Some Important Nutritional Fact about Cereals:

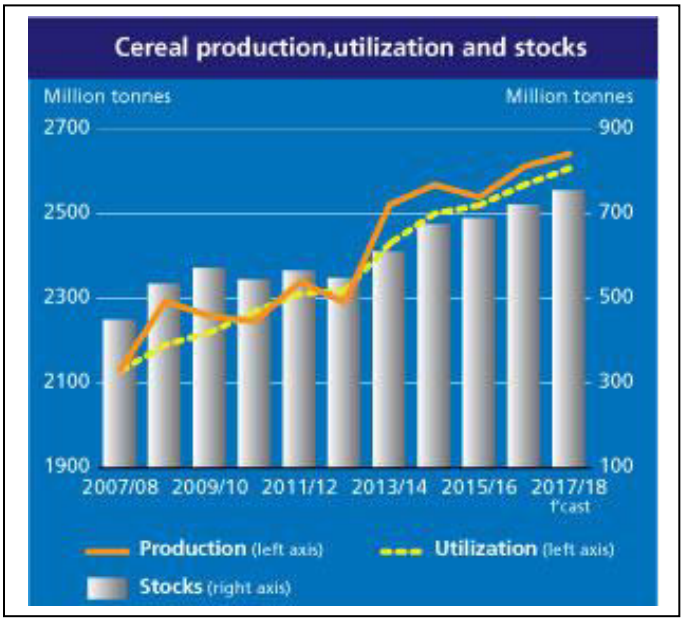
Nutrient composition of selected raw cereal grains (per 100 grams)						
Source: *Composition of Foods*, Agriculture Handbook no. 8-20, U.S. Department of Agriculture.						
cereal grain	**energy (kcal)**	**water (g)**	**carbohydrate (g)**	**protein (g)**	**fat (g)**	**minerals (g)**
barley (pearled)	352	10.09	77.72	9.91	1.16	1.11
corn (field)	365	10.37	74.26	9.42	4.74	1.20
millet	378	8.67	72.85	11.02	4.22	3.25
oats (oatmeal)	384	8.80	67.00	16.00	6.30	1.90
rice (brown; long-grain)	370	10.37	77.24	7.94	2.92	1.53
rye	335	10.95	69.76	14.76	2.50	2.02
sorghum	339	9.20	74.63	11.30	3.30	1.57
wheat (hard red winter)	327	13.10	71.18	12.61	1.54	1.57

Some grains are deficient in the essential amino acid, lysine. That is why many vegetarian cultures, in order to get a balanced diet, combine their diet of grains with legumes.

Many legumes, however, are deficient in the essential amino acid methionine, which grains contain. Thus, a combination of legumes with grains forms a well-balanced diet for vegetarians. Common examples of such combinations are dal (lentils) with rice bySouth Indians and Bengalis, dal with wheat in Pakistan and North India, and beans with corn tortillas, tofu with rice, and peanut butter with wheat bread (as sandwiches) in several other cultures, including Americans. The amount of crude protein found in grain is measured as the grain crude protein concentration.

Cereals contain exogenous opioid peptides called exorphins and include opioid food peptides like Gluten exorphin andopioid food peptides. They mimic the actions of endorphines because they bind to the same opioid receptors in the brain.

1.3. Utilizations of cereals:



(Source: Food and Agriculture Organization-FAO)

Lecture 2

Drying of Grains

1.4. Grain is dried to reduce its water activity and to increase there shelf life at the time of storage.

Proper moisture levels for safe storage

It is possible for long period safe storage if grain moisture content is less than 14%, and stored away from insects, rodents and birds. The following figure is the recommended moisture content for safe storage.

Storage duration	Required MC for safe storage	Potential problems
Weeks to a few months storage	14% or less	Molds, discoloration, respiration loss, insect damage, moisture adsorption
Storage for 8 to 12 months	13% or less	Insect damage
Storage of farmer's seeds	12% or less	Loss of germination
Storage for more than 1 year	9% or less	Loss of germination

Classifications of grain drying Methods:

- **In-storage drying methods (In-storage drying methods refers to those grain is dried and stored in the same container)**

1. **Low-temperature drying**:Low-temperature drying, also known as near-ambient drying, is one of in-storage drying methods. Low temperature drying system is better operated when the average daily temperature is between 30 °C and 50 °C. Rather than control the drying air temperature, the low-temperature drying focuses on the relative humidity in order to achieve equilibrium moisture content (EMC) in all grain layers. Low-temperature drying process usually takes 5 days to several months depends on several important variables: weather, airflow, initial moisture content and amount of heat used. By using heated air (LP heat, electric heat and solar heat), the relative humidity of the drying air is better controlled to achieve the desired moisture content. Usually, heated air dryer is used when the relative humidity larger than 70%. In electric heat dryers, an electrical resistant heater is usually placed before the fan to heat the airstream. In some

case, a humidistat is employed to control the heater. In solar heat dryers, the drying air passes through the solar collector first to be heated (usually 10 to 12 °F rise), then enters the bin through the fan and motor.

2. **Multiple-layer drying**:Multiple layer drying method refers to the use of LP heat or natural gas in drying corn. Compared to low-temperature methods, multiple-layer drying requires higher temperatures, which results in a shorter allowable storage time. Multiple-layer drying without stirring is the basic multiple-layer drying method, in which airstream is entered through an LP heater by a fan. Usually, the temperature rise after the LP burner is remained low in order to avoid over drying in the bottom layers in the bin. As soon as corn is dried in the bin, the burner is turned off and the fan is used to bring the corn to ambient temperature. The advantages of multiple-layer drying without stirring are little handling of corn, and bin can be used as either dryer or storage; the disadvantages are slow filling and over drying in the bottom layers (Bern and Brumm, 2010). Multiple-layer drying with stirring can not only dry grain equilibrium from top to bottom, but also decrease the air resistance of the grain. Moreover, using stirring system can avoid over drying in bottom layer problem and give a uniform grain moisture content in the whole bin. When drying is complete, the burner is turned off while the fan and stirrer are used to mix the corn to achieve equal moisture content and temperature. The advantages of adding stirring are preventing over drying and accelerating drying and allowable fill rate; the disadvantages of stirring system are additional expenses and decreasing bin capacity.

- **Batch drying methods**

1. **Bin batch drying**: In batch drying methods, certain amount of grain is placed first, usually 2 to 4 inches, the batch is dried and cooled later, then drying is stopped and batch is removed. The batch dryers are usually operating under this sequence and repeating this sequence for several times. The bin-batch drying methods employ a full perforated floor as the dryer. Without stirring, large variety of equipment is available and the batch can be used as both dryer and cooler, but there may be large moisture gradient from top to bottom and losing time in loading and unloading process. When adding stirring system, unequilibrium moisture content problem is avoided, however, stirrer is an added expense. When using bin-batch roof dryer, time losing problem can be solved. There is a drying floor under the bin roof and the drying fan and burner is installed high on the bin wall. When the drying process is completed, grain is put in the regular bin floor, thus unloading time is reduced. However, there is no wet grain holding in bin-batch roof dryers and there is more expense on machines.

2. **Column batch drying**: The column formed in this kind of dryer is made up of two vertical perforated steel sheets, which is about 12 inches thick each. The capacity of column batch dryers is too small to store grains. The advantages of column batch, stationary bed dryer are easy to move and the dyer can be used as cooler; while the disadvantages are time losing when cooling, loading and unloading and unequal moisture distribution when drying is completed. When column batch recirculating dryer is used, the moisture content variation problem is avoided, but the additional handling process may result in grain spoilage.

- **Continuous flow drying methods**

1. **Cross flow drying**: Cross flow dryers is one of the most widely used continuous flow dryers. In the cross flow dryer, the airstream is perpendicular to the grain flow. Then the grain near the drying air is over dried, while on the other side, grain is under dried. Moisture gradient exists when drying is complete. In reality, the lower the airflow rate, the higher the grain moisture content variation between two sides of the column.

2. **Counter flow drying**: In the concurrent flow dryer, both the grain and air are moving in the same direction, which means the wettest grain is subjected to the hottest drying air. The kernels leave the drying region at the same temperature and the same moisture content. Energy efficiency is 40% better compared to cross flow dryer. However, the bed depth must be deeper than 12 inches depth than cross flow type. Thus, fan power requirements are high in this type of dryer.

3. **Concurrent flow drying**: In the counter flow dryer, the grain and the air are moving in opposite directions, which mean the driest grain is subjected to the hottest drying air. The kernels leave the drying region at the same temperature and the same moisture as in concurrent flow dryers. The suggesting air temperatures are less than 180 °F because the driest kernels are more likely to be damaged by hot air.

Lecture 3

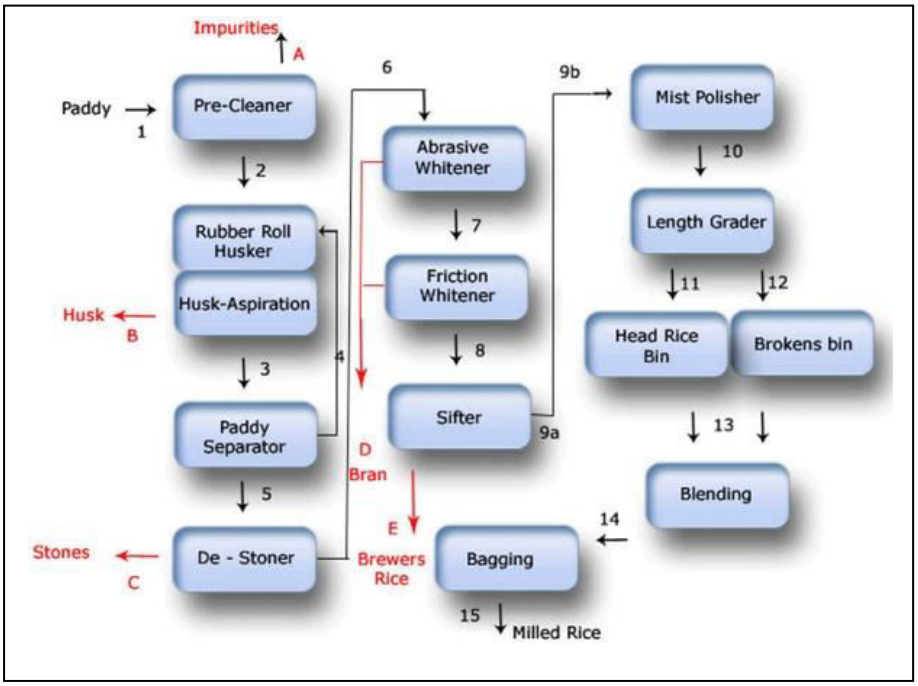
Milling of Rice and Processes for Rice-Based Products

1.5. Milling of Rice: Process Description:

1. **Paddy Cleaning -** Essential for removal of undesired foreign matter, paddy cleaning is given utmost importance to ensure proper functioning of the Rice Milling machinery. Rough rice is passed through a series of sieves and closed circuit aspiration system is provided to remove dust and light impurities through positive air suction.
   Undesired material, heavier than rough rice (but of similar size) is removed through a de-stoner/gravity separator. This machine works on the principle of specific gravity. Stones and other heavy impurities, being heavier, stay on the screen surface whereas rough rice, being lighter, fluidizes into the positive air gradient created by an external source.
2. **Paddy De-husking -** A streamlined paddy flow is directed into a pair of rubber rolls, rotating at different speeds, in opposite directions. A horizontal inward pressure is applied on the rubble rollers, pneumatically. Due to the difference in the seed of rotation, a shear force is generated on the surface of hull (with two sides being rubber by tow rubber rolls) that breaks apart of the surface/hull.
   Husk, being of lower specific gravity, is then separated form brown rice by a closed circuit aspiration system.
   This process leads to breakage of brown rice. Although a proper horizontal inward pressure is mot important factor for breakage or rice, de-husking efficiency is equally important and should be maintained between 75 to 85%.
3. **Paddy Separation -** Rice surface is smooth as compared to rough paddy surface. This difference in surface texture is utilized to separate brown rice from paddy through paddy separator. Grain surface with smooth texture, being of higher width, is removed off along with red grains by precision sizes.
4. **Rice Whitening -** Brown rice is rubbed with a rough surface, created using emery stones of specific grid size. The rough emery removes off the brown bran layer. The radial velocity of the stone wheels, grid size of the stones, clearance between stone surface & the other screen and the external pressure on the outlet chamber of the whitening machines determine the extent of whiteness.
   The bran layer removed from the surface if pneumatically conveyed to a separate room for further processing /storage.
5. **Rice Polishing -** The surface of whitened rice is still rough and is smoothened by a humidified rice polisher. The process involves rubbing of rice surface against another rice surface with mystified air acting as lubricant between the two surfaces. Usually a modified version of this process is used to produce superfine silky finish on rice surface.
   The bran layer removed from the surface if pneumatically conveyed to a separate room for further processing/storage.
6. **Rice Grading -** Broken rice is removed from whole rice by passing the lot through a cylindrical indented screen rotating at a particular speed. The broken/small grains, fit into the indents of the rotating cylinder, are lifted by centrifugal force and gravitational pull falls the grains into a trough. Adjusting the rotational speed and angle of trough can vary the average length of grains.

7. **Rice Colour Sorting -** Discoloured rice grains are removed off from the like coloured grains by Rice colour sorting machines. Photo sensors/CCD (Charged Coupled Device) sensors generate voltage signal on viewing discoloured grains, which are then removed off by air jet generated through solenoid valves.

Schematic Diagram of Flow of Processes in a Typical Modern Rice Mill:



(1) paddy fed into the intake pit; (2) precleaned paddy moves to the rubber roll husker; (3) mixture of brown rice and unhusked paddy moves to the separator; (4) unhusked paddy is separated and returned to the rubber roll husker; (5) brown rice moves to the destoner; (6) destoned brown rice moves to the first stage (abrasive) whitener; (7) partially milled rice moves to the second stage (friction) whitener; (8) milled rice moves to the sifter; (9a) (for simple rice mills) ungraded milled rice moves to bagging station; (9b) (for more sophisticated mills) milled rice moves to the polisher 1; (10) polished rice moves to length grader; (11) head rice moves to head rice bin; (12) broken rice moves to brokens bin; (13) pre-selected amount of head rice and broken rice moves to blending station; (14) custom-made blend of head rice and broken rice moves to bagging station; (15) bagged rice moves to the market; (A) straw, chaff, and empty grains are removed; (B) husk removed by the aspirator; (C) small stones and mud balls removed by destoner; (D) coarse (from first whitener) and fine (from second whitener) bran removed from the rice grain during the whitening process; and (E) small broken rice/brewer's rice removed by the sifter.

1.6. Rice Based Products:

Some Major Rice Based Products Are:

- **Precooked and quick-cooking rices**
- **Rice Noodles**
- **Rice cakes**
- **Fermented rice cakes and**
- **Rice puddings**
- **Rice Flakes**
- **Puffed Rice**
- **Rice Flour**

Nutrient composition per 100 g of selected rice products

Product	**Moisture**	**Food**	**Protein**	**Thiamine**	**Ribo-**	**Niacin**
(g)	**energy**	**(g)**	**(mg)**	**flavin**	**(mg)**	
	(kcal)			**(mg)**		
Instant rice, US	9.6	362	7.5	0.44	-	3.5
Rice, granulated, US[a]	7.4	383	6.0	0.42	0.11	5.8
Kaset rice-soybean infant food, Thailanda	5.2	401	11.0	0.2	0.4	1.0
Baby cereals, rice-based, UK[a]	4.9	386	10.9	1.60	1.20	23.0
Am, thin rice gruel, Philippines	95.9	17	0.1	0.02	0.02	0.4
Rice gruel, Philippines	91.5	30	0.6	0.01	0.01	0.1
Arrozcaldo, rice gruel, Philippines	83.8	63	2.0	0.02	0.03	0.4
Bihon, rice noodles, Philippines	12.4	364	5.0	trace	0.01	0.2
Fermented rice/black gram idli, India	45.0	220	7.6	0.32	0.30	0.9
Puto, fermented rice cake, Philippines	46.6	214	2.8	0.01	0.01	0.4
Chinese waxy rice cake, UK	29.8	290	3.5	trace	0.02	0.9
Bibingka, rice cake, Philippines	41.5	234	3.6	0.12	0.05	0.6

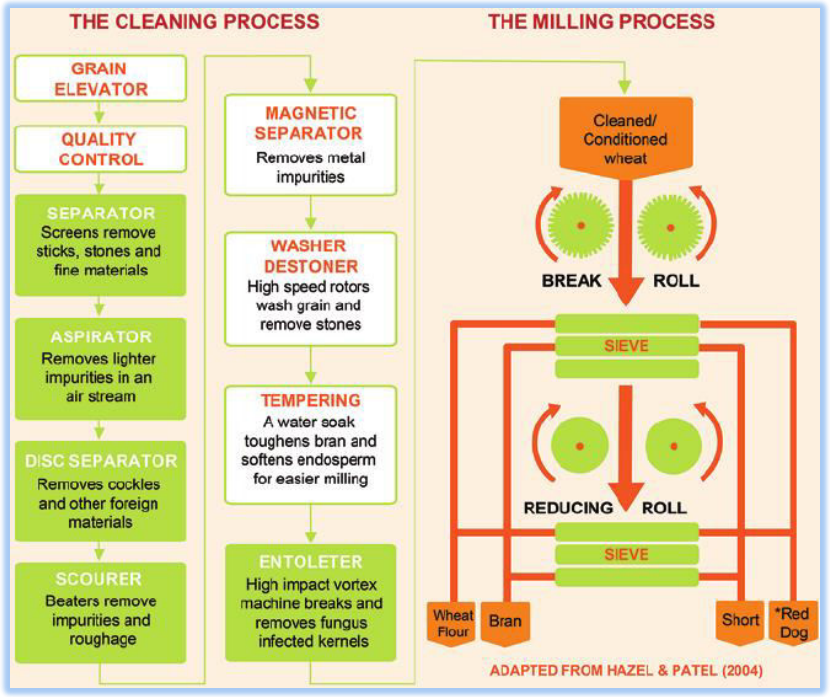
Waxy rice bibingka, Philippines	36.8	256	2.8	0.03	0.01	1.1
Kutsinta, rice cake with lye, Philippines	58.9	167	1.4	trace	0.01	0.2
Suman, waxy rice cake with lye,Philippines	52.3	191	3.2	trace	0.02	0.5
Sumansaibos, waxy rice cake with coconut milk, Philippines	57.5	171	3.1	0.01	0.01	0.3
Tikoy, waxy rice cake, Philippines	37.7	250	2.5	0.02	0.02	0.4
Putobumbong, purple waxy rice cake,Philippines	38.5	251	3.5	0.03	0.01	0.4
Palitaw, waxy rice preparation,Philippines	51.8	206	2.6	0.04	0.02	0.7
Kalamay, waxy rice preparation with coconut syrup, Philippines	48.2	208	2.7	0.01	0.01	0.3
Espasol, waxy rice product, Philippines	25.8	312	4.0	0.06	0.04	1.1
Tamales, rice flour preparation,Philippines	75.2	100	1.3	0.01	0.02	0.4
Puffed rice, US.	3.7	399	6.0	0.44	0.04	4.4
Puffed rice, non-waxy, sweetened	5.6	385	4.5	0.01	0.14	1.6
Puffed rice, presweetened, with cocoa, US[a]	3.4	401	4.5	0.42	0.06	6.3
Pinipig, flattened parboiled waxy rice,puffed, Philippines	3.3	392	3.1	trace	0.04	2.0
Putoseko, toasted rice bread,Philippines	4.8	388	6.0	0.06	0.02	0.5
Rice pudding, canned, UK	77.6	89	3.4	0.03	0.14	0.2
Chicken with rice soup,condensed, US	89.6	39	2.6	trace	0.02	0.6
Japanese sake rice wine, 32 proof	78.4	134	0.5	0	0	0
Chinese rice wine, 34 proof	79.1	132	0	trace	0.01	0.12
Rice flour, UK	11.8	366	6.4	0.10	0.05	2.1
Rice starch	13.8	343	0.8	-	-	-

- [a] With added vitamins and minerals.
  (Sources: Food and Nutrition Research Institute, 1980; Watt and Merrill, 1963; Luh and Bhumiratana, 1980; Holland, Unwin and Buss, 1988.)

Lecture 4

Milling of Wheat and Processes of Wheat Based Products

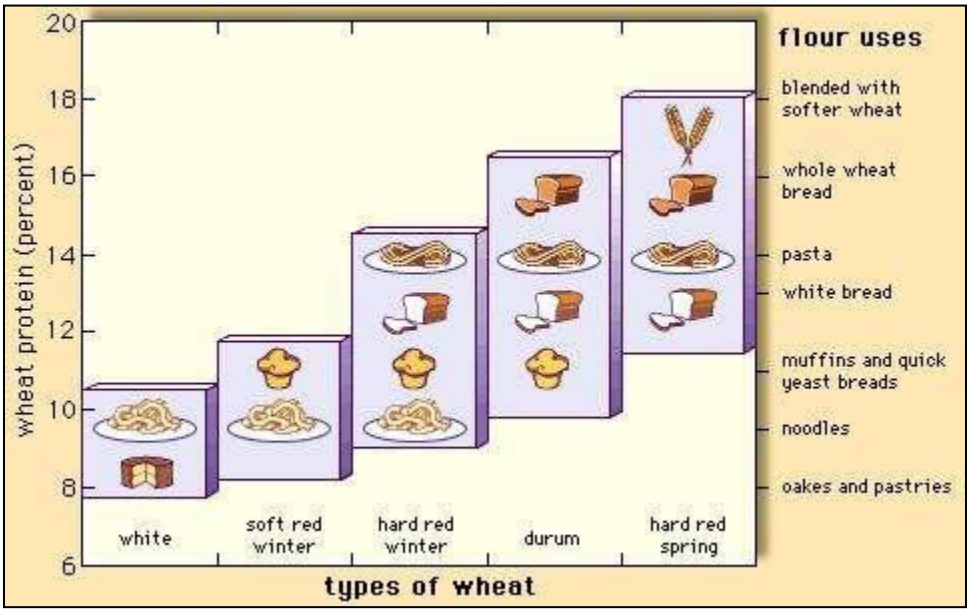
1.7. A Schematic Diagram of Wheat Milling Process:



1.8. Wheat Based Products:

- **Wheat Flour: Composition of Wheat Flour:**

Components	Wt% whole wheat flour	Wt% pearled wheat flour	Wt% barn- free wheat flour
Moisture	12.4	12	10.6
Starch	68.5	70	79.3
TKN	1.9	1.8	2.1
protein	11	10.3	12.3
phosphorus	0.286	0.291	0.174
Magnesium	0.067	0.067	0.019
Potassium	0.572	0.487	0.284
calcium	0.039	0.036	0.021



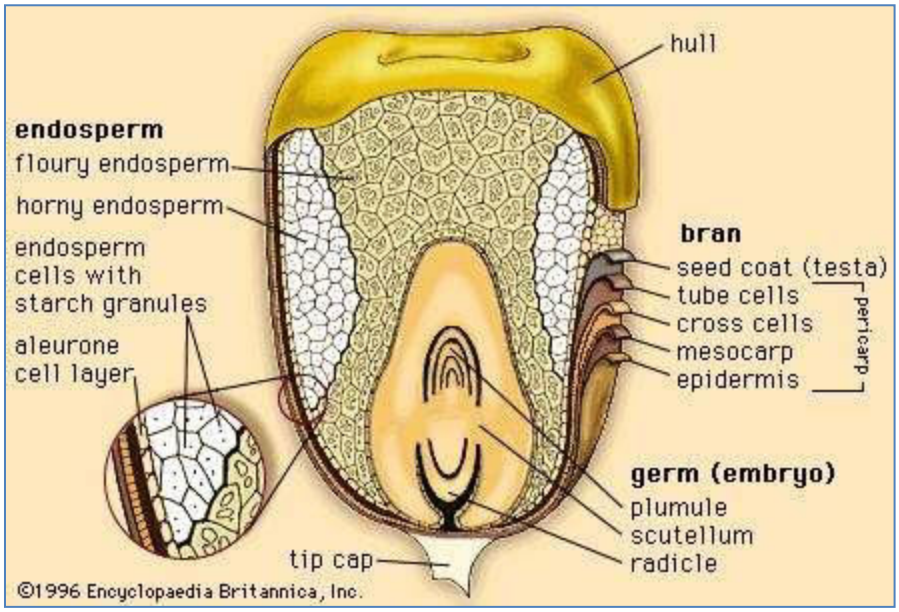
The protein content and major food uses of certain varieties of wheat. (*Encyclopædia Britannica, Inc.*)

Lecture 5

Milling and Utilization of Corn, Barley, Oat and Millets

1.9.1. Corn:

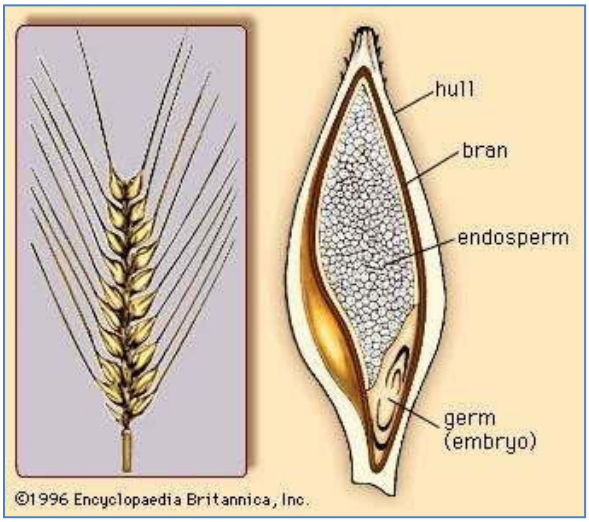
Corn, or maize, a cereal cultivated in most warm areas of the world, has many varieties. The United States, the principal producer of corn, cultivates two main commercial types, ***Zeaindurata*** (flint corn) and ***Z. indentata*** (dent corn). The plant grows to a height of about three metres or more. The corn kernel is large for a cereal, with a high embryo content, and corn oil extracted from the germ is commercially valuable. The microscopic appearance of the starch is distinctive, and the principal protein in ordinary corn is the prolaminzein, constituting half of the total protein. On hydrolysis zein yields only very small amounts of tryptophan or lysine, making it low in biological value. The proteins of corn, like those of most cereals other than wheat, do not provide an elastic gluten. Much of the corn is wet-processed to produce corn flour, widely used in cooking (***see below*** Starch products: Cornstarch). Corn, dry-milled as grits or as meal or turned into flaked corn with some of its starch partially gelatinized, is a popular component in compounded animal feedstuffs. In dry-milled form it is also the basis of human food throughout large areas of Africa and South America. Its nutritive value is limited by its low lysine content. Much recent research has involved development of a corn with higher lysine content. Mutants have been produced containing much less zein but possessing protein with higher than normal lysine and tryptophan contents, sometimes increased as high as 50 percent. These corns, called Opaque-2 and Floury-2, possess certain drawbacks. They are generally lower in yield than dent hybrids, are subject to more kernel damage when combine-harvested, and may be more difficult to process. Nevertheless, these new hybrid corns are expected to become widely cultivated, and the principles involved in their production may also be applied to sorghum, wheat, and rice. Corn is popular for use in breakfast foods.



1.9.2. Barley:

Most of the barley grown in the world is used for animal feed, but a special pure barley is the source of malt for beer production. Barley is also used in the manufacture of vinegar, malt extract, some milk-type beverages, and certain breakfast foods. In addition, in flaked form it is employed in some sections of the brewing industry, and pearl barley (skins removed by emery friction) is used in various cooked foods.

Barley can be cultivated on poorer soil and at lower temperatures than wheat. An important characteristic in barley is “winterhardiness,” which involves the ability to modify or withstand many types of stresses, particularly that of frost. However, barley is subject to many of the diseases and pests that affect wheat.

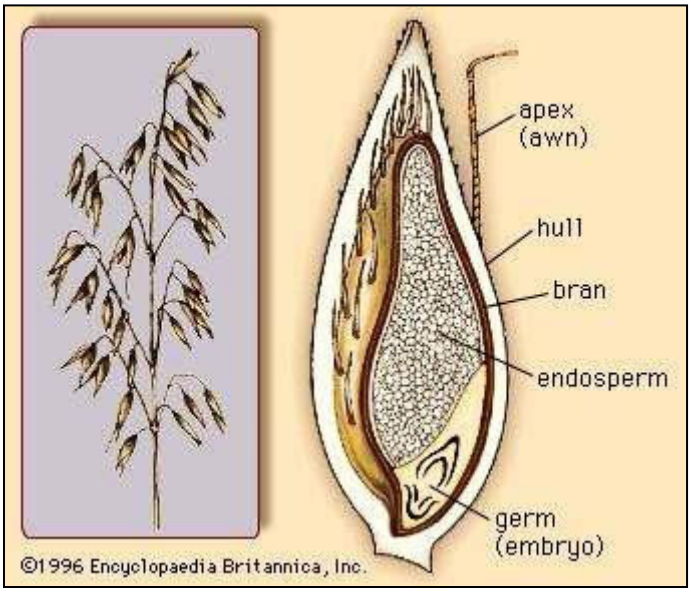


1.9.3. Oat:

Oats belong to the botanical genus ***Avena***, which includes a large number of types, the principal being ***A. sativa***, ***A. sterilis*** and ***A. strigosa***. Oats are widely grown in most countries but are not suitable for Mediterranean climates. Oats are frequently grown on farms as feed for the farm's livestock. They are well balanced chemically, with fairly high fat content, and are particularly suitable for feeding horses and sheep.

Although a large portion of the world's oat production is used for animal feed, oatmeal is a popular human food in many countries. Thin-skinned grains, fairly rich in protein and not too starchy, are selected. Preliminary cleaning is essential for human consumption. The oats are then kilned (roasted). Thin-husked oats yield 60 percent oatmeal; varieties with thick husks yield only 50 percent.

Rapid development of rancidity is a serious problem in oats and oat products. The free fatty acid content must be controlled because formation of these acids tends to produce a soapy taste resulting from the activity of the enzyme lipase. A few minutes of steam treatment normally destroys the lipase activity in the grain.



1.9.4. Millets:

This term is applied to a variety of small seeds originally cultivated by the ancient Egyptians, Greeks, and Romans and still part of the human diet in China, Japan, and India, though in Western countries it is used mainly for birdseed. The genus is termed ***Panicum***. The small seed is normally about two millimetres long and nearly two millimetres broad. The term ***proso*** is one of several alternative names. Japanese barnyard millet is a well-known variety.

Lecture 6

Common Infestation in Grains

1.10. Insect pests of stored grain:

1.10.1. List of some Insect pests which infect the grains:

- Lesser grain borer (***Rhyzoperthadominica***)
- Granary weevil (***Sitophilusgranarius***)
- Rice weevil (***Sitophilusoryzae***)
- Angoumois grain moth (***Sitotrogacerealella***)
- Rust-red flour beetle (***Triboliumcastaneum***)
- Confused flour beetle (***Triboliumconfusum***)
- Saw-toothed grain beetle (***Oryzaephilussurinamensis***)
- Flat grain beetle (***Cryptolestes*** spp.)
- Warehouse moth (***Ephestia*** spp.)
- Indian meal moth (***Plodiainterpunctella***)
- Warehouse beetle (***Trogoderma variable***)

1.10.2. Sources of infestation:

- Fields
- Carried-over commodities, waste and rejects.
- Agricultural machineries
- Processing plants Farm grain stores and re-used sacks
- Means of transportation
- Alternative hibernation sites and hosts

1.10.3. Basic steps for insect control:

In order to control insects in a storage warehouse or processing plants the following steps must be followed:

- **Monitoring** : Have an inspection or surveillance programme which will yield prompt awareness of a possible problem (presence, level, source) before it occurs
- **Identification** : Determine the extent and nature of the possible problem (species, type, level, means of transmission)

- **Control:** Devise a plan for controlling the problem (integration of all possible means to achieve good, cheap and safe pest control)

1.10.4. Types of control measures:

- **Physical and mechanical methods:**
  - ✓ Drying and disinfestations
  - ✓ Reducing inter-granular Space
  - ✓ Coating with clay or oil
  - ✓ Moisture proof, air tight, low cost and low thermal fluctuation structures storage
- **Chemical methods:**
  - ✓ Treatment of grain with contact insecticide
  - ✓ Treatment of grain by fumigation: Methyl bromide, Magnesium or Aluminum phosphide
- **Sanitation**
- **Exclusion**
- **Integrated pest management**

Controlling Infestations:

Stored Grain Insects

Pest and location	Insecticide	Metric	Rate of Measure	Application	Remarks
EMPTY BINS Rusty grain beetle, Red flour beetle Saw-toothed grain beetle, Granary weevil	malathion 500	300ml/5L water	10 fl oz of 50% EC/1 gal water	5 L/100m² (1gal/1000 ft²)	Apply to inside surfaces of bins. Also clean and spray area below perforated floors in bins with air drying systems. Wait one day before filling.
Treatment for stored grain and empty grain bins Rusty grain beetle, rice weevil, granary weevil, Indian meal moth, Mediterranean flour moth, red flour beetle	Diatomaceous earth – Protect-it	5 kg. Bag of powder	100 – 1000 grams/metric tonne of grain depending on insect and crop type		For wheat the Wheat board suggests no more than 100 gms/tonne as a maximum. As the activity of product produces death through dehydration, wait 4 weeks before mixing grain.
FUMIGATION OF GRAIN IN STORAGE	Phostoxin Gastoxin	Ready to use tablets or pellets	Ready to use tablets or pellets	Inject tablets or pellets evenly	Wax coating on pellets prevents release of gas for 4

				throughout grain according to label instructions	hours after opening container. Phostoxin is a very toxic gas; seal granary and post warning signs. Work in pairs. Use only when grain temp. is above 5°C (40°F).
Fumigation Period		Grain Temperature 4°C-12°C 12°-15°C1 16°-20°C	Fumigation Period 10 days 5 days 4 days		Following fumigation, aerate bins for 48 hours or until odor dissipates. Grain can be used for livestock feed following aeration.
CONTROL BY COLD TEMPERATURE	Rusty grain beetles an other stored grain insects can be killed by periods of cold temperatures as follows:				
		Grain Temperature -5° -10° -15°	Time required to kill insects 6 weeks 4 weeks 2 weeks		
	Grain temperatures can be lowered by aeration. Moving grain several times during cold weather may lower temperatures enough to kill insects.				

(Source: Kolach and McCullough, 1992.)

Lecture 7

Principle and Practice of Storage of Cereals

1.11. Principles of Storage of Grains:

a) Conditions of the Grains: Only clean, unbroken kernels should be selected for storage. Now two other elements can be added to this list. The grain should be dry and it should be cool when it is put into storage.

b) Climatic Conditions: Grain stores best in weather which is dry and cool. Unfortunately, the weather is not always dry and cool. During the serious rainy season even well dried grain can

become wet again if it is exposed to very wet air or rain. Since grain must be stored during all kinds of weather the type of storage method chosen must protect the grain from the worst possible weather conditions.

c) Store Conditions: A grain store must perform one task: the store must protect the grain from its natural enemies: mould and fungus, insects, rats, birds, and other animals.

To do this a grain store should have the following properties:

- The store must be dry.
- The store should be cool.
- The store should keep out the sun.
- The store should be clean.
- The store should have no holes or cracks in the roof, walls, or floor.
- The store might need to be treated with insecticide.

Storage Conditions of Some Cereals:

Grain	Relative Humidity (%)							
	30	40	50	60	70	80	90	100
	Equilibrium Moisture Content (%wb*) at 25°C							
Barley	8.5	9.7	10.8	12.1	13.5	15.8	19.5	26.8
Shelled Maize	8.3	9.8	11.2	12.9	14.0	15.6	19.6	23.8
Paddy	7.9	9.4	10.8	12.2	13.4	14.8	16.7	-
Milled Rice	9.0	10.3	11.5	12.6	12.8	15.4	18.1	23.6
Sorghum	8.6	9.8	11.0	12.0	13.8	15.8	18.8	21.9
Wheat	8.6	9.7	10.9	11.9	13.6	15.7	19.7	25.6

* wet basis

Source: Brooker *et al.* (1974)

Lecture 8

Storage Structures

1.12. Conditioning Processes of Cereal Grain:

Advantages of conditioning (drying):

1. Allows for harvesting tough grain and thereby reduces losses from weather and wildlife.
2. Extends available harvest period.
3. Earlier harvest is possible.
4. Drying tough or damp grain can reduce or eliminate spoilage in storage.
5. May improve market grade and acceptability of grain.
6. May afford alternative market outlets for grain.
7. May eliminate necessity of swathing to obtain "dry" grain.
8. May improve malting quality by reducing kernel peeling and cracking during combining. However, most maltsers will not knowingly buy grain which has been artificially dried.
9. Since artificially dried grain usually contains near maximum allowable water content, the extra weight generates more dollars when sold.

Disadvantages of conditioning (drying):

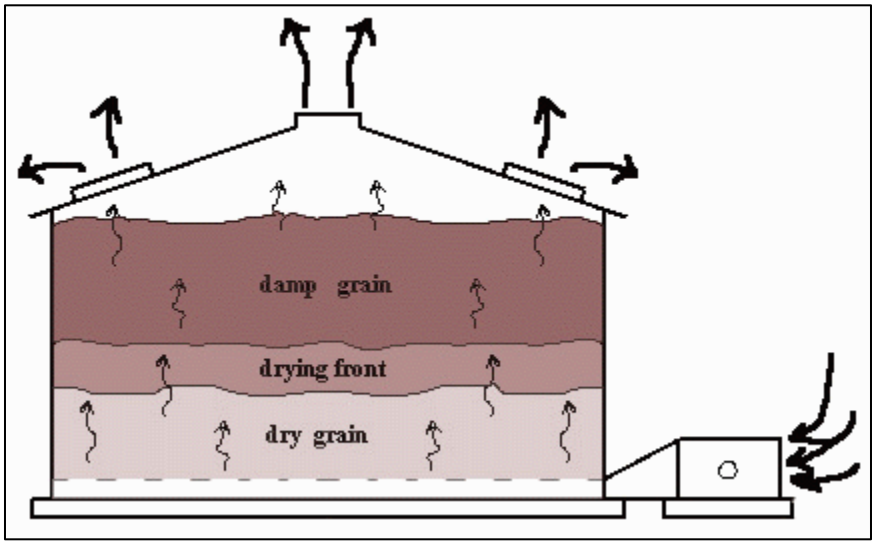
1. Requires extra capital for equipment, energy and operation.
2. Requires extra labor and inconvenience of handling unless centralized facilities are available.
3. Requires some experience to operate effectively.
4. May impair quality of malting barley if not operated properly (low air temperature).

Aeration:

Aeration is the process of ventilating stored grain at low air flow rates with the purpose of maintaining a fairly uniform grain temperature throughout the bin to prevent moisture accumulation at the top (or bottom] layers of the bin due to natural convection. The amount of air required to change the temperature of the grain may not change the moisture content very much. Although aeration is not a grain drying system and should not be considered as such, some drying can occur when the weather is very dry and the fan is run for a very long time. Moreover, the low airflows (1-2 litres/second/cubic metre) used are not sufficient for reliable safe storage unless grain temperatures are near or below 0 °C

Unheated or natural grain drying

In this system, the drying potential of surrounding air is utilized to remove moisture from the grain. It has been viewed as a race to get the grain dried before it spoils. Normally air is forced into the bin from the bottom through a fully perforated floor and exhausted through the roof vents. The moisture transfer from the grain to air takes place in the drying zone (Figure 1).



Unheated air drying

The key to success is to move the drying zone through the top of the grain mass within the allowable storage time. The allowable time for drying is reduced at high grain temperature and moisture content. This means a higher airflow requirement to accomplish drying within the allowable storage for wetter grain. Similarly at higher temperatures, high airflow rates are required to complete drying before grain spoils.

Dry aeration:

Dry aeration is a modification of the system that utilizes heated air drying followed by rapid cooling of the grain in the dryer before transferring to storage. In dry aeration, the hot grain is transferred to a cooling or dry aeration bin. There it is tempered (stored without airflow) for 8 to 10 hours before being slowly cooled. The grain may be transferred to another bin for storage.Thereare three advantages with dry aeration over heated air drying with in-dryer cooling:

- Improved energy efficiencies
- Less danger of grain quality reduction
- Increased drying capacity due to higher drying temperature and replacement of the cooling section by an additional drying section.

In-storage cooling:

The differences between in-storage cooling and dryeration is that when the hot grain is delivered from the dryer to a cooling bin with a partially perforated floor, the fan is started immediately rather than allowing the grain to temper. Tempering is eliminated in order to reduce or eliminate the condensation on the roof and walls. This allows the grain to be stored in the cooling bin rather than being transferred to another bin for storage. In-storage cooling may be an attractive alternative for bins with partially perforated floors, since it allows them to be used for both cooling and final storage.

Heated air grain drying:

Whenever aeration or natural air drying fails to adequately condition grain for storage, a heated air dryer may be incorporated into the harvesting storage system. Compared to natural air drying, the heated air drying absorbs more moisture from the grain thus drying the grain faster. Over drying of a cereal grain however, reduces the weight of grain that will be sold as less water is being sold. Also, it is more expensive in terms of propane costs. These costs must be balanced against how long the wheat has to be safely stored and under what storage conditions.

Solar Drying:

Spreading out a thin layer of grain in the sun is a form of solar drying that has been practiced for many years all over the world and is still being carried out in many tropical countries. However the disadvantages of this system are:

- Uncertainty of success due to variable weather
- Non uniform grain quality.

To circumvent these problems associated with traditional sun drying while still directly using the energy emitted by the sun, solar collectors have been applied in conjunction with a fan, a duct system and a bin in which grain is dried and stored.

Solar grain drying has been investigated in Alberta as one alternative to grain drying but has not proved to be dependable.
This has been attributed to the high cost of collectors and the unreliable sunshine when it is needed for drying. The conclusion has been that in Alberta, both hot air and natural air grain drying are more appropriate than solar grain drying.

The design of solar grain dryers cannot be as precise as for other types of driers because of the diffuse, intermittent and unpredictable nature of solar energy.

Types of Grain Dryers:

Major types of hot air dryers are designed as:

- Bin
- Batch
- Continuous flow

Module II 8L

Lecture 1

Feed for livestock from wheat bran and germ

2.1. Feed for livestock from wheat bran and germ:

Traditionally, the milling of wheat produces flour for human use and appreciable quantities of by-products for animal feeds. The Hard Winter Wheats are generally high in protein, averaging

13-15%, whereas the Soft White Wheats tend to be lower in protein, averaging 11-12%. Hard spring wheats are increasingly grown in Ontario, and, when grown under appropriate cropping practices, may replace hard winter wheat.

Byproducts of wheat include:

- Bran, consisting almost entirely of the outer coatings of the wheat kernels.
- Shorts or Brown Shorts, consisting of bran, germ, flour and tailings. They contain somewhat more flour than midds and have the appearance of a finely ground meal containing somewhat less brownish material than midds.
- Standard Middlings or the Middlings consisting of the fine particles of bran and germ with very little Red Dog.
- Red Dog, sometimes called light shorts; a product from the tail of the mill that consists, chiefly, of the aleuron layer with small particles of bran, germ and flour.
- Germ, consisting of the wheat germ separated in the milling process by grinding.
- Flour which normally goes into human foods.

Species Usage

i) Beef: Feeding wheat to ruminants requires some caution as wheat tends to be more apt than other cereal grains to cause acute indigestion in animals which are unadapted to it. The primary problem appears to be the high gluten content of wheat which in the rumen can result in a "pasty" consistency to the rumen contents and reduced rumen motility. Whole wheat may be efficiently used by cattle, but it's nutritive value is improved by some form of processing. It is generally conceded that its feeding value is optimized by dry-rolling, coarse grinding or steam-rolling to produce a thick flake. Fine grinding of wheat generally reduces the feed intake and is likely to cause acidosis and/or bloat. Never-the-less, when available for feed, it can be substituted equally for corn on the basis of TDN to a maximum of 25% of dry matter intake for beef.

ii) Sheep: Whole-grained wheat intended for adult sheep need not be ground or processed before incorporating into rations since these species chew feed more completely. In the case of early-weaned and artificially-reared lambs, the palatability of whole-grain wheat is improved by pelleting.

Wheat as a Pellet Binder

The glutenous nature of wheat makes it an excellent pelleting aid. 10% wheat in a formula will often enhance pellet durability, particularly in rations with little other natural binder. By-products such as gluten feed and distillers grains are low in carbohydrate which can bind pellets. For this function, hard wheat is required.

Feeding Recommendations for Livestock:

Beef: up to 25% DM Intake

Sheep: up to 35-40% of the grain ration (As-fed basis)

Lecture 2

Production of Starch

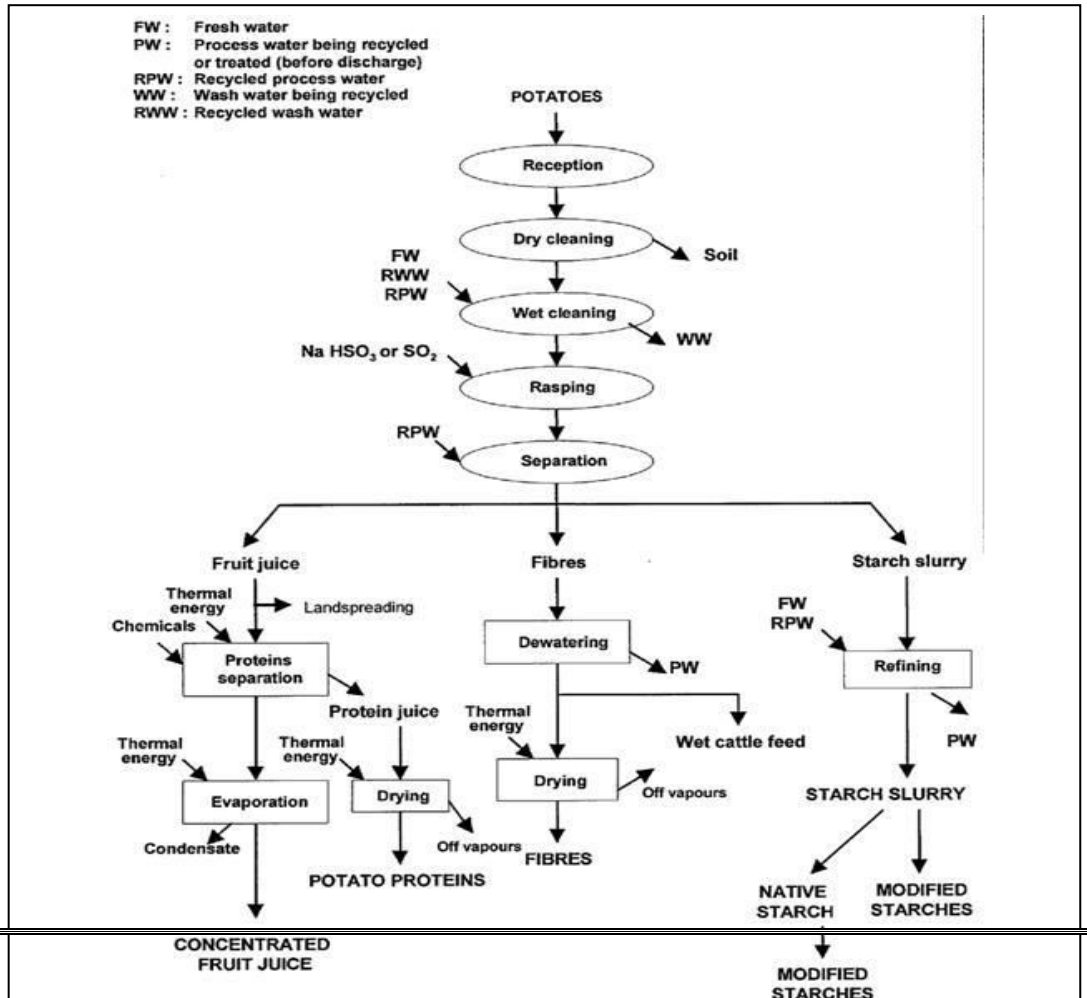
2.2. Production of Starch:

Starch production is an isolation of starch from plant sources. It takes place in starch plants. Starch industry is a part of food processing which is using starch as a starting material for production of starch derivatives, hydrolysates, dextrins.

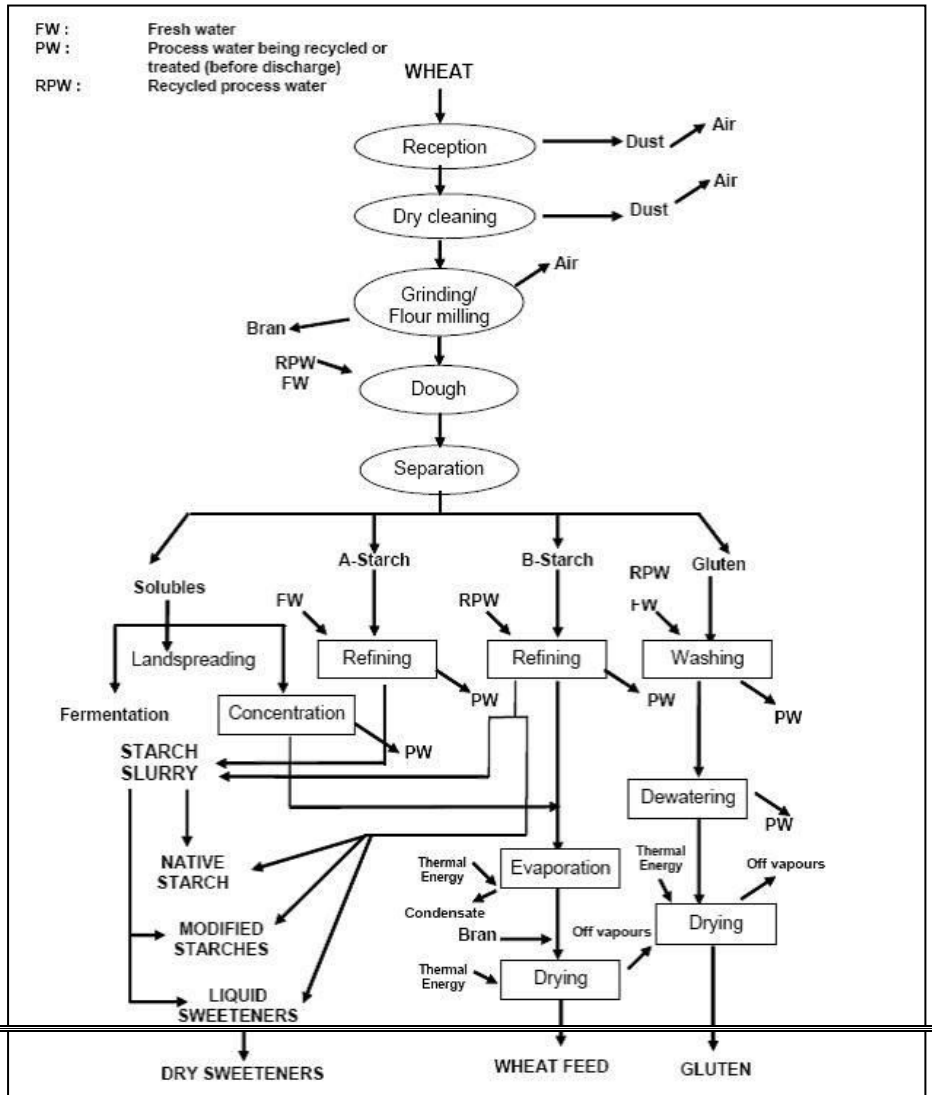
At first, the raw material for the preparation of the starch was wheat. Currently main starch sources are:

- maize (in America) – 70%,
- potatoes (in Europe) – 12%,
- wheat - 8%,
- tapioca - 9%,

Flow-diagram of production of starches potatoes:



Flow-diagram of production of starches wheat:



Lecture 3

Production of Modified Starch

2.3. Production of Modified Starch:

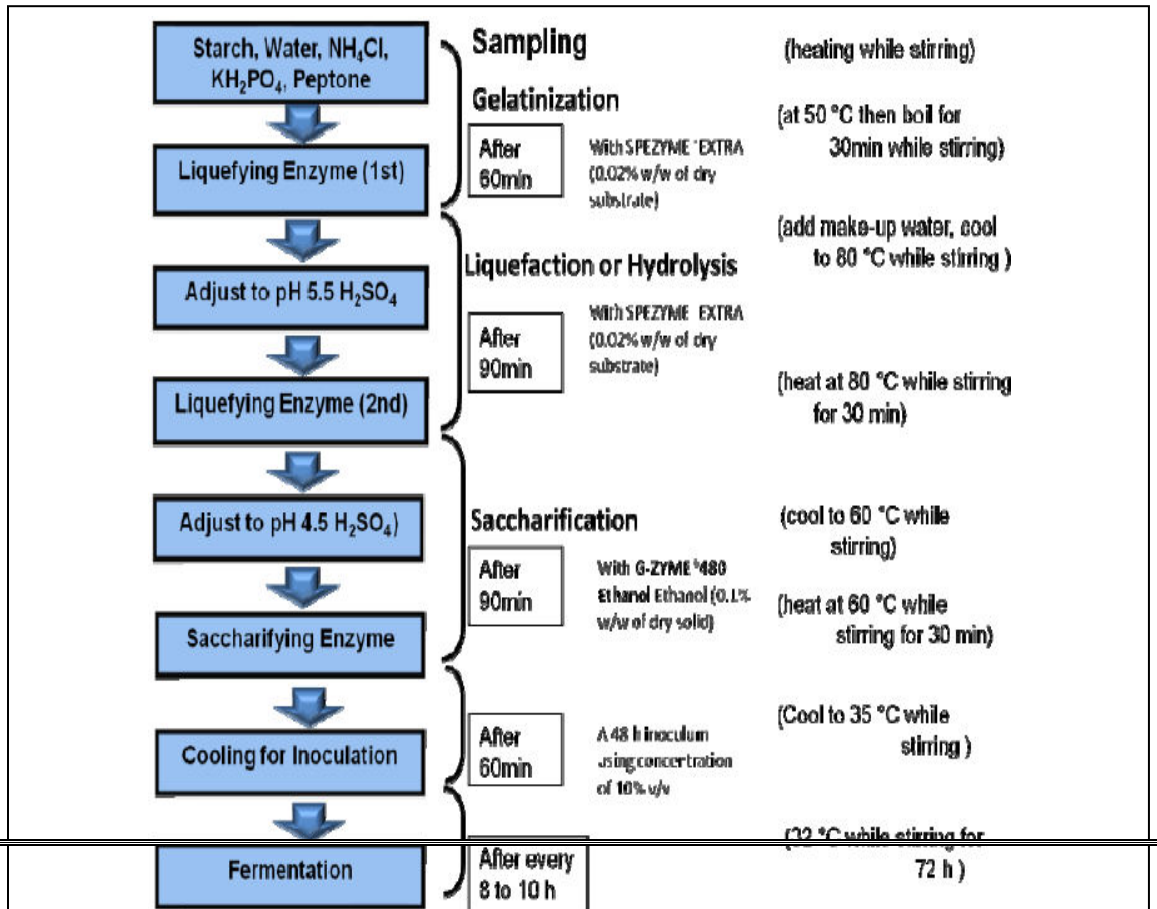
Modified starch, also called starch derivatives, are prepared by physically, enzymatically, or chemically treating native starch to change its properties. Modified starches are used in practically all starch applications, such as in food products as a thickening agent, stabilizer or emulsifier; in pharmaceuticals as a disintegrant; as binder in coated paper. They are also used in many other applications.

Modification Methods:

- **Pregelatinized starch**: It is the simplest starch modification, prepared by cooking the slurry, roll drying, spray drying or, extrusion process. It maintains starch integrity while provide cold water thickening.
- **Cross-linked starch**: Cross linking is the most important modified form that used in industry. It involves replacement of hydrogen bond present between starch chains by stronger, permanent covalent bonds. Distarch phosphate or, adipate are the most commonly used cross-linked starch. Cross-linked starches offer acid, heat and shear stability over the native starch.
- **Oxidized starch:** It is obtained by reaction with sodium hypochlorite or peroxide .These are mainly used as surface sizing agent or coating binder and available in different viscosity grade.

- **Cationic starch**: Cationic starches are produced by reacting native starches with tertiary or, quaternary amines, using wet or dry production processes . They are mainly used in paper forming process.
- **Anionic starch**:Anionic starches are prepared by reaction with phosphoric acid and alkali metal phosphates or by making derivative with carboxymethyl group.
- **Thinned starch**: These are produced through depolymerization reaction by hydrochloric acid or other acids.
- **Acetylated starch**: Starch after treatment with acetic anhydride produces starch esters which are useful in biodegradable applications . In particular, high DS starch acetates provide thermoplasticity, hydrophobicity and compatibility with other additives.
- **Dextrins**: Dextrination is the heating of powdered starch, mostly in the presence of small amounts of acids, at different temperatures and with different reaction times.Dextrins are used as adhesives in paper and textile based industry.
- **Grafted starch**: Grafted starches are produced by free radical copolymerization with ethylenically unsaturated monomers. Starch grafted with synthetic polymers are most utilized starches from different botanical origins were grafted with 1, 3 butadiene, styrene, acrylamide, acrylonitrile and Meth acrylic acid using free redox reaction.
- **Starch ethers**: Starch ethers are produced by a nucleophilic substitution reaction with an ethylenically unsaturated monomer, followed by acid-catalyzed hydrolysis for viscosity adjustment .
- **Physically modified starch**: Native starch can be modified with mechanical treatment, using spray drying technique, annealing technique.
- **Enzyme modified starch:**Starch modified with amylase enzyme produces derivative with good adhesion property and mainly used in coating the food with colorant.

General Flow-Chart of Modified Starch Production:

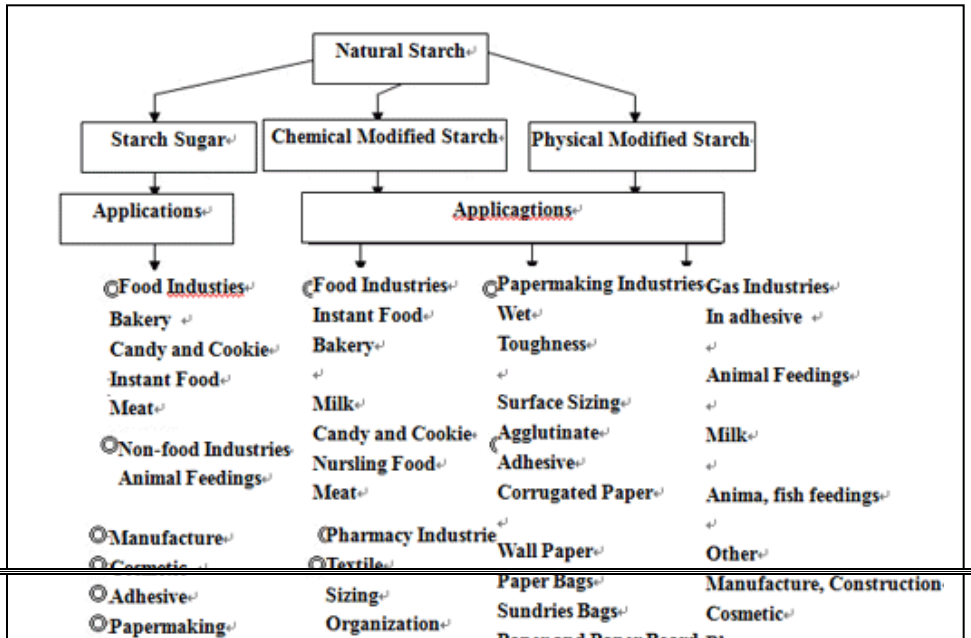


Lecture 4

Applications of Modified Starch

2.4. Applications of Modified Starch:

Applications of Modified Starches:



Applications of Modified Starch in Food Industries:

It has been almost decades since commercial production of starch for food and industrial application was initiated. Native starch is utilized in the food industry in a number of forms, but we shall concerns about modified starches in food industry which is mainly used to enhance paste consistency, thickening, smoothness and clarity and also to impart cold storage stability and freeze thaw stability in comparison to its native counterpart. Most modified starches involve introduction of low levels of substituent group through the interaction of hydroxyl group. Food industry generally recommends modified starches with less degree of substitution (0.2 to 0.0001 or, less) . Modified starches are used in different food types like baked food, baby foods, snacks, confectionaries etc.

- **Frozen Food:** To stabilize the food products starches are used in frozen bottle foods to provide freeze-thaw stability and retrogradation.
- **Flavor Encapsulation**: Modified starches are used to encapsulate or, preserve the flavor of the food products. Octenylsuccinylated derivatives and other starch hydrolyzates are used as flavor encapsulation.
- **Dairy Products**: Modified starches are used in a wider way to the dairy products; it provides variety of effects, including enhanced viscosity, cuttability, mouthfeel and stability. In puddings, starch is used to enhance viscosity and smoothness. Starches are used in yogurts and sour cream to control syneresis and enhance thickness.
- **Canned Food:** Canning process preserves food for up to several years by achieving a temperature sufficient to destroy or inactivate food poisoning or spoilage microbes. Starch is most commonly used to thicken, stabilize and enhance the mouthfeel of canned

foods such as puddings, pie- fillings, soups, sauces and gravies. Highly cross-linked starches are used for this purpose.

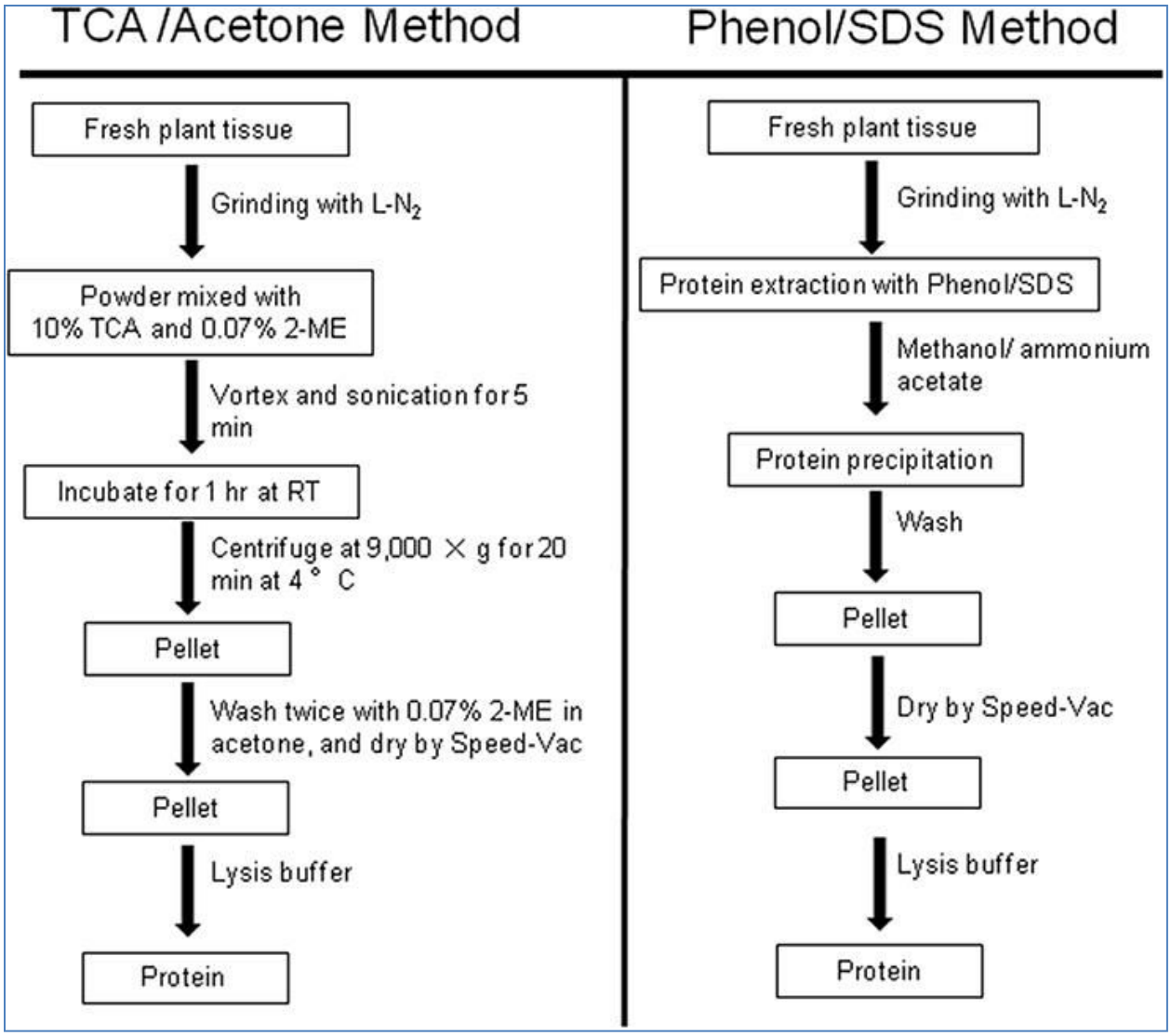
Lecture 5

Extraction of Proteins from Cereals

2.5 Extraction of Proteins from Cereals:

The proteins in cereal seeds are usually classified in four groups according to their solubility criteria: albumins, globulins, prolamins, and glutelins. They can be specifically extracted. A general procedure for extracting the proteins present in green seeds or immature cereal kernels is given. Then several procedures mostly adapted to cereal seeds are reported for: (1) the whole storage proteins (mostly prolamins and glutelins); (2) the albumins-globulins extracted using salt buffer; (3) the amphiphilic proteins extracted using a phase partitioning process; and (4) the proteins strongly attached to or within the starch granules of the seed endosperm.

Flow-Chart of Extraction of Plant Proteins:



Lecture 6

Potato Processing: Production of Potato Chips

2.6. Potato Processing: Production of Potato Chips:

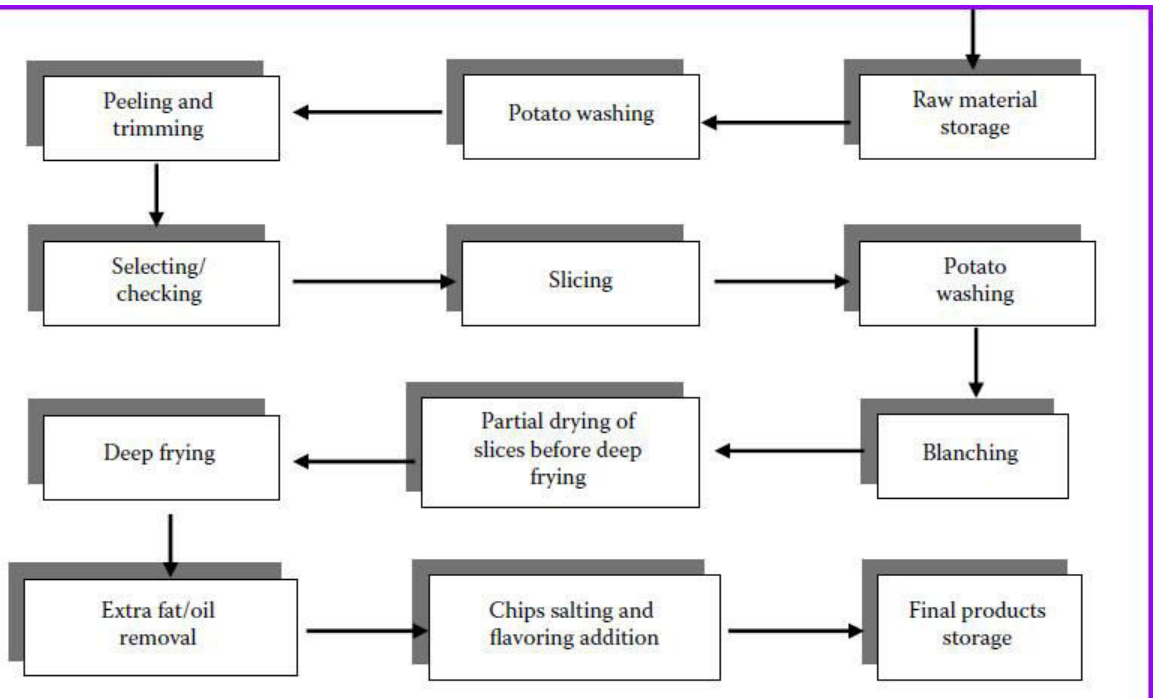
Potato Chips: Potato chips are widely consumed, especially by young people, due to their tastefulness. They are delicious fried foods characterized by a salty taste, crispy texture, and fatty mouthfeel.

Beside potatoes another major raw material of potato chips is frying fat or oil. There are some recommendation of the characteristics of the oil.

Recommended Limits for the Frying Fat/Oil Characteristics

max FFA	2.5%
min smoke point	150°C
max polar materials content	10%–20%
max peroxide value for good quality fat	10–30 meq/kg (after frying: 80 meq/kg)
max totox value	10
max ΔE268 nm for good quality fat	0.10 (after frying: 0.15)

Flow- chart of potato chips production:



Process flow diagram for the production of potato chips.

Note: Slicing is important for quality of chips; slice thickness should range between 0.7 and 1.8 mm (opt. 1.0–1.2 mm). Sliced potatoes are washed to remove starch, sugars, etc., and protect

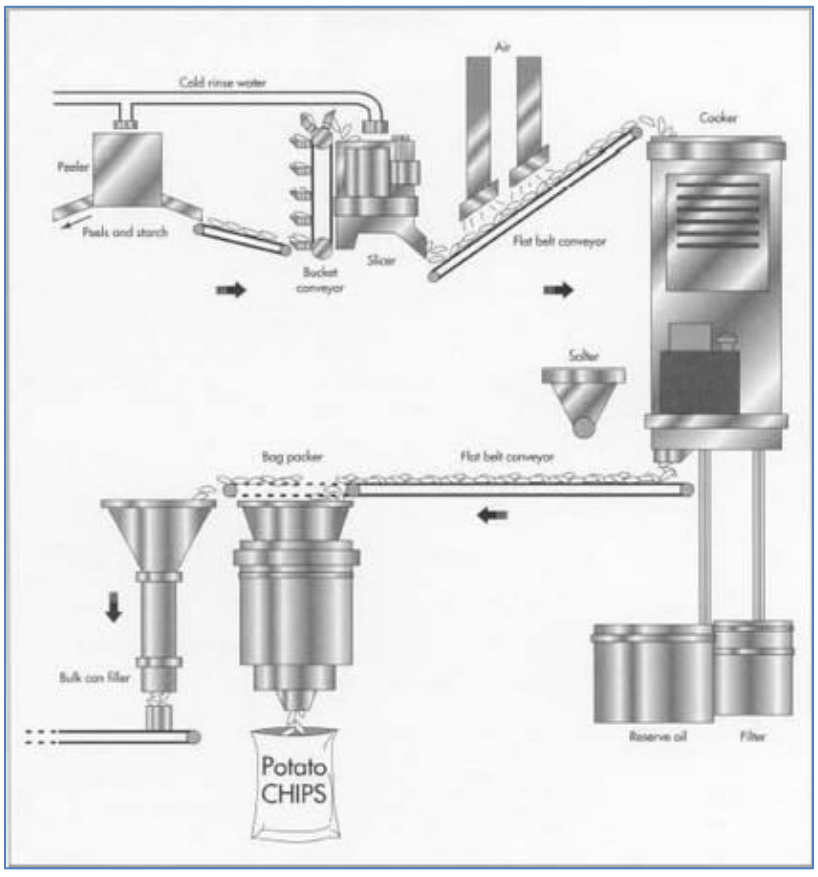
them against browning reactions. This also ensures the production of crispy and light-colored chips. Blanching of chips before frying by immersing them in water or salt solutions (sodium bisulfite) at 65°C–95°C for about 1 min improves their color. After blanching and before frying, partial drying of slices should occur to avoid excessive oil absorption by the product.

Quality Control:

Taste samples are made from each batch throughout the manufacturing process, usually at a rate of once per hour. The tasters check the chips for salt, seasoning, moisture, color, and overall flavor. Color is compared to charts that show acceptable chip colors.

Preventing breakage is a primary goal for potato chip manufacturers. Companies have installed safeguards at various points in the manufacturing process to decrease the chances for breakage. The heights that chips fall from conveyer belts to fryers have been decreased. Plastic conveyer belts have been replaced with wide mesh stainless steel belts. These allow only the larger chips to travel to the fryers and the smaller potato slivers to fall through the mesh.

Equipment of Potato chips Production:



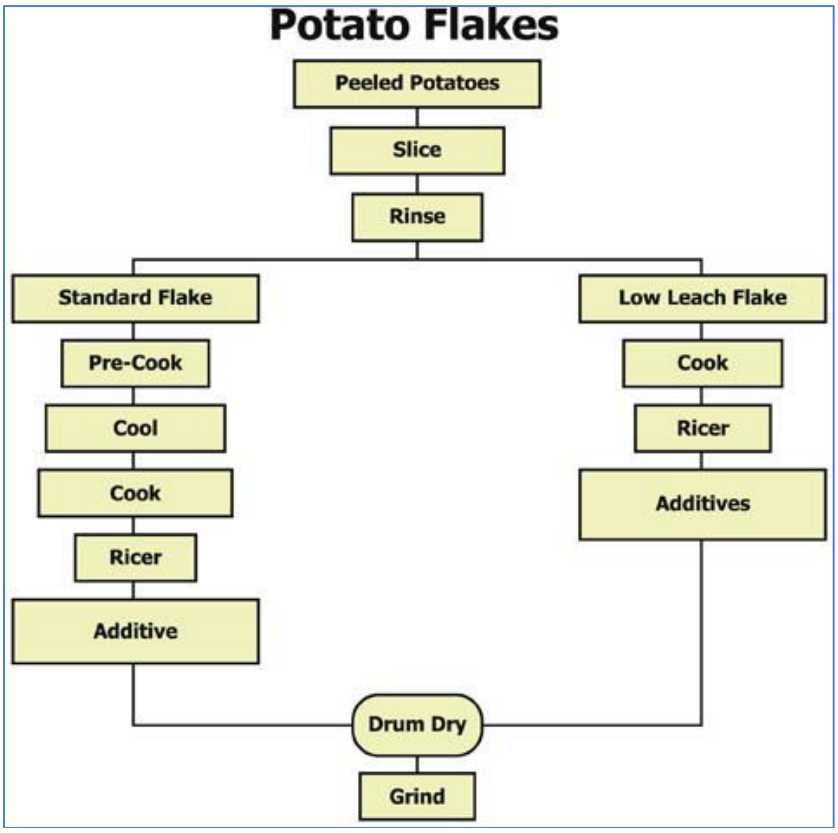
Lecture 7

Production of Potato Flakes

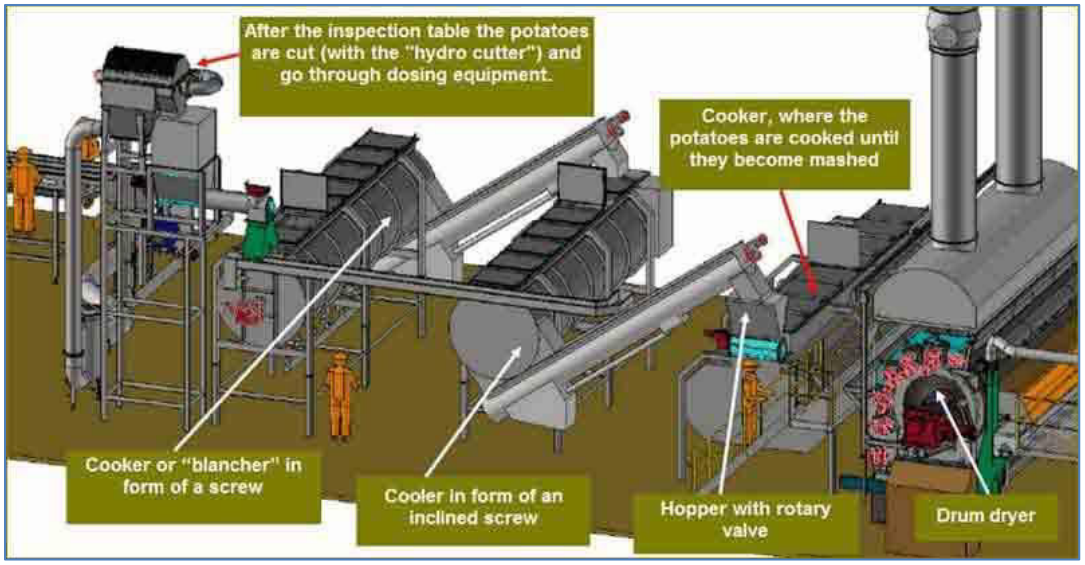
2.7. Production of potato flakes:

Potato Flakes: Potato flakes are flat chunks of dehydrated mashed potato. Potatoes are cooked and mashed, then crushed by rollers on the surface of a drum. The mashed potato is fast-dried until its humidity reaches the desired level, then the layer of dried, mashed potato is scraped from the drum. This sheet is broken up by a mill sifter, and the resulting flakes are then packed. Although many of the potato cells are broken during production, the texture of the reconstituted product is kept firm by blanching, subsequent cooling, and the use of an additive, a monoglyceride emulsifier.

Flow-Chart of Potato Flake Production:



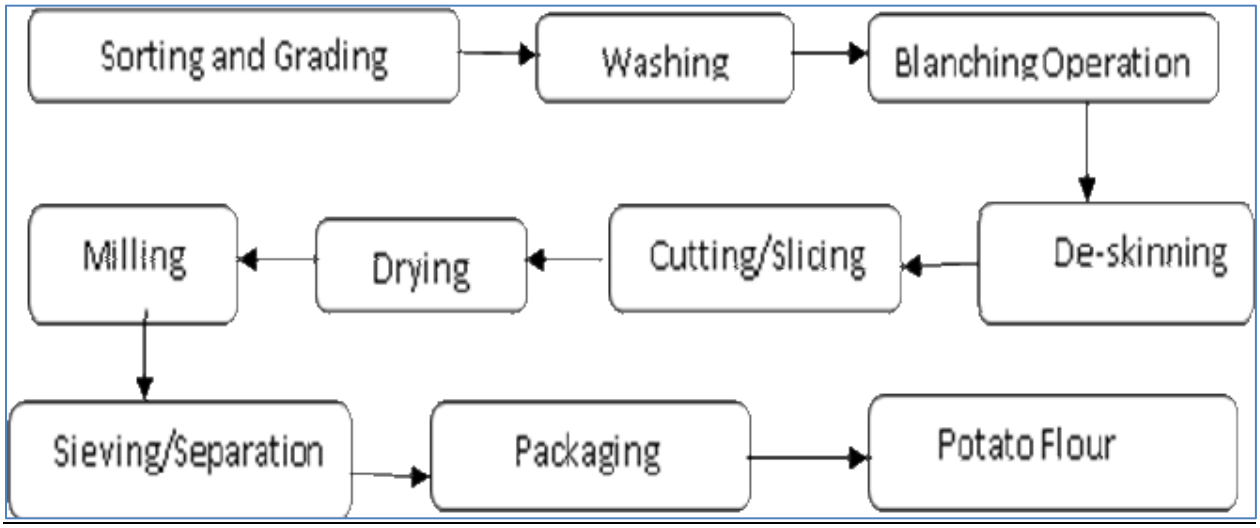
Equipment used in Potato Flakes Production:



Lecture 8

Production of Potato Powder

2.8. Production of potato powder:



Module III 8L

Lecture 1

Handling and Quality Assessment of Fruits & Vegetables; Storage of Fruits & Vegetables

3.1. Post-Harvest Technology:

Post-harvest technologies constitute an inter-disciplinary science and techniques applied to agricultural commodities after harvest for the purpose of preservation, conservation, quality control/enhancement, processing, packaging, storage, distribution, marketing, and utilization to meet the food and nutritional requirements of consumers in relation to their needs.

Importance of Post-Harvest Technology:

- to maintain quality (appearance, texture, flavor and nutritive value)
- to protect food safety,
- to reduce losses between harvest and consumption.

Quality Assessment of Fruits and Vegetables:

The following qualities are assessed:

1. Textural quality

2. Flavour

3. Nutritional Value

3.2. Storage of Fruits and Vegetables

Fruits and vegetables are highly perishable in nature. To extend their post-harvest availability, it is essential to store them under proper storage conditions. So as to increase the shelf life of fresh fruits and vegetables, they should be harvested at proper stage of maturity. Pre-cooling and post-harvest treatments such as application of fungicides, bactericides, growth regulators, wax immulsions, ethylene absorbents, anti-transpirants, senescence retardants are also of almost importance , to extend the marketable life of harvested horticultural commodities. There are different types of storage as briefly detailed below:

1. Ambient Temperature Storage:

Storage at room temperature.

2. Cold Storage:

Storage of the fruits and vegetables at the temperature lower than ambient temperature. The low temperature requirement varies from crop to crop. If the fresh fruits and vegetables are

stored at the temperature below their optimum low requirement, develop chilling injury and therefore, loose the marketability. The fruits stored at low temperature exhibit more shelf life than those stored at ambient temperature. The cold storage requirement and storage life of fruits and vegetables are given in following tables.

Cold Storage Requirement and Storage Life of Fruits:

Sr.No	Name of Fruit	Storage Temp	R.H%	Approximate Life
1	Cashew apple	0-1.5	85-90	4-5 Weeks
2	Mangoes	7-9	85-90	4-7 Weeks
3	Oranges (Mosambi)	4-7	85-90	4 months
4	Pomegranate	0-1.5	80-95	4-6 weeks
5	Sapota	1.5-3.0	85-90	6-8 weeks

Cold Storage Requirement and Storage Life of Vegetables:

Sr.No	Name of Fruit	Storage Temp	R.H%	Approximate Life
1	Cabbage	0 -2.5	90-95	3-4 month
2	Potato	0 -2.5	85-90	4 months
3	Peas	0 -2.5	85-90	1 -3 weeks
4	Okra	7.5	90-95	7-10 days
5	Tomato ripe	4.5-10	85-90	4-7 days

Cold Storage:

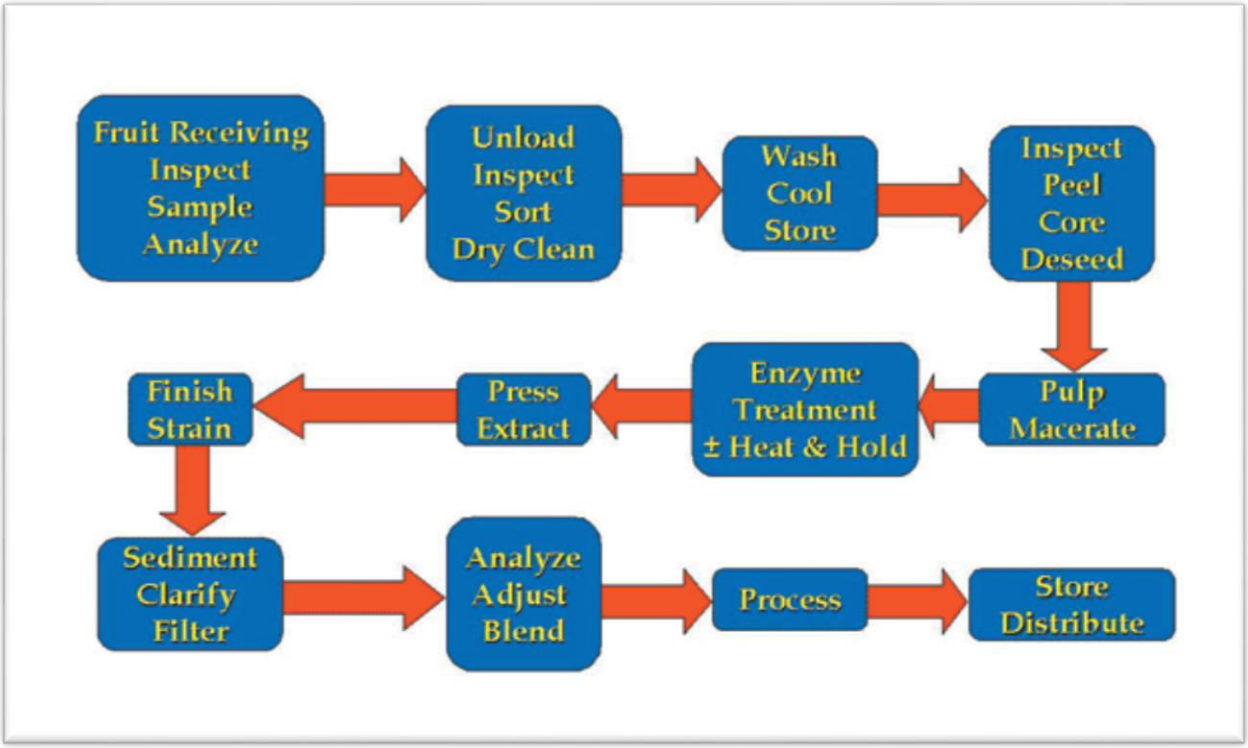
The successful cold storage of fruit depends on a number of factors. Cold storage involves many physiological and biological problems. In the storage of fruits, it is always described to prolong ripening for as long as long possible and to delay the breaking down processes. Even after harvesting of the fruits the process of respiration continues and brings about ripening change in colour softening of flesh, increase in sugar content and development of flavour. These changes occur more rapidly at higher temperatures. This means that the lower the temperature of storage the longer would be the storage life of the fruit, but the fruit is disorganized resulting in physiological injuries such as development of pitting on the skin, change of colour and internal breakdown.

Lecture 2

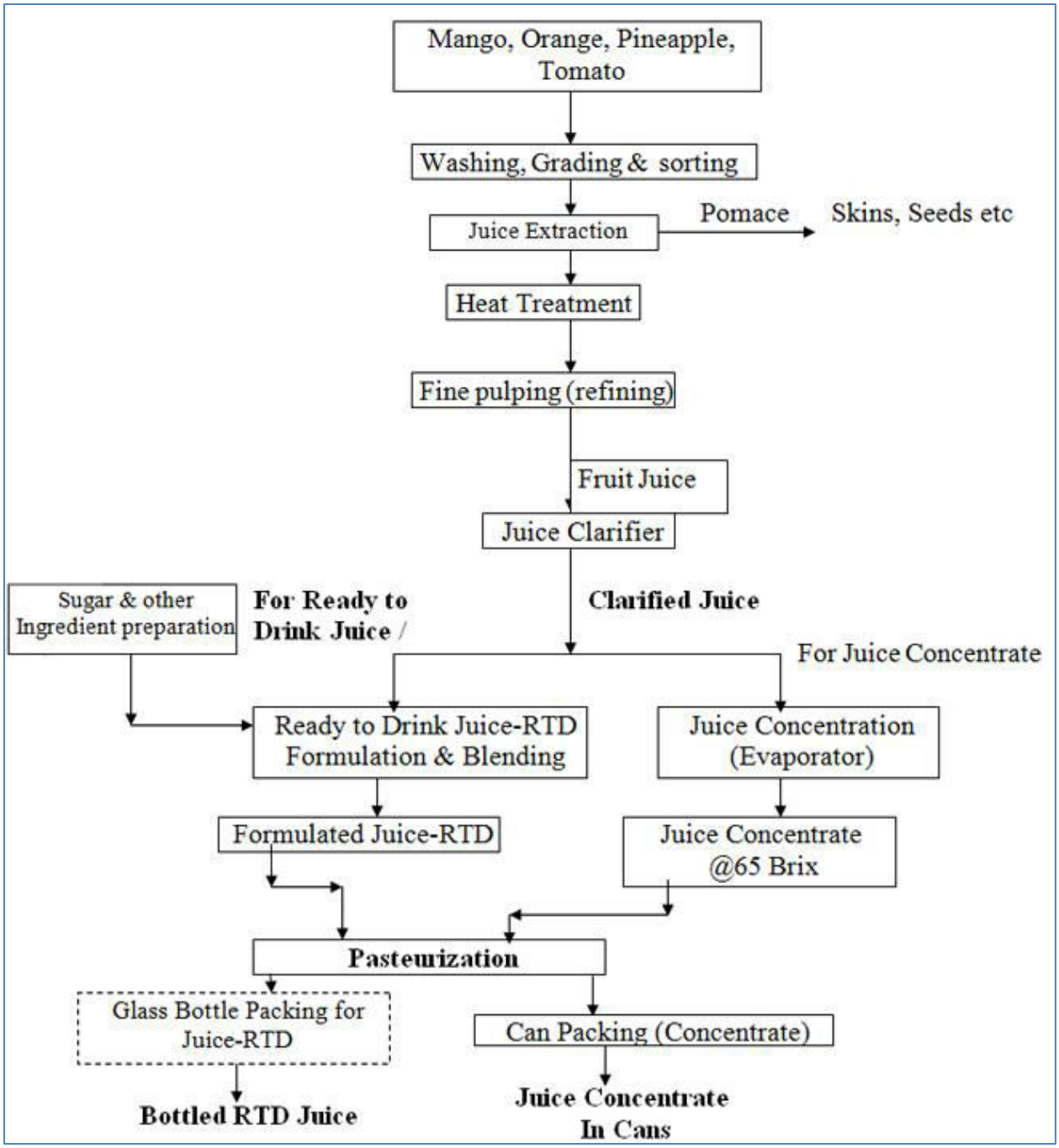
Production of fruits and vegetable juices/puree/nectar

3.3.1. Production of Fruits and Vegetable Juice:

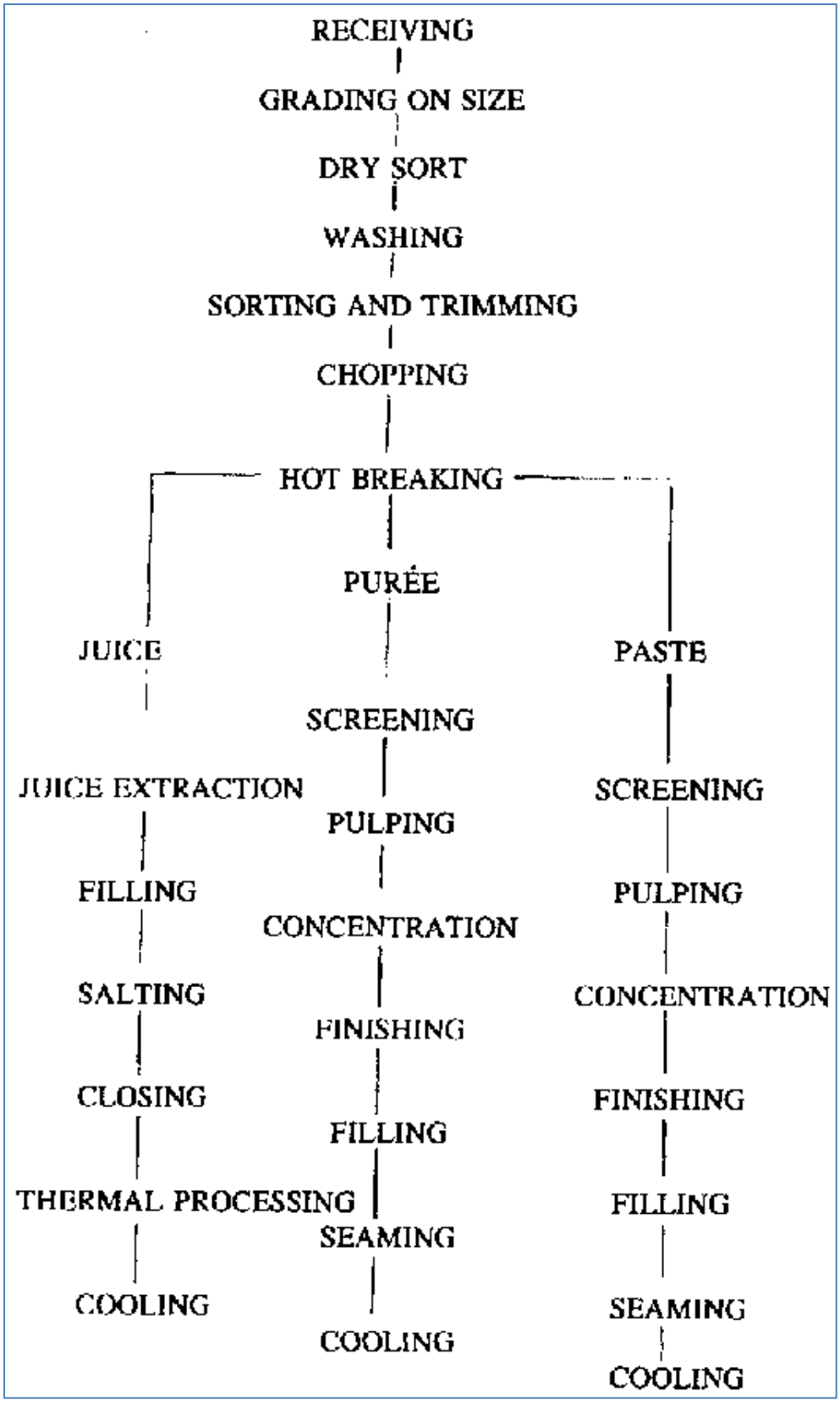
General Procedure of Fruit Juice Production:



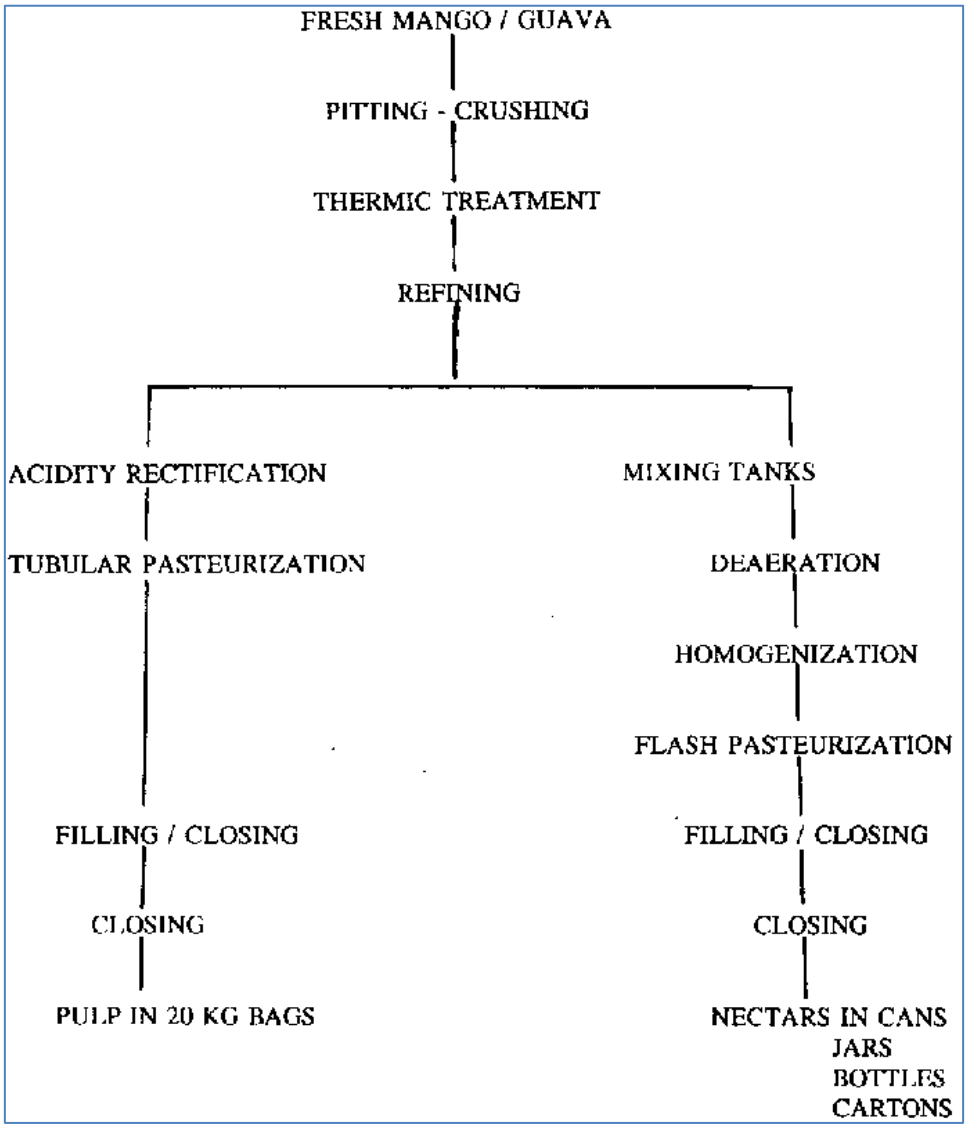
Flow Chart of Fruit Juice Production:



3.3.2. Production of Fruits and Vegetable Puree:



3.3.3. Production of Fruits and Vegetable Nectar:



Lecture 3

Production of Intermediate moisture foods from fruits : jam, jelly;

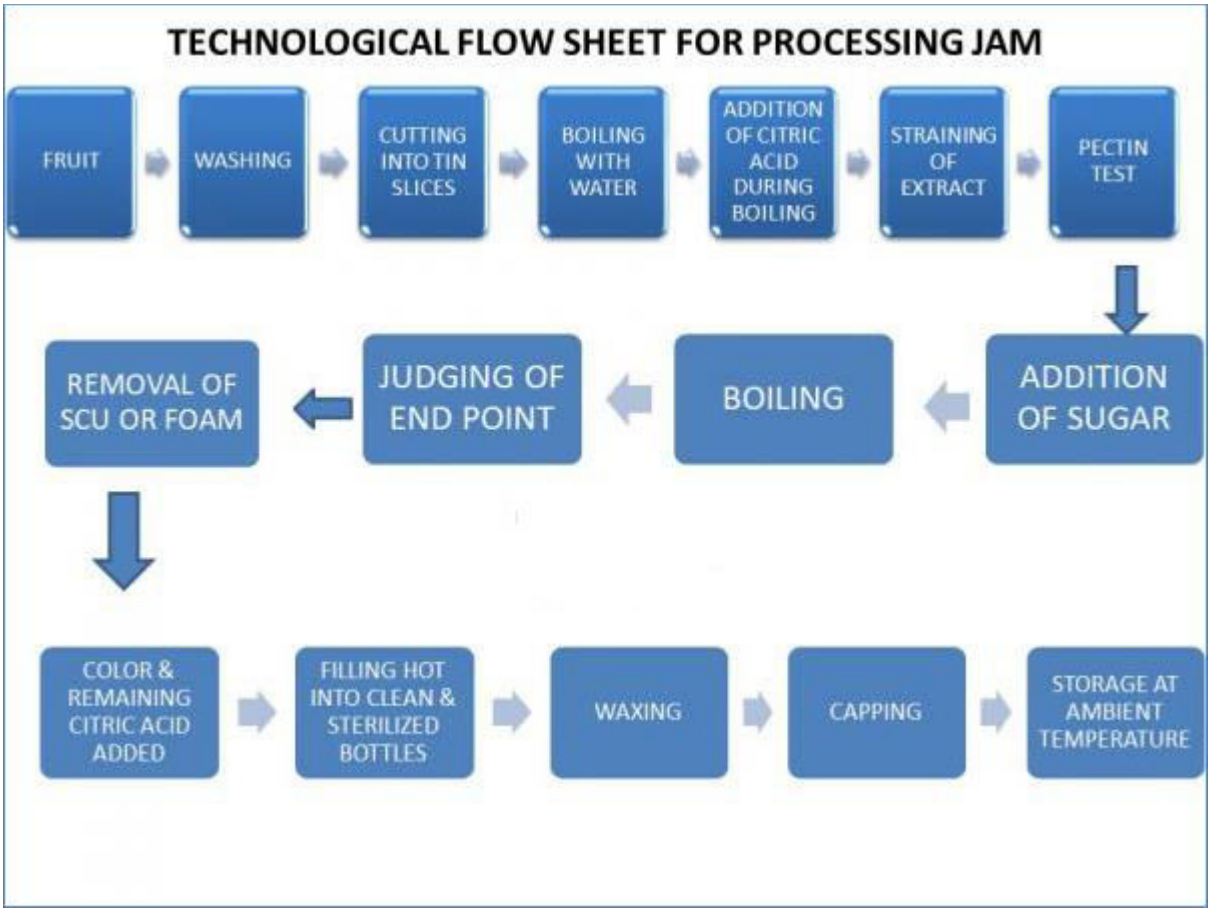
3.4.1. Production of Fruit Jam:

Definition of Jam: Jam means the product prepared from sound, ripe, fresh, dehydrated, frozen or previously packed fruits including fruit juices, fruit pulp, fruit juice concentrate or dry fruit by boiling its pieces or pulp or puree with nutritive sweeteners namely sugar, dextrose, invert sugar or liquid glucose to a suitable consistency. It may also contain fruit pieces and any other ingredients suitable to the products. It may be prepared from any of the suitable fruits, singly or in combination. It shall have the flavour of the original fruit(s) and shall be free from burnt or objectionable flavours and crystallization.

FSSAI specifications for jam production:

Content	Concentration
Fruit Pulp	45%
TSS(Total soluble solids)	65%
Citric acid	5g
Preservative	40 ppm of SO_2

General flow-chart for production of fruit jam:



Problems in jam production :

- Crystallization
- Sticky or gummy jam
- Premature setting
- Surface graining and shrinkage

3.4.2. Production of Fruit Jelly:

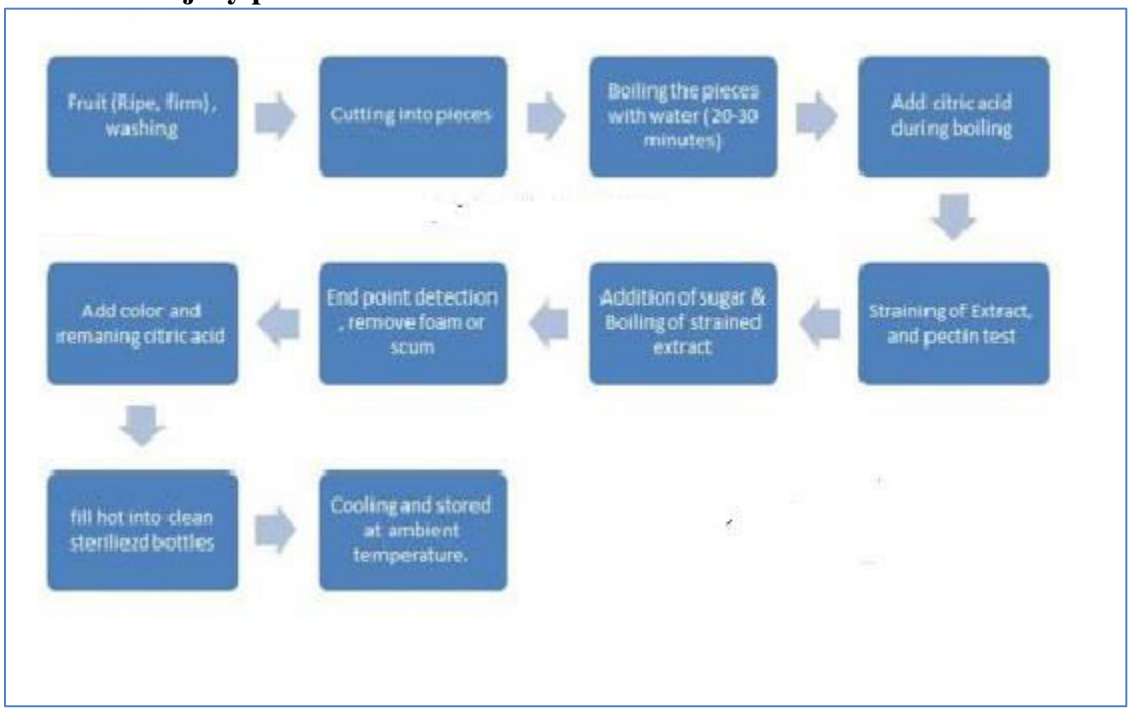
Fruits such as orange, mango, berries, apple, banana, papaya are mostly utilized for jelly and marmalade making.Fruit Jelly means the product prepared by boiling fruit juice or fruit (s) of sound quality, with or without water, expressing and straining the juice, adding nutritive sweeteners, and concentrating to such a consistency that gelatinization takes place on cooling. The product shall not be syrupy, sticky or gummy and shall be clear, sparkling and transparent.

Jelly Should Have Following Requirements:

- Total soluble solids not less than 65%
- Fruit content should not less than 45%

An important consideration in the jelly making is pectin, acid content, sugar content, and end point detection. Pectin is present in the form of Calcium Pectate which is responsible for firmness in fruits. Under suitable conditions, pectin forms a gel with sugar and acid. Both immature and over ripe are not suitable for jelly.
The pH and sugar are important parameters for settling of jelly. The amount of pectin can be determined by alcohol test or jelmeter test which helps to indicates how many parts of sugar are to be added to one part of juice. The final jelly should contain at least 0.5 % acid but not more than 1%because more amount of acid leads to syneresis in jelly. Sugar imparts sweetness as well as body. If the level of sugar is high jelly retains less water which results in stiff jelly because of dehydration. Prolonged boiling of jelly leads to inversion of sugar and destruction of pectin. The end point of boiling can be judged by sheet or flake test, drop test, or temperature test.

Flowchart of jelly production:



Problems in Jelly Making :

1. Failure to set- more amount of sugar, lack of acid /pectin, coking below or above end point leads to settling problem in jelly.
2. Cloudy or foggy jellies are due to non clarified extract, immature fruit for jelly making, scum is not removed.
3. An excessive amount of sugar leads to the formation of crystals in jelly.

4. Syneresis of jelly is caused due to excess of acid, low concentration of sugar, fermentation of sugars etc.

Lecture 4

Production of Intermediate moisture foods from fruits : marmalade, leathers, candy

3.4.3. Production of Fruit Marmalade:

Marmalade means a product prepared by boiling sound fruits with peel, pulp and juice, with or without water, added nutritive sweeteners and concentrating to such a consistency that gelatinization takes place on cooling of the product. It shall not be syrupy, sticky or gummy and shall be clear and transparent.

It can be produced from kumquats, lemons, limes, grapefruits, mandarins, sweet oranges, bergamots, and other citrus fruits, or any combination of them.

The specific requirements are as follows:

- Total soluble solids (m/m) - Min. 65.0 %
- Fruit content except peel (m/m) - Min. 45.0 %
- Peel in suspension - Min. 5.0 %

Marmalades are classified into:

1. Jelly marmalade

2. Jam marmalade

The method of preparation for jam marmalade is practically the same as that for jelly marmalade. In this case the pectin extract of fruit is not clarified and the whole pulp is used. Sugar is added according to the weight of fruit, generally in the proportion of 1:1. The pulp-sugar mixture is cooked till the TSS content reaches 65 per cent.

Problems in marmalade making: Browning during storage is very common which can be prevented by addition of 0.09 g of KMS per kg of marmalade and not using tin containers. KMS dissolved in a small quantity of water is added to the marmalade while it is cooling. KMS also eliminates the possibility of spoilage due to moulds.

3.4.4.Production of Fruit Leather:

Definition: Fruit Leathers - general information Fruit leathers are dried sheets of fruit pulp which have a soft, rubbery texture and a sweet taste. They can be made from most fruits, although mango, apricot, banana and tamarind leathers are amongst the most popular. Leathers can also be made from a mixture of fruits. Fruit leathers are eaten as snack foods instead of boiled sweets. They are also used as ingredients in the manufacture of cookies, cakes and ice cream. The preservation of fruit leathers depends on their low moisture content (15-25%), the natural acidity of the fruit and the high sugar content. When properly dried and packaged, fruit leathers have a shelf life of up to 9 months.

Steps of Fruit Leather Preparation:

- **Preparation of the fruit:** Fruit should be washed in clean water, peeled and the stones removed. Washing water can be chlorinated by adding 1 teaspoon of bleach to 4.5 litres of water. All fruit should be ripe and free from bruising. Any rotten or bruised fruit should be thrown away as this will spoil the colour and flavour of the leather. Pineapple contains an enzyme that damages the skin. Therefore, gloves should be worn when handling pineapple. The puree must be heated to a higher temperature for a longer time to destroy the enzyme (it must be boiled for 20 minutes). Bananas have a low level of acidity and turn brown very rapidly after peeling and cutting. To prevent this, they should be immersed in water containing sodium metabisulphite (400 parts per million of sulphur dioxide) immediately after peeling. Soft fruit, such as berries and apricots, are delicate and should be handled carefully to avoid bruising. Only stainless steel knives should be used to chop the fruit. Other metals will discolour the fruit flesh.
- **Preparation of the fruit pulp/puree**: At the simplest level, fruit is made into a puree by hand using a food mill or mouli legume. If electricity is available, a liquidiser or blender can be used to increase the production output. The liquidised fruit is strained or sieved to remove fibres, seeds etc and make a smooth puree. Fruit puree can be semi-processed and stored in sealed drums for further processing later in the season. Sulphur dioxide (SO_2) (600ppm) is added to the drums to prevent the growth of microorganisms. The semi-processed fruit can be stored for several months.
- **Added Ingredients:** Chemical preservatives may be added to the fruit puree to maintain a bright colour in the leather. Preservatives are also added if the puree is to be stored before processing. A variety of ingredients can be added to the fruit puree - sugar to increase the sweetness, citric acid to increase the acidity and chopped nuts, coconut or spices to vary the taste and flavour.
- **Heating:** The puree must be heated to 90^0C to inactivate the enzymes and reduce the level of microbiological contamination. A double pan boiler is recommended for heating to avoid burning the puree.

- **Drying:** The fruit puree is poured in a thin layer (3-6mm thick) on plastic trays or wooden trays lined with greaseproof paper. The puree can be poured into a square which is later cut into small pieces, or into small circles which are rolled up when dry. The leathers should not be dried in direct sunlight as this will cause the colour to fade and reduce the levels of vitamins A and C. Indirect solar dryers or mechanical dryers should be used. The leather should be dried overnight in a solar dryer or for about 5 hours in a mechanical dryer. After this time it is turned over and dried on the other side. The leather is dried until it has a final moisture content of 15-25%. After drying, the leather pieces should be dusted lightly with starch to prevent them sticking together.
- **Packaging:** Fruit leather is usually sold as a roll that is interleaved with greaseproof paper to prevent it from sticking together. Strips of the leather are weighed, laid on a piece of greaseproof paper and rolled with the paper. The rolls or discs of leather are packed in polythene or polypropylene heat-sealed bags. The bags should be placed in boxes to protect them from the light.

3.4.5. Production of Fruit Candy:

Definition:

A fruit impregnated with cane sugar and glucose and subsequently drained and dried is called "Candied Fruit."TutiFruiti is a candy like product prepared from raw papaya.

Material:

Raw papaya, Sugar, Citric Acid, Peeling knife, Cutting knife, Coring knife, etc.

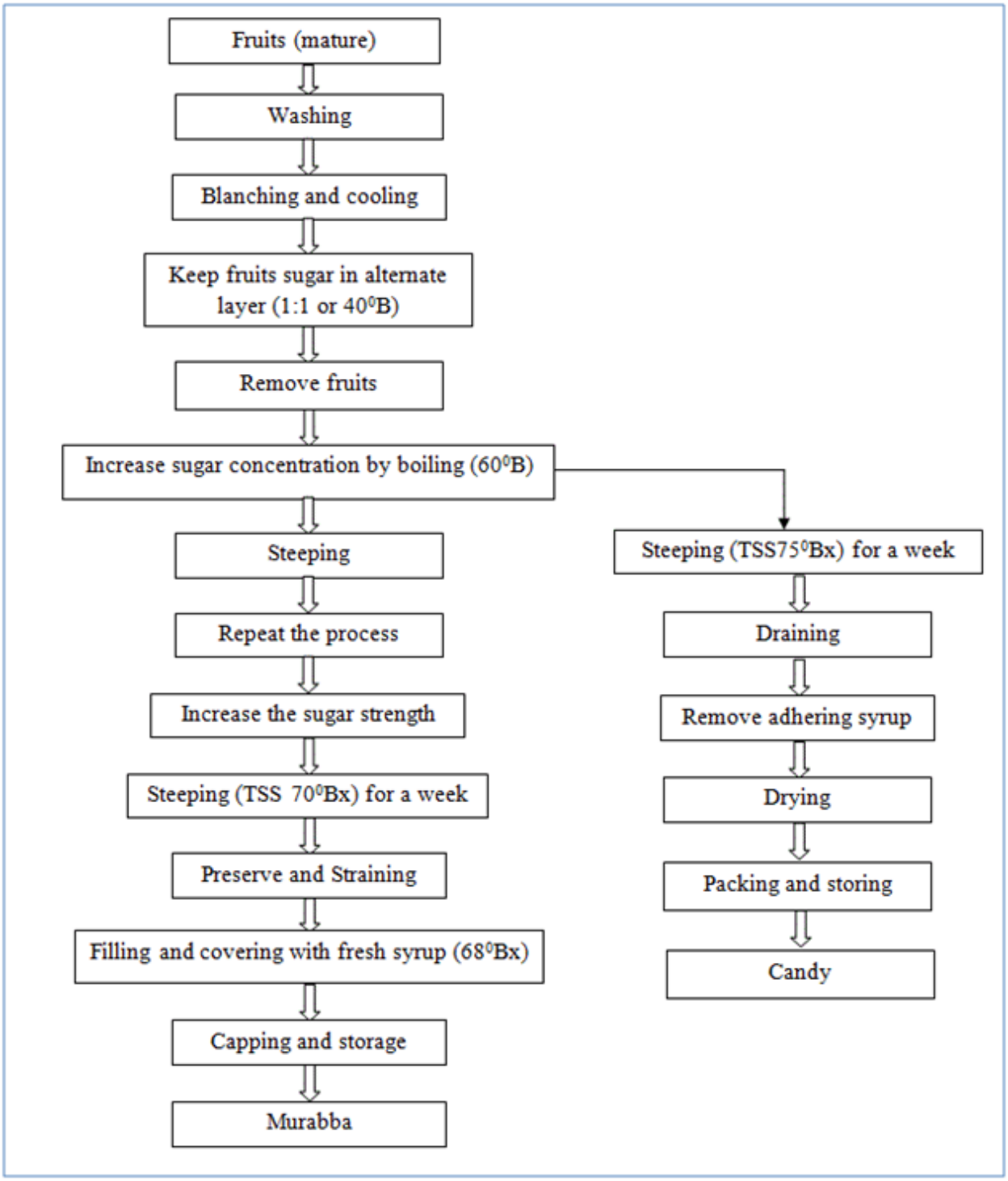
Procedure of Preparation of Candy:

Raw papaya fruits were selected. After washing, the fruits were peeled, cut into two halves and seeds removed. The halves were cut into uniform size bits (0.9 X 0.9 X 0.7 cm) and boiled in water (1:2 ratio) for 5-10 minutes and cooled in cold water.

Sugar, amounting to half the weight of the prepared fruit was placed in alternate layers and allowed for 24 hours. On next day, half the sugar of previous is added to raise the T.S.S (Total Soluble Solid) and cooked. During final cooking, remaining sugar and 1% Citric acid were added.

The syrup was finally drained and the Tuti –Fruiti was dried in air at room temperature.

Flow-Chart of Fruit Candy Preparation:



Lecture 5

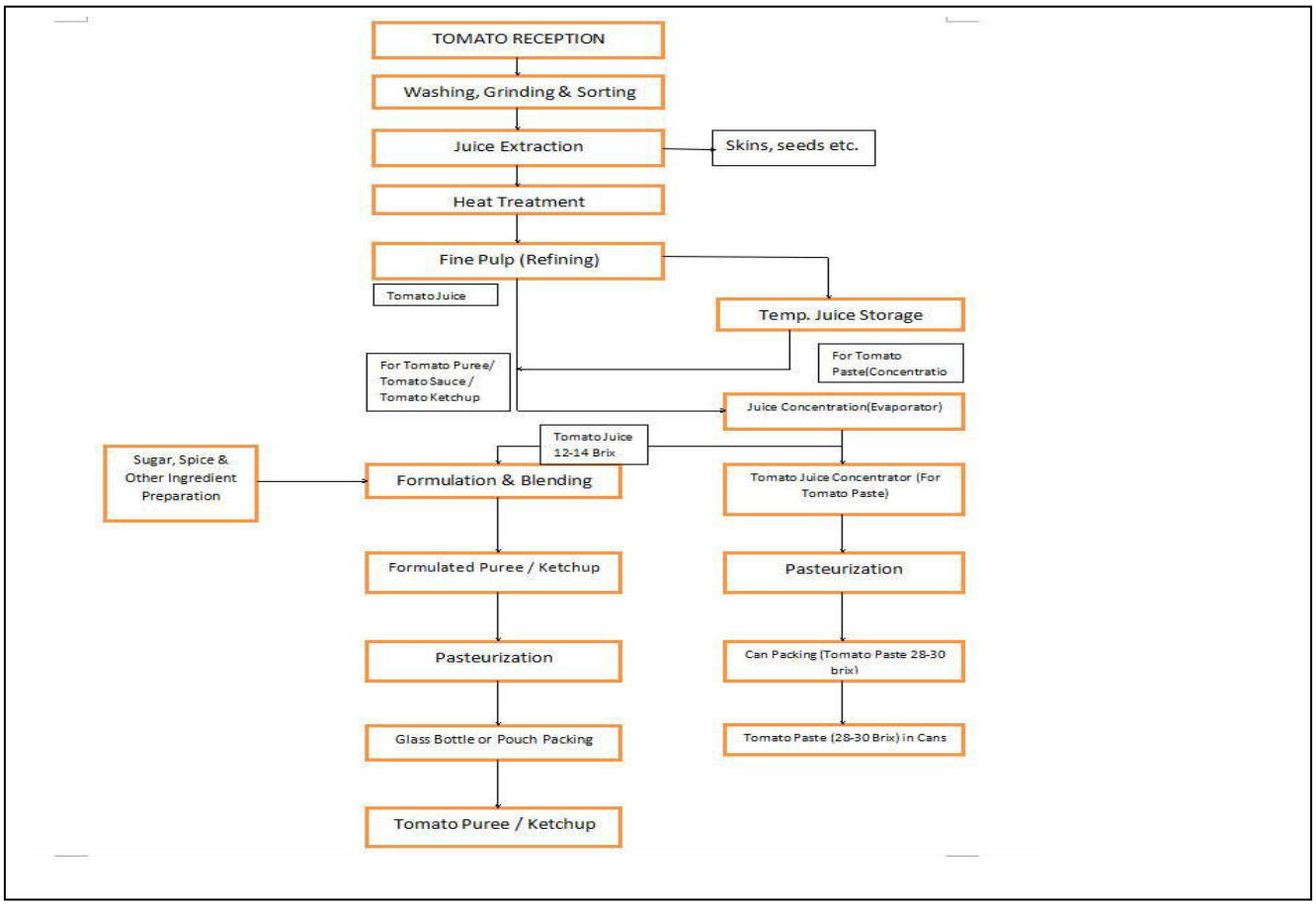
Production of Sauce and ketchup from tomato

3.5. Production of Tomato Sauce or Ketchup:

- A typical tomato sauce would be based on sieved or whole tomatoes, and/or tomato paste. It would also contain water, sugar, vinegar, salt and seasoning. The desired product viscosity would normally be achieved using a starch-based thickener.

- Tomato ketchup is a condiment manufactured from similar ingredients, although paste is used rather than whole tomatoes. Premium quality ketchups with a high solids content derive their viscosity from a combination of water retention of the fibrous strands in the paste and the gelling effect of pectin found naturally in tomatoes. High pressure homogenization is also used to obtain the desired viscosity. This is common with lower solids content ketchup, which may also contain starch-based thickeners.

Flow Chart of Tomato Ketchup Preparation:



Lecture 6

Dehydrated fruits & vegetables

3.6. Dehydrated Fruits and Vegetables:

Different drying processes:

- **Sun Drying:** This is rather difficult because this process need three to four sunny days of at least 100^0F in a row.
- **Oven Drying:** Oven drying is an acceptable method of drying food, but it isn't very energy efficient, and foods aren't very flavorful in the end. If your oven cannot obtain temperatures below 200^0F, use another method for food dehydration.
- **Electric Dehydrating** This is the best method of dehydrating food. An electric dehydrator is energy efficient and can be operated at low temperatures needed to maintain nutritive values in the food. Your electric food dehydrator should have some sort of heat control and a fan to maintain air circulation during the drying process.

Fruits and vegetables should be dehydrated between 120 and 140 ^{0}F.

When storing your dried product, keep in mind that no moisture should be allowed to enter the container...ever. Dried food absorbs moisture from the air, so the storage container must be airtight. Some acceptable storage containers are jars and plastic freezer bags. If storing fruit leather, wrap in plastic wrap and store in a airtight container. Store your containers of dried food in a cool, dark, dry place. 60 degrees Fahrenheit or below is best.

Drying procedure for different vegetables:

All vegetables except onions and peppers,and mushrooms should be washed, sliced, and blanched. Vegetables are placed in single layers on trays. Depending of drying conditions, drying times make take longer. Vegetables are dried at least at 130^0F.

- **Beans, green:**Stem and break beans into 1-inch pieces.Blanch. Dry 6-12 hours until brittle.
- **Beets:** Cook and peel beets. Cut into 1/4-inch pieces. Dry 3-10 hours until leathery.
- **Broccoli:** Cut and dry 4-10 hours.
- **Carrots:** Peel, slice or shred. Dry 6-12 hours until almost brittle.
- **Cauliflower:** Cut and dry 6-14 hours.
- **Corn:**Cut corn off cob after blanching and dry 6-12 hours until brittle.
- **Mushrooms:** Brush off, don't wash. Dry at 90 degrees for 3 hours, and then 125 degrees for the remaining drying time. Dry 4-10 hours until brittle.

- **Onions:** Slice 1/4-inch thick. Dry 6-12 hours until crisp.
- **Peas:** Dry 5-14 hours until brittle.
- **Peppers, sweet:** Remove seeds and chop. Dry 5-12 hours until leathery.
- **Potatoes:** Slice 1/8-inch thick. Dry 6-12 hours until crisp.
- **Tomatoes:** Dip in boiling water to loosen skins, peel,slice or quarter. Dry 6-12 hours until crisp.
- **Zucchini:** Slice 1/8-inch thick and dry 5-10 hours until brittle.

Drying procedure for different fruits:

All fruit should be washed,pitted and sliced. Arrange in single layers on trays. Fruits are dried at 135^0F. Some fruits can be pretreated, like, with lemon juice or ascorbic acid or it won't darken while you are preparing it for drying. Just slice the fruit into the solution and soak for 5 minutes.

- **Apples:**Peel, core and slice into 3/8-inch rings, or cut into 1/4-inch slices. Pretreat and dry 6-12 hours until pliable.
- **Apricots:** Cut in half and turn inside out to dry. Pretreat and dry 8-20 hours until pliable.
- **Bananas:** Peel, cut into 1/4-inch slices and pretreat. Dry 8-16 hours until plialbe or almost crisp.
- **Blueberries:** Dry 10-20 hours until leathery.
- **Cherries:** Cut in half and dry 18-26 hours until leathery and slightly sticky.
- **Peaches:** Peel, halve or quarter. Pretreat and dry 6-20 hours until pliable.
- **Pears:** Peel, cut into 1/4-inch slices, and pretreat. Dry 6-20 hours until leathery.
- **Pineapple:** Core and slice 1/4-inch thick. Dry 6-16 hours until leathery and not sticky.
- **Strawberries:** Halve or cut into 1/4-inch thick slices. Dry 6-16 hours until pliable and almost crisp.

Lecture 7

Utilization of by-products from fruit-based industries – extraction of pectin, fat/oil from peel and seeds

3.7.1. Extraction of pectin:

Pectin is found in most plants, but is most concentrated in citrus fruits (oranges, lemons, grapefruits) and apples. Pectin obtained from citrus peels is referred to as citrus pectin.

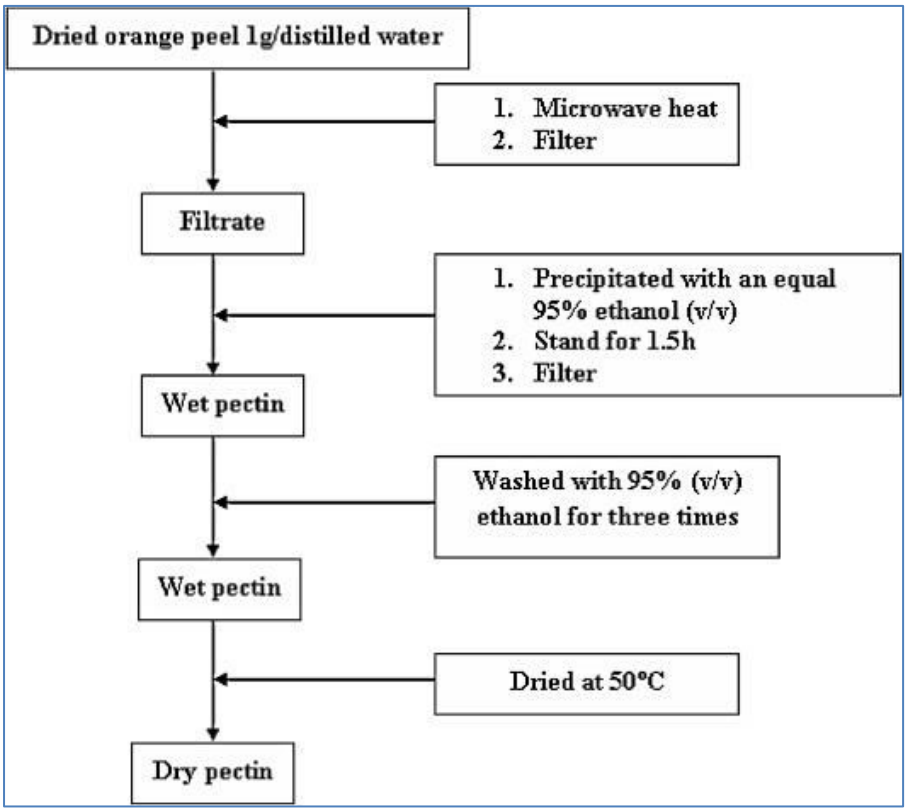
The extraction of pectins can lead to large variations in the chemical structure of the final material. Pectins are industrially extracted from citrus peels and apple pomace by hot acidified water. Extraction conditions of pH 1.5 to 3.0 and temperatures of 60-100^0 C for 0.5 to 6 hours are varied to give a material that has the desired gelling capacity and degree of methylation. The separation of the viscous material from the swollen and partially disintegrated plant material remains a problem. Grinding and washing with ethanol are used but this can lead to co-precipitation with intracellular proteins, starches and nucleic acids.

Another method by which this contamination may be avoided is by wet ball milling at low temperature. Enzymatic degradation of the pectin is avoided by addition of a surfactant like sodium dodecyl sulphate (SDS). Sodium deoxycholate (SDC) is used dilute to remove pigments and lipids and a treatment with 90% dimethyl sulphoxide (DMSO) will remove the bulk of the starch.

The advantage of alcohol treatment is that the resulting preparation is in a very suitable form for further modification to high methoxylated (HM) pectins using acid treatment or to low methoxy pectin (LM) by treatment with ammonia. The disadvantage of alcoholic treatment could be the possibility of reinforcing hydrogen bonding between cell wall constituents and effecting the extraction of the pectins. The extraction method may therefore be optimised for the type of pectin required, be it modified or native.

Pectins can also be extracted using enzymes. Scientific studies have all extracted pectins using galacturonase enzymes. This results in short but branched segments. In order to extract unaltered pectinsarabinase and galactanase could be used to avoid degradation.

Flowchart of extraction of pectin from orange peel:

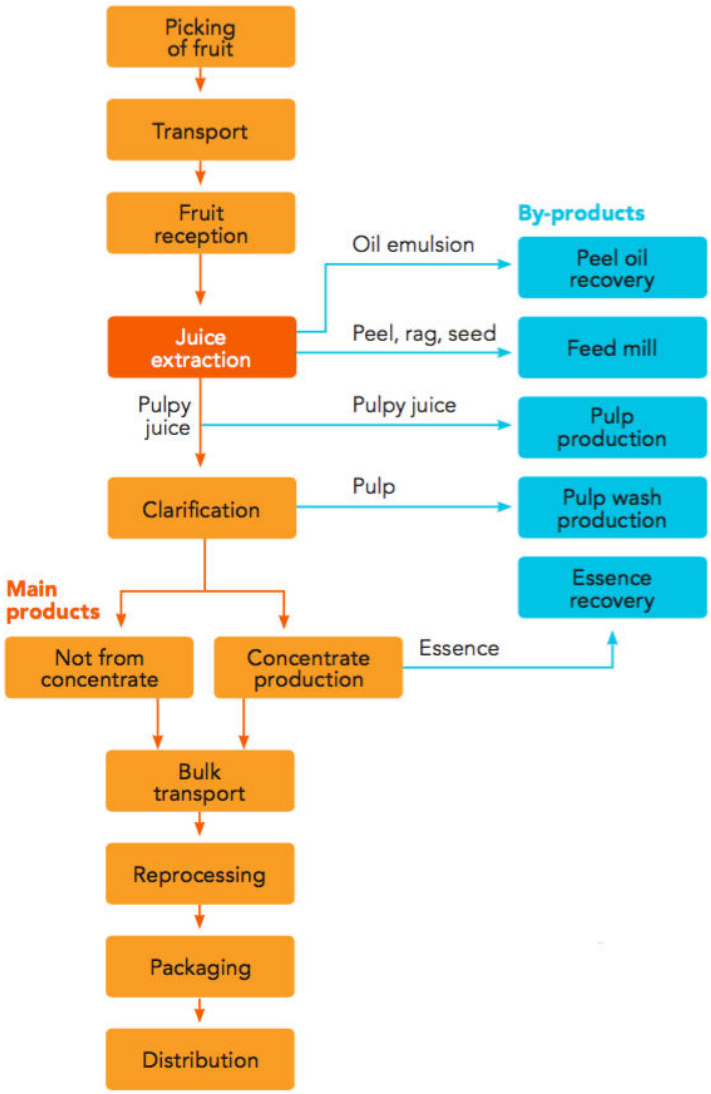


Lecture 8

Extraction of Aroma From Peel and Pomace; Candied Peel

3.8.1. Extraction of aroma from peel and pomace:

Aroma or essential oils are the byproducts of the fruit processing industries. A flow chart is given below which shows how in an orange juice processing industry can produce essential oils as byproducts:



Recovered peel oil represents some 0.3% of the fruit intake. The emulsion of oil and water from the extractor section is clarified by centrifugation in two steps. The purified oil contains dissolved waxes that are removed by winterization (refrigeration) of the oil for a specific time.

3.8.2. Candied Peel:

Materials required:

- 3 oranges
- 1½ cups granulated sugar
- ¾ cup water

Production Procedure:

1. Rinse the oranges.
2. Cut the top and bottom off each orange and score the skin into quarters.
3. Remove the skin (peel and pith, the white part), and cut the skin into strips about ¼" wide. Wrap the oranges in plastic wrap to store for other use.
4. Place the strips of peel in a large saucepan and cover with cold water.
5. Set on the stove on high heat and bring to a boil. Drain the water from the peels and repeat this process twice more.
6. In a small bowl, whisk together the sugar and ¾ cup water.
7. Pour the sugar water into a medium saucepan and bring to a simmer. Let the mixture cook for 8-9 minutes at a constant simmer.
8. Add the peel and cook for 45 minutes to 1 hour, OR just until the peels are translucent, adjusting heat as necessary to maintain the simmer. Avoid stirring, as this will cause crystallation. If necessary, swirl the pan to make sure that all of the peels get covered with the syrup.
9. Drain any remaining syrup from the peels and set aside for other use (perhaps tea?!) There will probably be only a tablespoon or two of syrup left. Spread the peels out on a drying rack and leave to dry for 4-5 hours. Store in an airtight container.

Module IV 8L

Lecture 1

Non-Alcoholic Beverages: Processing of Tea

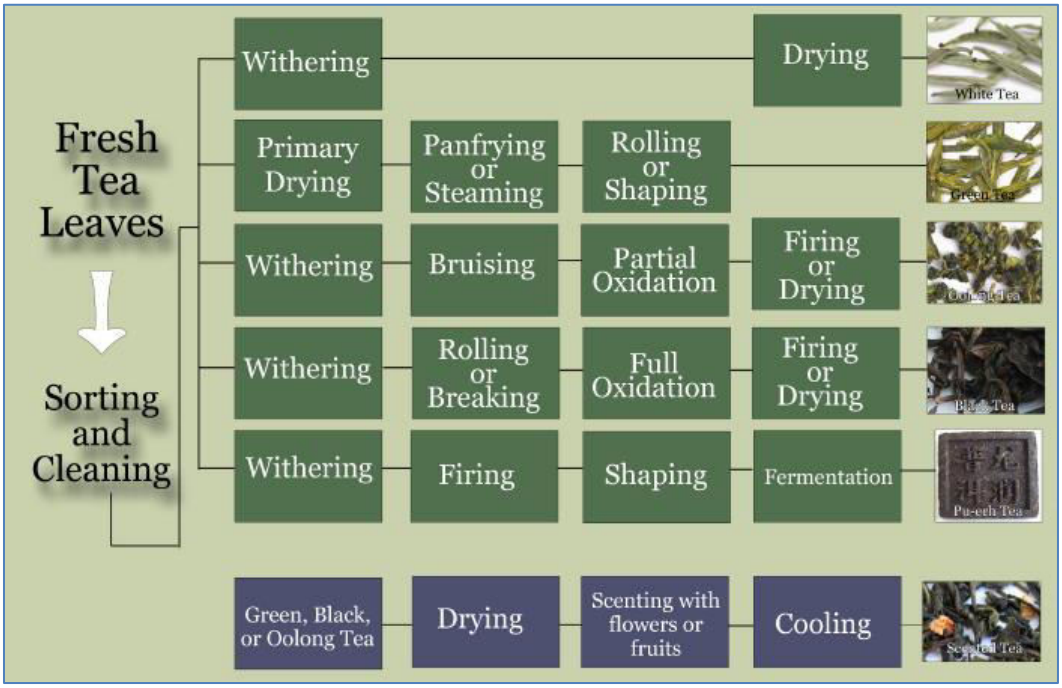
4.1. Processing of Tea:

1. **Plucking**: Tea leaves and flushes, which includes a terminal bud and two young leaves, are picked from *Camellia sinensis* bushes typically twice a year during early spring and early summer or late spring. Autumn or winter pickings of tea flushes are much less common, though they occur when climate permits. Picking is done by hand when a higher quality tea is needed, or where labour costs are not prohibitive. Depending on the skill of the picker, hand-picking is performed by pulling the flush with a snap of the forearm, arm, or even the shoulders, with the picker grasping the tea shoot using the thumb and forefinger, with the middle finger sometimes used in combination. Tea flushes and leaves can also be picked by machine, though there will be more broken leaves and partial flushes reducing the quality of the tea. However, it has also been shown that machine plucking in correctly timed harvesting periods can produce good leaves for the production of high quality teas.
2. **Withering / Wilting**: The tea leaves will begin to wilt soon after picking, with a gradual onset of *enzymatic oxidation*. Withering is used to remove excess water from the leaves and allows a very slight amount of oxidation. The leaves can be either put under the sun or left in a cool breezy room to pull moisture out from the leaves. The leaves sometimes lose more than a quarter of their weight in water during withering. The process is also important in promoting the breakdown of leaf proteins into free amino acids and increases the availability of freed caffeine, both of which change the taste of the tea.
3. **Disruption**: Known in the Western tea industry as "disruption" or "leaf maceration", the teas are bruised or torn in order to promote and quicken oxidation. The leaves may be lightly bruised on their edges by shaking and tossing in a bamboo tray or tumbling in baskets.More extensive leaf disruption can be done by kneading, rolling, tearing, and crushing, usually by machinery. The bruising breaks down the structures inside and outside of the leaf cells and allows from the co-mingling of oxidative enzymes with various substrates, which allows for the beginning of oxidation. This also releases some of the leaf juices, which may aid in oxidation and change the taste profile of the tea.
4. **Oxidation / Fermentation**: For teas that require oxidation, the leaves are left on their own in a climate-controlled room where they turn progressively darker. This is accompanied by agitation in some cases. In this process thechlorophyll in the leaves is enzymatically broken down, and its tannins are released or transformed. This process is sometimes referred to as "fermentation" in the tea industry. The tea producer may choose when the oxidation should be stopped, which depends on the desired qualities in the final tea as well as the weather conditions (heat and humidity). For light oolong teas this may

be anywhere from 5-40% oxidation, in darker oolong teas 60-70%, and inblack teas 100% oxidation. Oxidation is highly important in the formation of many taste and aroma compounds, which give a tea its liquor colour, strength, and briskness. Depending on the type of tea desired, under or over-oxidation/fermentation can result in grassy flavours, or overly thick winey flavours.

5. **Fixation / Kill-green**: Kill-green is done to stop the tea leaf oxidation at a desired level. This process is accomplished by moderately heating tea leaves, thus deactivating their oxidative enzymes and removing unwanted scents in the leaves, without damaging the flavour of the tea. Traditionally, the tea leaves are panned in a wok or steamed, but with advancements in technology, kill-green is sometimes done by baking or "panning" in a rolling drum. In some white teas and some black teas such as CTC blacks, kill-green is done simultaneously with drying.

Flow –chart of tea processing:

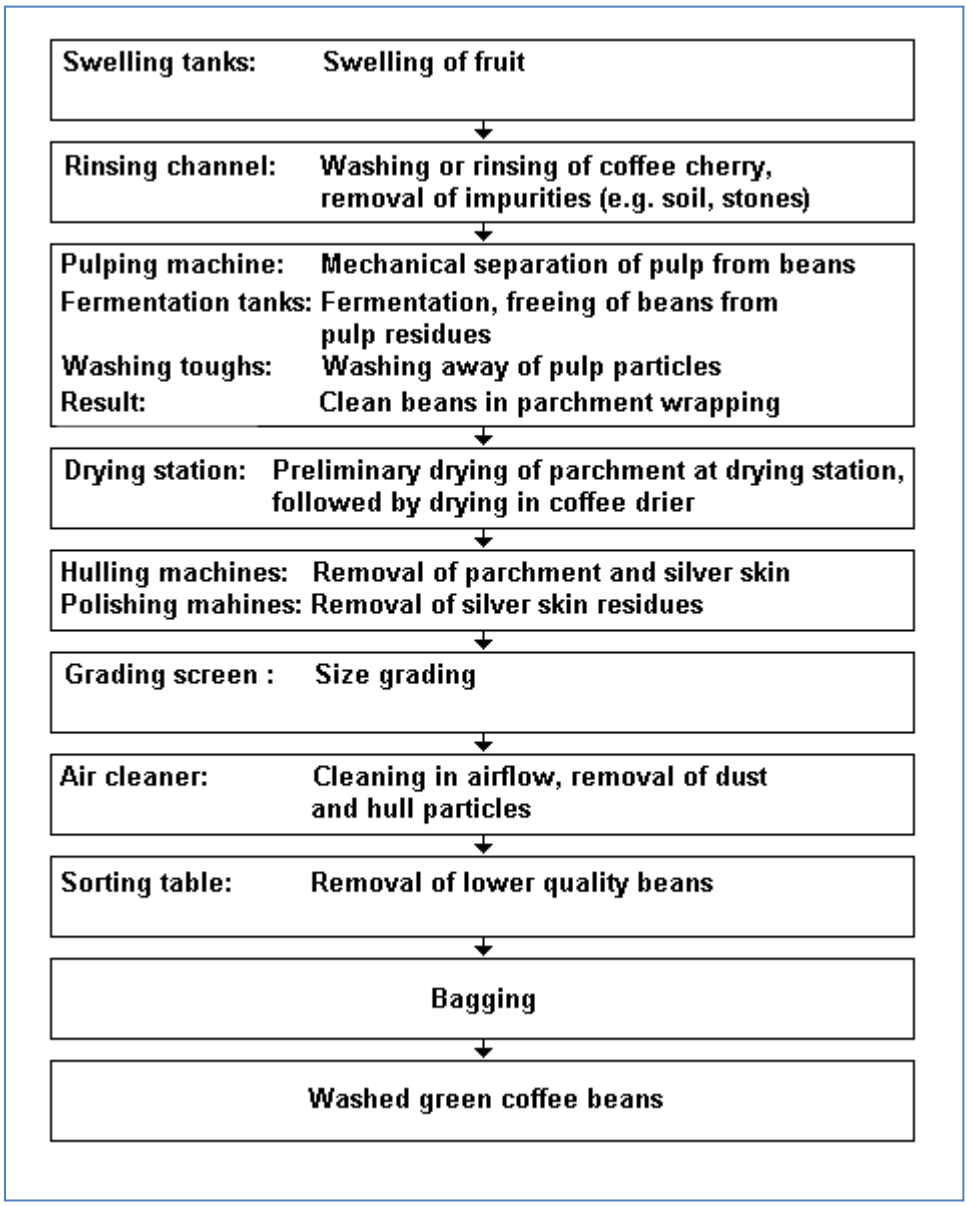


Lecture 2

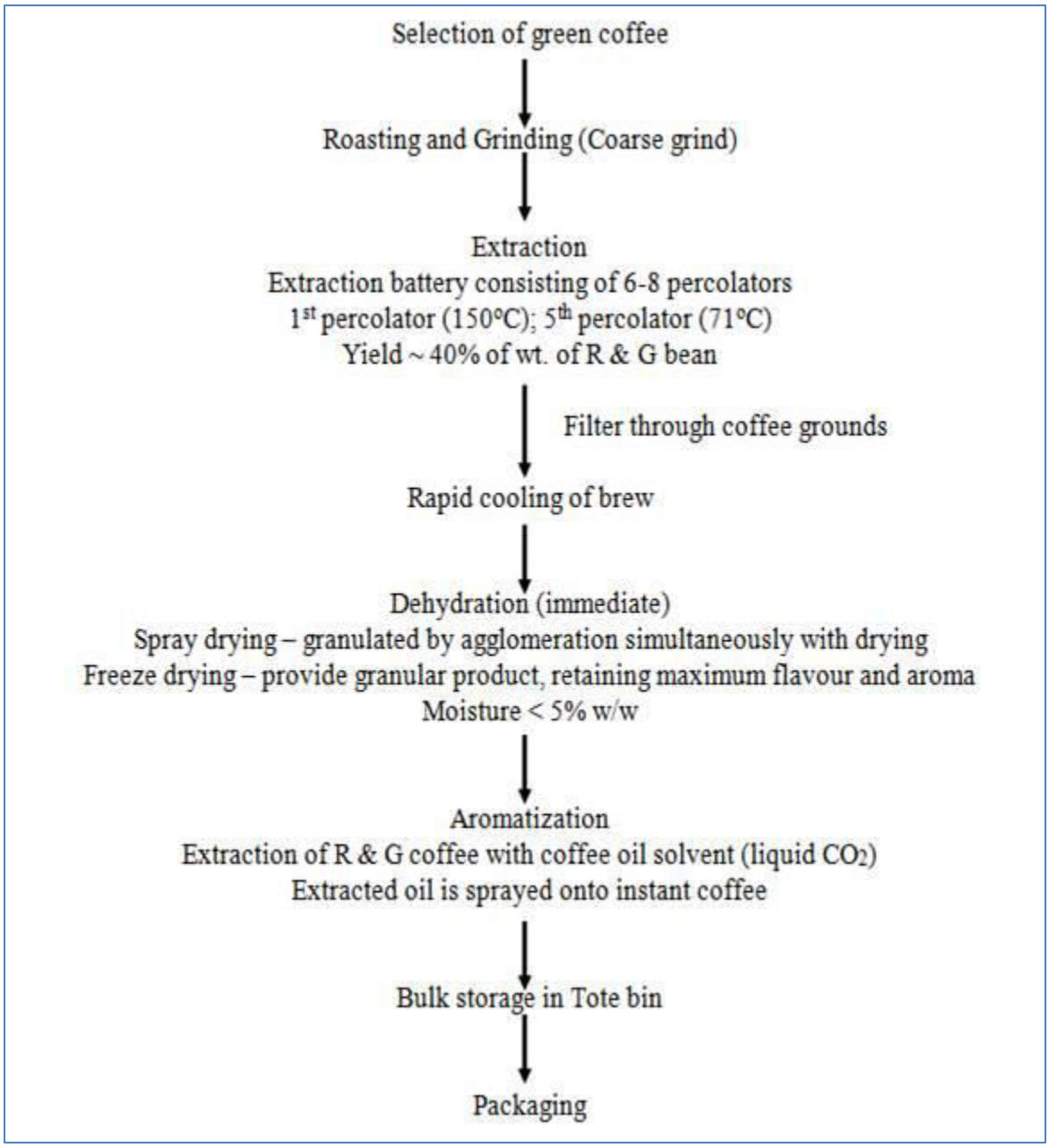
Processing of Coffee: Instant Coffee Processing;

4.2. Processing of Coffee:

Flow Chart of Processing of Coffee Beans:



Flow Chart for Processing of Instant Coffee powder:

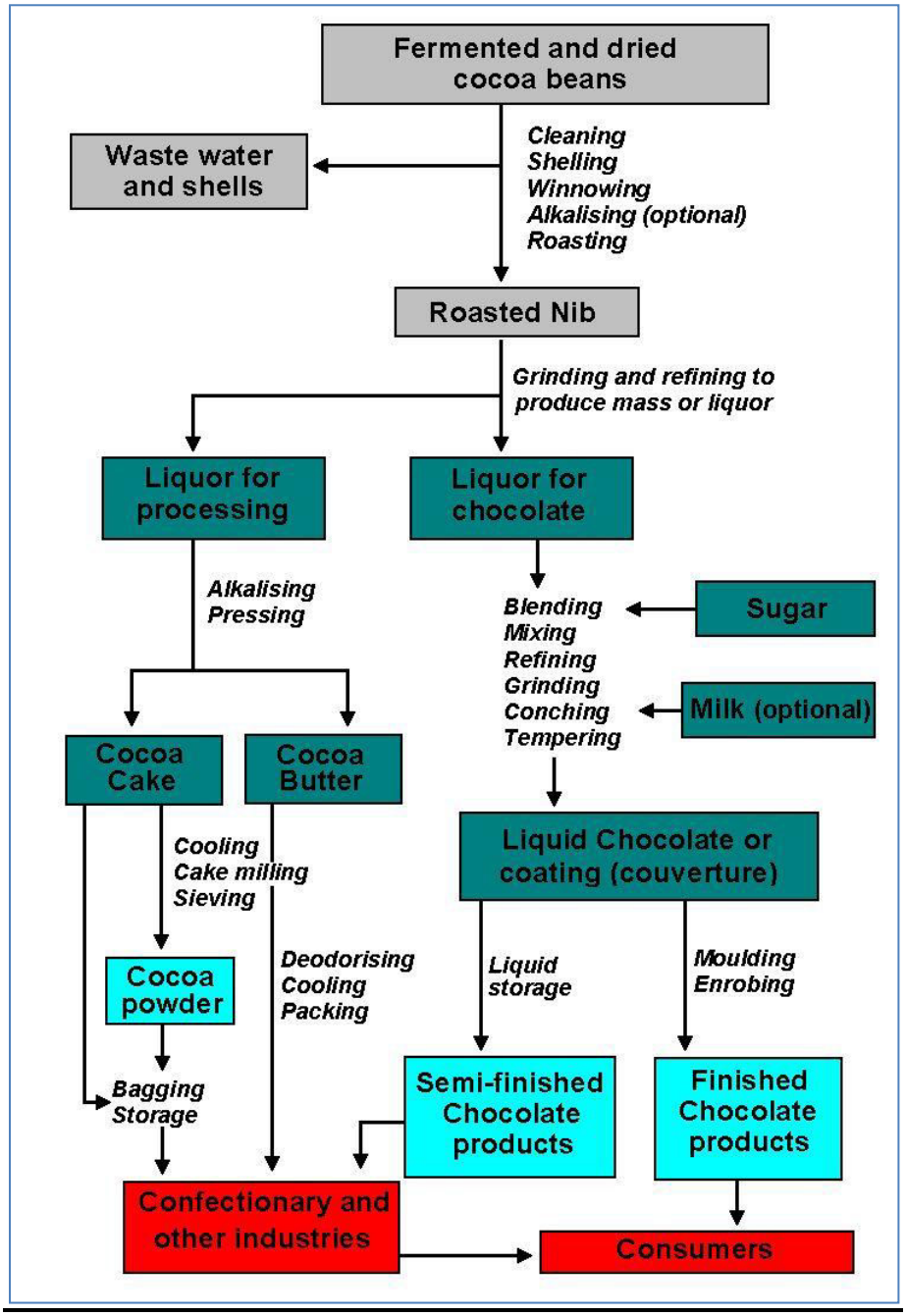


Lecture 3

Processing of Cocoa:Production of Chocolate and Cocoa Butter

4.3. Production of chocolate:

Flow Chart of Production of Chocolate and Cocoa Butter from Cocoa beans:

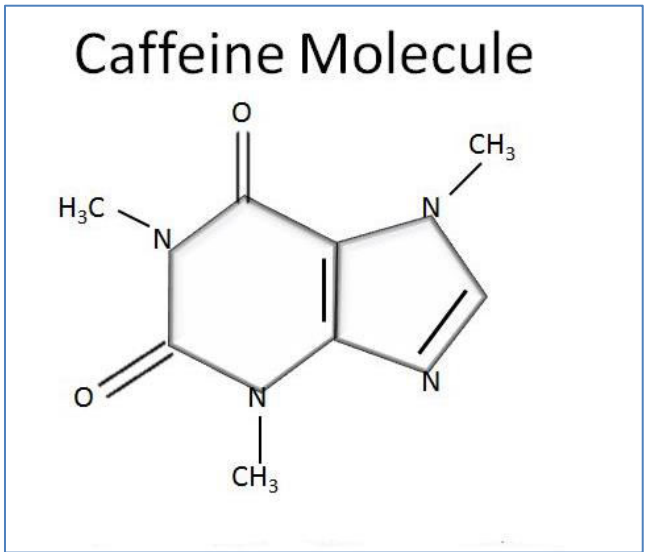


Lecture 4

Extraction of Caffeine from Tea Leaves

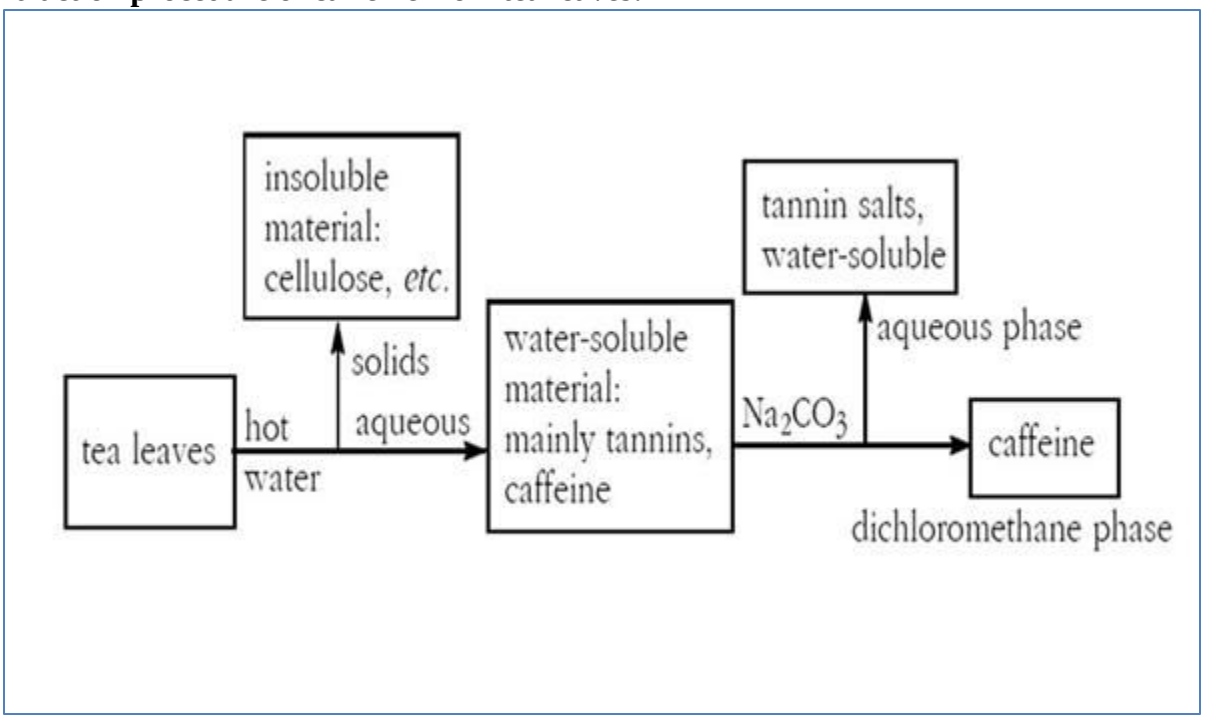
4.4. Extraction of caffeine from tea leaves:

Caffeine: Caffeine is a central nervous system (CNS) stimulant of the methylxanthine class. 11mg caffeine is present in 100 gm of tea leaves.



Structure of Caffeine molecule

Extraction procedure of caffeine from tea leaves:



Lecture 5

Food Additives: Coloring Agents, Humectants

4.5. Food Additives: Food additives are substances added to products to perform specific technological functions. These functions include preserving, increasing shelf-life or inhibiting the growth of pathogens, or adding colouring and flavouring to food for interest and variety. It is also a substance or a mixture of substance other than basic foodstuffs, which is present in food as a result of production, processing, or packing

- There are about 3000 additives to preserve and improve foods.

Why additives are added to food?

- Maintaining the nutritional quality of the food;
- Enhancing the keeping quality or stability of food thereby reducing food wastage;
- Making food attractive to consumers in a manner which precludes deception;
- Providing essentials aids in food processing

Food additives could be of two types:

- **Direct additives** are added to a food for a specific purpose and are identified on the ingredient label of the food.
- **Indirect additives** unintentionally become part of the food in trace amount due to its handling, packaging, etc.

Excessive levels of an additive or inclusion of an undeclared additive may be directly dangerous in some instances.

All the additives are regulated by Food & Drug Administration (FDA)

Food & Drug Administration(FDA):

Food and Agriculture Organization (FAO) & the World Health Organization (WHO) provide oversight. Giving stricter guidelines about food additives.

Food and Drug Administration

- Responsible that the food we eat is safe!!!
- Getting a food additive accepted is not simple task, due to strict guidelines
- A manufacture must submit evidence from extensive test, showing the substance does not cause short or long term harm
- If satisfied they then determine how much is safe for the public to eat

Natural vs. Synthetic:

- What are some examples of natural additives??

Ans. Salt, Sugar, Spices

- Artificial or synthetic are made in a laboratory; they aren't found naturally in food

The chemical "ingredients" are the same as any that occur in nature, but the chemicals are joined or modified in the food science lab to produce a substance.

Common Types of Food Additives:

- Preservatives
- Anti-oxidants
- Sweeteners
- Food Colours
- Humictant
- Flavours
- Stabilizers
- Emulsifiers

4.5.1. Colouring agents:

Food Colours:

- Impart high asthetic appeal to food
- Could be of natural origin, or derived from synthetic coal tar dyes
- Variabl stability under food processing conditions

- Almost all soft drinks, cheeses, ice cream, jams, and jellies owe at least part of their coloring to additives.
- Some colors are made from food (caramelizing sugars)
- However, nearly ½ the common colorings are created in the laboratories

Roles of Colour Additives:

- restore colour lost during processing or storage,
- ensure that each batch produced is identical in appearance or does not appear 'off';
- reinforces colour already in foods, e.g. enhance the yellowness of a custard;
- give colour to foods which otherwise would be colourless (e.g. soft drinks) and so make them more attractive

Example of Colouring Additives:

Natural	**Natural Identical**	**Certified Colour**
Anthocynins	Beta Carotene	Allura red
Betalins	Riboflavin	Sunset Yellow
Caramel		Tartrazine
Chlorophyll		Brillant Blue
Paprika		Erthrosine
Turmeric		
Saffron		

4.5.2. Humectants:

Humectants are additives that bind water and control water activity.
Water activity reduction achieved by adding humectants tofood enhances stability, maintains texture, and reduces microbial activity.Humectant use in foods is widespread and has a long history. Salt and sugar are the oldest, most widely usedhumectants. Other commonly used humectants include sorbitol, glycerol, and propylene glycol. As food additives,humectants must meet several criteria for acceptance: safety, lack of adverse odors and flavors, nutritional value,economy, and ease of use. A primary benefit is the reduction of microbial activity in foods, achieved throughreduction of $a_w$to less than 0.90.

Examples of some humectants include:

- Propylene glycol, hexylene glycol, and butylene glycol
- Aloe vera gel
- Alpha hydroxy acids such as lactic acid
- Egg yolk and egg white
- Glyceryl triacetate
- Honey
- Molasses
- Polymeric polyols such as polydextrose
- Quillaia
- Sodium hexametaphosphate
- Sugar alcohols (sugar polyols) such as glycerol, sorbitol, xylitol, maltitol

Lecture 6

Natural and artificial low calorie sweeteners

4.5.3: Sweeteners:

- Include natural sweeteners such as sucrose, glucose, and invert syrup; and artificial sweeteners such as aspartame, saccharin, sucralose, acesulphame K etc.
- Targeted toward diabetics, the obese and those suffering from dental caries
- Stability during food processing in an important critera

What are artificial sweeteners?

- Non carbohydrate based, and hence have different physical and chemical properties
- Have flavour characteristics different from sugar
- Intensely sweet

- Usually Lower calorie substitutes for sugar.

Why are they used in our food?

- The obesity epidemic and increased prevalence of diabetes gave rise to the artificial sweetener industry.
- Because processed foods are loaded with sugar, today's diets are higher in sugar than ever before. This results in excess calorie consumption and weight gain.
- Artificial sweeteners were created as lower-calorie alternatives to sugar in hopes of decrease the rise in obesity and diabetes.
- Artificial sweeteners may be a good alternative to sugar if someone have diabetes. Unlike sugar, artificial sweeteners generally don't raise blood sugar levels because they are not carbohydrates.
- **Dental cavities.** Unlike sugar, artificial sweeteners don't contribute to tooth decay.

Types of artificial sweeteners:

- Nutritive" and "Nonnutritive" : a difference in the amount of energy provided (4 kcal/g)
- Sugar alcohols or polyols: less energy per gram (2 kcal/g); not fully absorbed from the gut
- Nonnutritive sweeteners offer no energy (or insignificant energy): high-intensity sweeteners

The following is a list of currently used artificial sweeteners. These are assigned an "E Number", a number assigned to all Food additives:

- E420 Sorbitol
- E421 Mannitol
- E422 Glycerol
- E950 Acesulfame potassium (k)
- E951 Aspartame
- E952 Cyclamate
- E953 Isomalt
- E954 Saccharin
- E955 Sucralose
- E956 Alitame
- E957 Thaumatin
- E959 Neohesperidinedihydrochalcone
- E962 Aspartame-acesulfame salt
- E965 Maltito
- lE966 Lactitol
- E967 Xylitol
- E968 Erythritol

Table 1. Polyols and novel sugar sweeteners

Type	kcal/g	Regulatory status	Other names	Estimated Daily Intake (EDI) or Acceptable Daily Intake (ADI)	Description
Monosaccharide polyols or novel sugars					
Sorbitol	2.6	GRAS[a] — Label must warn about a laxative effect	Same as chemical name		50%-70% as sweet as sucrose; some individuals experience a laxative effect from a load of ≥50 g.
Mannitol	1.6	Approved food additive; the label must warn about a laxative effect	Same as chemical name		50%-70% as sweet as sucrose; some individuals experience a laxative effect from a load of ≥20 g
Xylitol	2.4	Approved food additive for use in foods for special dietary uses	Same as chemical name		As sweet as sucrose; new forms have better free-flowing abilities.
Erythritol	0.2	Independent GRAS determinations; no questions from FDA	Same as chemical name	EDI mean: 1 g/p/d; 90th percentile: 4 g/p/d	60%-80% as sweet as sucrose;
D-Tagatose	1.5	Independent GRAS determinations; no questions from FDA	Same as chemical name	EDI mean: 7.5 g/p/d; 90th percentile: 15 g/p/d ADI 15 grams/60 kg adult/d	75%-92% as sweet as sucrose;
Disaccharide polyols or novel sugars					
Isomalt	2	GRAS affirmation petition filed	Same as chemical name		45%-65% as sweet as sucrose; used as a bulking agent.
Lactitol	2	GRAS affirmation petition filed	Same as chemical name		30%-40% as sweet as sucrose; used as a bulking agent.
Maltitol	2.1	GRAS affirmation petition filed	Same as chemical name		90% as sweet as sucrose; used as a bulking agent.
Trehalose	4	Independent GRAS determinations; no questions from FDA	Same as chemical name	EDI mean: 34 g/p/d; 90th percentile: 68 g/p/d	45% as sweet as sucrose; funct
Polysaccharide polyols					
HSH	3	GRAS affirmation petition filed	Hydrogenated starch hydrolysates; maltitol syrup		25%-50% as sweet as sucrose (depending on the monosaccharide composition)

Commonly used nonnutritive sweeteners:

- Saccharin: 300X sweeter than sucrose
- Sucralose: 600X sweeter than sucrose
- Aspartame: (150-220)X sweeter than sucrose
- Acesulfame-K: (150-200)X sweeter than sucrose
- Cyclamates: (30-50)X sweeter than sucrose
- Thaumatin : (2000-3000)X sweeter than sucrose
- Steviol: (100-200) X sweeter than sucrose
- Neotame: (8000-13000) X sweeter than sucrose
- Monellin: (150-300) X sweeter than sucrose

- Phyllodulcin: (200-300) X sweeter than sucrose

Are they safe?

- Sometimes cited as cancer-causing agents
- That's largely because of studies dating to the 1970s that linked saccharin to bladder cancer in laboratory rats. Because of those studies, saccharin once carried a warning label that it may be hazardous to our health.
- The National Cancer Institute states that there is no scientific evidence that any of the FDA-approved artificial sweeteners are linked to an increased risk for cancer or other serious health problems. And numerous research studies confirm that artificial sweeteners are generally safe in limited quantities, even for pregnant women.
- Artificial sweeteners are regulated by the FDA as food additives. They must be reviewed and approved by the FDA before being made available for sale. In some cases, the FDA declares a substance "generally recognized as safe" (GRAS).
- The FDA has also established an acceptable daily intake (ADI) for each artificial sweetener. This is the maximum amount considered safe to consume each day over the course of our lifetime. ADIs are intended to be about 100 times less than the smallest amount that might cause health concerns.

Lecture 7

Anti-caking agents, pH control agents

4.5.4. Anti-caking Agent:
An **anti-caking agent** is an additive placed in powdered or granulated materials, such as table salt or confectionaries to prevent the formation of lumps (caking) and for easing packaging, transport, and consumption.

List of Anti-caking agents:

The most widely used anti-caking agents include the stearates of calcium and magnesium, silica and various silicates, talc, as well as flour and starch. Ferrocyanides are used for table salt. The following anti-caking agents are listed in order by theirnumber in the Codex Alimentarius.

- 341 tricalcium phosphate
- 460(ii) powdered cellulose
- 470b magnesium stearate
- 500 sodium bicarbonate
- 535 sodium ferrocyanide
- 536 potassium ferrocyanide
- 538 calcium ferrocyanide

- 542 bone phosphate (i.e. Calcium phosphate)
- 550 sodium silicate
- 551 silicon dioxide
- 552 calcium silicate
- 553a magnesium trisilicate
- 553b talcum powder
- 554 sodium aluminosilicate
- 555 potassium aluminium silicate
- 556 calcium aluminosilicate
- 558 bentonite
- 559 aluminium silicate
- 570 stearic acid
- 900 polydimethylsiloxane

4.5.5. pH Controlling Agent:

Acidity regulators, or pH control agents, are food additives added to change or maintain pH (acidity or basicity). They can be organic or mineralacids, bases, neutralizing agents, or buffering agents. Typical agents include these acids and their sodium salts: sorbic acid, acetic acid, benzoic acid, and propionic acid. Acidity regulators are indicated by their E number, such as E260 (acetic acid), or simply listed as "food acid".

List of Permitted pH Adjusting Agents:

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
A.1	Acetic Acid	(1) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(1) Good Manufacturing Practice
		(2) Canned Asparagus	(2) Good Manufacturing Practice
		(3) Gelatin	(3) Good Manufacturing Practice
		(4) Unstandardized foods	(4) Good Manufacturing Practice
A.2	Adipic Acid	Unstandardized foods	Good Manufacturing Practice
A.3	Ammonium Aluminum Sulphate	(1) Baking powder	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
A.4	Ammonium Bicarbonate	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Unstandardized foods	(2) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
A.5	Ammonium Carbonate	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Unstandardized foods	(2) Good Manufacturing Practice
A.6	Ammonium Citrate, dibasic	Unstandardized foods	Good Manufacturing Practice
A.7	Ammonium Citrate, monobasic	Unstandardized foods	Good Manufacturing Practice
A.8	Ammonium Hydroxide	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Gelatin	(2) Good Manufacturing Practice
		(3) Unstandardized foods	(3) Good Manufacturing Practice
A.9	Ammonium Phosphate, dibasic	(1) Ale; Bacterial cultures; Baking powder; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized bakery products	(2) Good Manufacturing Practice
A.10	Ammonium Phosphate, monobasic	(1) Ale; Bacterial cultures; Baking powder; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized bakery products	(2) Good Manufacturing Practice
		(3) Uncultured buttermilk	(3) 0.1%
C.1	Calcium Acetate	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.1A	Calcium Acid Pyrophosphate	(1) Baking powder	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.2	Calcium Carbonate	(1) Ice cream mix; Ice milk mix	(1) Good Manufacturing Practice
		(2) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added	(2) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		ingredients); (naming the variety) Whey cheese	
		(3) Grape juice	(3) Good Manufacturing Practice
		(4) Unstandardized foods	(4) Good Manufacturing Practice
		(5) Cocoa products	(5) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(6) Wine	(6) Good Manufacturing Practice in accordance with the requirements of section B.02.100
		(7) Infant cereal products	(7) Good Manufacturing Practice
C.3	Calcium Chloride	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.4	Calcium Citrate	(1) Infant formula	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.5	Calcium Fumarate	Unstandardized foods	Good Manufacturing Practice
C.6	Calcium Gluconate	Unstandardized foods	Good Manufacturing Practice
C.7	Calcium Hydroxide	(1) Ale; Beer; Ice cream mix; Ice milk mix; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Canned peas	(2) 0.01% in accordance with the requirements of section B.11.002
		(3) Infant formula	(3) Good Manufacturing Practice
		(4) Grape Juice	(4) Good Manufacturing Practice
		(5) Unstandardized foods	(5) Good Manufacturing Practice
C.8	Calcium Lactate	(1) Baking powder	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.9	Calcium Oxide	(1) Ale; Beer; Ice cream mix; Ice milk mix; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.10	Calcium Phosphate,	Unstandardized foods	Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
	dibasic		
C.11	Calcium Phosphate, monobasic	(1) Ale; Baking powder; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
C.12	Calcium Phosphate, tribasic	Unstandardized foods	Good Manufacturing Practice
C.13	Calcium Sulphate	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Wine	(2) Good Manufacturing Practice in accordance with the requirements of section B.02.100
C.13A	Carbon Dioxide	(Naming the variety) Cheese	Good Manufacturing Practice in accordance with the requirements of section B.08.033
C.14	Citric Acid	(1) Ale; Beer; Cider; Honey wine; Malt liquor; Porter; Stout; Wine	(1) Good Manufacturing Practice
		(2) Apple (or rhubarb) and (naming the fruit) jam; Apricot nectar; Beans; Beans with pork; Canned mushrooms; Canned (naming the fruit); Canned (naming the vegetable); Canned tomatoes; Concentrated tomato paste; Fig marmalade; Fig marmalade with pectin; Frozen mushrooms; Frozen (naming the fruit); Frozen (naming the vegetable); Grape juice; Mincemeat; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; Olives; Peach nectar; Pear nectar; Pickles; Pineapple marmalade; Pineapple marmalade with pectin; Relishes; Tomato juice; Tomato paste; Tomato pulp; Tomato puree	(2) Good Manufacturing Practice
		(3) Dried egg-white (dried albumen); Dried whole egg; Dried yolk; Frozen clams; Frozen crab; Frozen crustaceans; Frozen egg-white (frozen albumen); Frozen fish; Frozen fish fillets; Frozen lobster; Frozen marine mammals; Frozen minced fish; Frozen molluscs; Frozen shrimp; Frozen squid; Frozen whole egg; Frozen yolk; Gelatin; Glaze for frozen fish; Liquid egg-white (liquid albumen); Liquid whole egg; Liquid yolk; Other Frozen marine invertebrates; Prepared fish or prepared meat (Division 21); Preserved fish or preserved meat (Division 21)	(3) Good Manufacturing Practice
		(4) Cocoa products	(4) 1.0%, singly or in combination with tartaric acid, calculated on a fat-free basis
		(5) Cold-pack cheese food; Cold-pack cheese food with (naming the added ingredients); Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cottage cheese; Cream cheese spread; Cream cheese spread with (naming the added ingredients); Creamed cottage cheese; Ice cream mix; Ice milk mix; Processed cheese food;	(5) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); Sherbet; (naming the variety) Whey cheese;	
		(6) French dressing; Margarine; Mayonnaise; Salad dressing	(6) Good Manufacturing Practice
		(7) Infant formula	(7) Good Manufacturing Practice
		(8) Unstandardized foods	(8) Good Manufacturing Practice
		(9) Blackstrap molasses destined for the manufacture of confectionery glazes for snack foods, treated with asparaginase in accordance with item A.3 of the *List of Permitted Food Enzymes*	(9) Good Manufacturing Practice
C.15	Cream of Tartar	Same foods as listed for Potassium Acid Tartrate	Same levels as prescribed for Potassium Acid Tartrate
F.1	Fumaric Acid	(1) Gelatin	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
		(3) Wine	(3) Good Manufacturing Practice
G.1	Gluconic Acid	Unstandardized foods	Good Manufacturing Practice
G.2	Glucono-delta-lactone	Unstandardized foods	Good Manufacturing Practice
H.1	Hydrochloric Acid	(1) Ale; Beer; Gelatin; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Infant formula	(2) Good Manufacturing Practice
		(3) Bakery fillings; Flavour emulsions; Icings	(3) Good Manufacturing Practice
L.1	Lactic Acid	(1) Ale; Baking powder; Beer; Bread; Cider; Cottage cheese; Creamed cottage cheese; Dried egg-white (dried albumen); Dried whole egg; Dried yolk; French dressing; Frozen egg-white (frozen albumen); Frozen whole egg; Frozen yolk; Ice cream mix; Ice milk mix; Liquid egg-white (liquid albumen); Liquid whole egg; Liquid yolk; Malt liquor; Mayonnaise; Olives; Pickles; Porter; Relishes; Salad dressing; Sherbet; Stout	(1) Good Manufacturing Practice
		(2) Canned pears; Canned strawberries	(2) Good Manufacturing Practice
		(3) Margarine	(3) Good Manufacturing Practice
		(4) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming	(4) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	
		(5) Unstandardized foods	(5) Good Manufacturing Practice
		(6) Wine	(6) Good Manufacturing Practice
M.2	Magnesium Carbonate	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Ice cream mix; Ice milk mix	(2) Good Manufacturing Practice
		(3) Unstandardized foods	(3) Good Manufacturing Practice
M.3	Magnesium Citrate	Soft drinks	Good Manufacturing Practice
M.4	Magnesium Fumarate	Unstandardized foods	Good Manufacturing Practice
M.5	Magnesium Hydroxide	(1) Canned peas	(1) 0.05% in accordance with the requirements of section B.11.002
		(2) Cocoa products	(2) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(3) Gelatin; Ice cream mix; Ice milk mix	(3) Good Manufacturing Practice
		(4) Bacterial cultures	(4) Good Manufacturing Practice
M.6	Magnesium Oxide	Ice cream mix; Ice milk mix	Good Manufacturing Practice
M.6A	Magnesium Phosphate	Bacterial cultures	Good Manufacturing Practice
M.7	Magnesium Sulphate	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Bacterial cultures	(2) Good Manufacturing Practice
M.8	Malic Acid	(1) Apple (or rhubarb) and (naming the fruit) jam; Apricot nectar; Canned asparagus; Fig marmalade; Fig marmalade with pectin; Frozen (naming the fruit); (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; Peach nectar; Pear nectar; Pineapple marmalade; Pineapple marmalade with pectin	(1) Good Manufacturing Practice
		(2) Canned applesauce; Canned pears; Canned strawberries	(2) Good Manufacturing Practice
		(3) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added	(3) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	
		(4) Unstandardized foods	(4) Good Manufacturing Practice
		(5) Wine	(5) Good Manufacturing Practice
M.8A	Manganese Sulphate	Bacterial cultures	Good Manufacturing Practice
M.9	Metatartaric Acid	Wine	0.01%
P.1	Phosphoric Acid	(1) Ale; Beer; Cottage Cheese; Creamed cottage cheese; Gelatin; Light beer; Malt liquor; Monoglycerides and mono- and di-glycerides; Porter; Stout	(1) Good Manufacturing Practice
		(2) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(2) Good Manufacturing Practice
		(3) Fish protein	(3) Good Manufacturing Practice
		(4) Unstandardized foods	(4) Good Manufacturing Practice
		(5) Cocoa products	(5) 0.5%, expressed as P_2O_5, calculated on a fat-free basis
P.2	Potassium Acid Tartrate	(1) Baking powder; Honey wine	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
		(3) Wine	(3) 0.42%
P.3	Potassium Aluminum Sulphate	(1) Ale; Baking powder; Beer; Light beer; Malt liquor; Oil-soluble annatto; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
P.4	Potassium Bicarbonate	(1) Baking powder; Malted milk; Malted milk powder	(1) Good Manufacturing Practice
		(2) Cocoa products	(2) Sufficient to process the cocoa products in accordance with

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
			the requirements of section B.04.005
		(3) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(3) Good Manufacturing Practice
		(4) Infant formula	(4) Good Manufacturing Practice
		(5) Margarine	(5) Good Manufacturing Practice
		(6) Unstandardized foods	(6) Good Manufacturing Practice
		(7) Wine	(7) Good Manufacturing Practice
P.5	Potassium Carbonate	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(2) Good Manufacturing Practice
		(3) Margarine	(3) Good Manufacturing Practice
		(4) Unstandardized foods	(4) Good Manufacturing Practice
		(5) A blend of prepared fish and prepared meat referred to in paragraph B.21.006(*n*)	(5) Good Manufacturing Practice
		(6) Wine	(6) Good Manufacturing Practice
P.6	Potassium Chloride	Ale; Beer; Light beer; Malt liquor; Porter; Stout	Good Manufacturing Practice
P.7	Potassium Citrate	(1) Infant formula	(1) Good Manufacturing Practice
		(2) Margarine	(2) Good Manufacturing Practice
		(3)	(3)

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		Unstandardized foods	Good Manufacturing Practice
		(4) Wine	(4) Good Manufacturing Practice
P.8	Potassium Fumarate	Unstandardized foods	Good Manufacturing Practice
P.9	Potassium Hydroxide	(1) Oil-soluble annatto	(1) 1.0%
		(2) Cocoa products	(2) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(3) Ice cream mix; Ice milk mix; Pumping pickle, cover pickle and dry cure employed in the curing of preserved meat or preserved meat by-product	(3) Good Manufacturing Practice
		(4) Infant formula	(4) Good Manufacturing Practice
		(5) Margarine	(5) Good Manufacturing Practice
		(6) Grape juice	(6) Good Manufacturing Practice
		(7) Unstandardized foods	(7) Good Manufacturing Practice
P.9A	Potassium Lactate	(1) Margarine	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
P.10	Potassium Phosphate, dibasic	Unstandardized foods	Good Manufacturing Practice
P.10A	Potassium Phosphate, tribasic	(1) Ale; Beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
P.11	Potassium Sulphate	Ale; Beer; Light beer; Malt liquor; Porter; Stout	Good Manufacturing Practice
P.12	Potassium Tartrate	Cider	Good Manufacturing Practice
P.13	Potassium Tripolyphosphate	Unstandardized foods	Good Manufacturing Practice
S.1	Sodium Acetate	Unstandardized foods	Good Manufacturing Practice
S.2	Sodium Acid Pyrophosphate	(1) Baking powder	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
S.3	Sodium Acid Tartrate	Baking Powder	Good Manufacturing Practice
S.4	Sodium Aluminum Phosphate	Unstandardized foods	Good Manufacturing Practice
S.5	Sodium Aluminum Sulphate	(1) Baking powder	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
S.6	Sodium Bicarbonate	(1) Apple (or rhubarb) and (naming the fruit) jam; Baking powder; Dried egg-white (dried albumen); Dried whole egg; Dried yolk; Fig marmalade; Fig marmalade with pectin; Frozen egg-white (frozen albumen); Frozen whole egg; Frozen yolk; Ice cream mix; Ice milk mix; Liquid egg-white (liquid albumen); Liquid whole egg; Liquid yolk; Malted milk powder; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; Oil-soluble annatto; Pineapple marmalade; Pineapple marmalade with pectin; Pumping pickle, cover pickle and dry cure employed in the curing of preserved meat or preserved meat by-product	(1) Good Manufacturing Practice
		(2) Cocoa products	(2) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(3) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(3) Good Manufacturing Practice
		(4) Infant formula	(4) Good Manufacturing Practice
		(5) Margarine	(5) Good Manufacturing Practice
		(6) Unstandardized foods	(6) Good Manufacturing Practice
S.7	Sodium Bisulphate	(1) Ale; Beer; Canned applesauce; Canned carrots; Canned corn; Canned green beans; Canned mushrooms; Canned olives; Canned peaches; Canned peas; Canned pears; Canned pickles; Canned sweet potatoes; Canned relish; Canned tomatoes; Canned yams; Canned pineapple; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
		(3) Cream cheese spread; Processed cheddar cheese; Processed cheese food; Processed cream cheese; Processed Gouda cheese; Processed Jack cheese; Processed Monterey cheese; Processed Mozzarella cheese; Processed Muenster cheese	(3) Good Manufacturing Practice
		(4) Mayonnaise; Salad Dressing	(4) Good Manufacturing Practice
S.8	Sodium Carbonate	(1) Apple (or rhubarb) and (naming the fruit) jam; Dried egg-white (dried albumen); Dried whole egg; Dried yolk; Fig marmalade; Fig marmalade with pectin; Frozen egg-white (frozen albumen);	(1) Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		Frozen whole egg; Frozen yolk; Gelatin; Ice cream mix; Ice milk mix; Liquid egg-white (liquid albumen); Liquid whole egg; Liquid yolk; Meat binder or (naming the meat product) binder where sold for use in preserved meat or preserved meat by-product; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; Pineapple marmalade; Pineapple marmalade with pectin	
		(2) Cocoa products	(2) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(3) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(3) Good Manufacturing Practice
		(4) Margarine	(4) Good Manufacturing Practice
		(5) Unstandardized foods	(5) Good Manufacturing Practice
		(6) Squid meat intended for processing	(6) Good Manufacturing Practice
S.9	Sodium Citrate	(1) Apple (or rhubarb) and (naming the fruit) jam; Cottage cheese; Cream; Creamed cottage cheese; Ice cream mix; Ice milk mix; (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; Pineapple marmalade or Fig marmalade; Pineapple marmalade with pectin or Fig marmalade with pectin; Sherbet	(1) Good Manufacturing Practice
		(2) Infant formula	(2) Good Manufacturing Practice
		(3) Unstandardized foods	(3) Good Manufacturing Practice
		(4) Margarine	(4) Good Manufacturing Practice
		(5) Frozen clams; Frozen crab; Frozen crustaceans; Frozen fish; Frozen fish fillets; Frozen lobster; Frozen marine mammals; Frozen minced fish; Frozen molluscs; Frozen shrimp; Frozen squid; Glaze for frozen fish; Other Frozen marine invertebrates; Prepared fish or prepared meat (Division 21); Preserved fish or preserved meat (Division 21)	(5) Good Manufacturing Practice
S.12	Sodium Fumarate	Unstandardized foods	Good Manufacturing Practice

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
S.13	Sodium Gluconate	Unstandardized foods	Good Manufacturing Practice
S.14	Sodium Hexametaphosphate	Unstandardized foods	Good Manufacturing Practice
S.15	Sodium Hydroxide	(1) Cocoa products	(1) Sufficient to process the cocoa products in accordance with the requirements of section B.04.005
		(2) Gelatin; Ice cream mix; Ice milk mix; (naming the flavour) Partly skimmed milk; (naming the flavour) Skim milk; Pumping pickle, cover pickle and dry cure employed in the curing of preserved meat or preserved meat by-product	(2) Good Manufacturing Practice
		(3) Infant formula	(3) Good Manufacturing Practice
		(4) Margarine	(4) Good Manufacturing Practice
		(5) Unstandardized foods	(5) Good Manufacturing Practice
		(6) (Naming the variety) Whey cheese; Whey cheese	(6) Good Manufacturing Practice
		(7) Frozen egg-white (frozen albumen); Liquid egg-white (liquid albumen)	(7) Good Manufacturing Practice
S.16	Sodium Lactate	(1) Margarine	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
S.17	Sodium Phosphate, dibasic	(1) Ale; Bacterial culture; Beer; Cream; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
S.18	Sodium Phosphate, monobasic	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
S.19	Sodium Phosphate, tribasic	(1) Ale; Beer; Light beer; Malt liquor; Porter; Stout	(1) Good Manufacturing Practice
		(2) Unstandardized foods	(2) Good Manufacturing Practice
S.19A	Sodium Potassium Hexametaphosphate	Unstandardized foods	Good Manufacturing Practice
S.20	Sodium Potassium Tartrate	(1) Apple (or rhubarb) and (naming the fruit) jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; Pineapple marmalade or Fig marmalade; Pineapple marmalade with pectin or Fig marmalade with pectin	(1) Good Manufacturing Practice
		(2)	(2)

Item No.	Column 1 Additive	Column 2 Permitted in or Upon	Column 3 Maximum Level of Use and Other Conditions
		Unstandardized foods	Good Manufacturing Practice
		(3) Margarine	(3) Good Manufacturing Practice
S.20A	Sodium Potassium Tripolyphosphate	Unstandardized foods	Good Manufacturing Practice
S.21	Sodium Pyrophosphate, tetrabasic	Unstandardized foods	Good Manufacturing Practice
S.22	Sodium Tripolyphos-phate	Unstandardized foods	Good Manufacturing Practice
S.23	Sulphuric Acid	Ale; Beer; Light beer; Malt liquor; Porter; Stout	Good Manufacturing Practice
S.24	Sulphurous Acid	Gelatin	Good Manufacturing Practice provided the finished product does not contain more than 500 p.p.m. calculated as sulphur dioxide
T.1	Tartaric Acid	(1) Ale; Apple (or rhubarb) and (naming the fruit) jam; Baking powder; Beer; Canned asparagus; Cider; Fig marmalade; Fig marmalade with pectin; French dressing; Gelatin; Honey wine; Ice cream mix; Ice milk mix; (naming the fruit) Jam; (naming the fruit) Jam with pectin; (naming the fruit) Jelly; (naming the fruit) Jelly with pectin; Light beer; Malt liquor; (naming the citrus fruit) Marmalade; (naming the citrus fruit) Marmalade with pectin; Mayonnaise; Pineapple marmalade; Pineapple marmalade with pectin; Porter; Salad dressing; Sherbet; Stout; Wine	(1) Good Manufacturing Practice
		(2) Canned pears; Canned strawberries	(2) Good Manufacturing Practice
		(3) Cold-pack cheese food; Cold-pack (naming the variety) cheese; Cold-pack (naming the variety) cheese with (naming the added ingredients); Cold-pack cheese food with (naming the added ingredients); Cream cheese spread; Cream cheese spread with (naming the added ingredients); Processed cheese food; Processed cheese food with (naming the added ingredients); Processed cheese spread; Processed cheese spread with (naming the added ingredients); Processed (naming the variety) cheese; Processed (naming the variety) cheese with (naming the added ingredients); (naming the variety) Whey cheese	(3) Good Manufacturing Practice
		(4) Margarine	(4) Good Manufacturing Practice
		(5) Unstandardized foods	(5) Good Manufacturing Practice
		(6) Cocoa products	(6) 1%, singly or in combination with citric acid, calculated on a fat-free basis

Lecture 8

Thickeners, Nutrients

4.5.6. Thickening Agent:

A thickening agent or thickener is a substance which can increase the viscosity of a liquid without substantially changing its other properties. Edible thickeners are commonly used to thicken sauces, soups, and puddings without altering their taste. Thickeners may also improve the suspension of other ingredients or emulsions which increases the stability of the product. Thickening agents are often regulated as food additives. Some thickening agents are gelling agents (gellants), forming a gel, dissolving in the liquid phase as a colloid mixture that forms a weakly cohesive internal structure. Others act as mechanical thixotropic additives with discrete particles adhering or interlocking to resist strain.

Food thickeners frequently are based on either polysaccharides (starches, vegetable gums, and pectin), or proteins. This category includes starches as arrowroot, cornstarch, katakuri starch, potato starch, sago, tapioca and their starch derivatives. Microbial and Vegetable gums used as food thickeners include alginin, guar gum, locust bean gum, and xanthan gum. Proteins used as food thickeners include collagen, egg whites, and gelatin. Sugars include agar and carrageenan. Other thickening agents act on the proteins already present in a food. One example is sodium pyrophosphate, which acts on casein in milk during the preparation of instant pudding.

Gelling agents are food additives used to thicken and stabilize various foods, like jellies, desserts and candies. The agents provide the foods with texture through formation of a gel. Some stabilizers and thickening agents are gelling agents.

Typical gelling agents include natural gums, starches, pectins, agar-agar and gelatin. Often they are based on polysaccharides or proteins.

Examples are:

- Alginic acid (E400), sodium alginate (E401), potassium alginate (E402), ammonium alginate (E403), calcium alginate (E404) - polysaccharides from brown algae
- Agar (E406, a polysaccharide obtained from red algaes)
- Carrageenan (E407, a polysaccharide obtained from red seaweeds)
- Locust bean gum (E410, a natural gum polysaccharide from the seeds of the Carob tree)
- Pectin (E440, a polysaccharide obtained from apple or citrus-fruit)
- Gelatin (E441, made by partial hydrolysis of animal collagen)

4.5.7 Nutrients as Food Additives:

Nutrients functions are to improve or maintain the nutritional quality of foods. Many food additives, including vitamins and minerals, serve nutritional functions. Other nutritional additives include amino acids, fatty acids as well as other pure chemical compounds.

Vitamins and minerals added to many common foods such as milk, flour, cereal, and margarine to make up for elements likely to be lacking in a personal diet, replace those lost in processing or improve shelf life.

Most salt contains iodine to prevent goiter a condition resulting for iodine deficiency. It was one of the earliest used of nutritional additives to correct dietary deficiencies. In 1833, the French chemist Boussingault recommended the addition of iodine to table salt to prevent goiter.

Nutritional additives can be used to restore nutrients to levels found in the food before storage, packaging, handling and processing.

Other example of nutritional additives is fluoride may be added to drinking water to supply the mineral fluorine, required for normal tooth development in children.

Margarine, for example, is used as substitute for butter for economic reasons, Vitamin A and D thus need to be added to margarine to raise it nutritional value equal to that of the butter. Nutritional food additives.

Question Bank:

Group A

1. Multiple choice question (MCQ) (answer any ten) (10X1=10)

(i)The color of

a)Erythrosine is red and Tartrazine is yellow.

b)Erythrosine is yellow and Tartrazine is red.

c)both are red.

d)both are yellow.

(ii) Nutra-sweet is nothing but

a)Saccharin. b)Aspartame. c)Stevioside. d)none of these.

(iii) Masa is prepared from

a) wheat, b) corn, c) rice, d) maize

(iv) During baking process of bread ethanol is

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a) absorbed, b) evaporated, c) condensed, d) reacted

v) The enzyme which is used to clarify the fruit juice is

a) starch liquefying enzyme b) pectinase c) proteolytic enzyme d) all of these

vi) To clarify the fruit juice fining agent(s) used

a) gelatin b) casein c) albumen d) all of these

vii) In Pasteurized fruit juice the bacteria which may be present is

a) *Bacillus subtilis* b) *Bacillus mesentericus* c) both of these d) none of these

viii) Apple is a fruit having

a) low-acid, low-pectin b) low-acid, high-pectin c) high-acid, high-pectin d) high-acid, low-pectin

(ix)Example of a thickener is

a)mannitol. b)starch, c)sugar, d)none of these

(x)The beverage which does not contain fruit pulp is

a)fruit juice. b)fruit cordial, c)fruit squash, d)none of these

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(xi) The fat content of sponge cake is

a) 20%, b) 35%, c) 6%, d) 11%

(xii) Bread flour should contain at least

a) 5%, b) 11%, c) 8%, d) 15% of protein

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xiii) Liquid pectin is commercially prepared from

a) papaya b) guava c) pomegranate d) none of these

xiv) Jellying temperature (in ^{0} C) is

a) 40-45 b) 80-100 c) 104-105 d) 120-121

xv) Fresh tomato juice has T.S.S.

a) 5.66% b) 8.37% c) 12% d) 25%

xvi) The maximum limit of permitted synthetic colour to be used in a food product is

a) 40 ppm b) 200 ppm c) 350 ppm d) 1000 ppm

(xvii)Fruit containing adequate pectin and low quantity acid is

a) guava. b)apple. c)pomegranate, d)none of these.

(xviii)In production of citrus peel oil preliminary treatment of peel is done by

a) $CaCl_2$, b)$NaHCO_3$, c)both of these, d)none of these.

(xix) During bread making oxidizing agents are used to oxidize

a) –SH group, b) –COOH group, c) –CHO group, d) S-S group

(xx) Insect contamination of wheat grain can be detected by

a) maltose test, b) starch test, c) soft x-ray analysis, d) protein test

xxi) Saffron contains

a) bixin b) crocetin c) curcumin d) none of these

xxii) Under the brand name of Nutra-sweet

a) aspartame b) sucralose c) acesulfame-K d) saccharine is sold.

xxiii) Under the brand name of Splenda

a) aspartame b) sucralose c) acesulfame-K d) saccharine is sold.

xxiv) The only inorganic acid permitted to food is

a) hydrochloric acid b) sulfuric acid c) phosphoric acid d) citric acid

(xxv)Cocoa and chocolate contain the alkaloid substance

a)theobromine, b)caffeine, c)both of these, d)none of these.

(xxvi)Saffron contains the coloring material

a) bixin, b)crocetin, c)curcumin, d)none of these.

(xxvii) Hard wheat is used for preparation of

a) Bread, b) Cake, c) Pastry, d) None of these

(xxviii) The maximum moisture content of flour is

a) 10%, b) 14%, c) 5%, d) 9%

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xxix) Example of non-carbohydrate material is

a) pectin b) gelatin c) alginic acid d) guar gum

xxx) Mannitol is used as

a) humectant b) anti-sticking agent c) both of these d) none of these.

(xxxi)Anatto is the same as

a)bixin, b)crocetin, c)curcumin, d)none of these.

(xxxii)The volatile toxic component formed during roasting of coffee beans is

a)caffeine, b)2-thiofuran, c)chicory, d)none of these.

(xxxiii) Incorn the most abundant protein present is

a) albumin, b) prolamine, c) avenin, d) globulin .

(xxxiv) Triticale is a hybrid of

a) wheat and rye, b) rye and corn c) bajra and ragi, d) none of these

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(xxxv)Splenda is the brand name of

a)aspartame, b)sucralose, c)glycyrrhizins, d)steviocide.

(xxxvi)Hot pulping of tomato juice gives

a)less yield of the juice. b)poor color of the juice. c)good flavor of the juice. d)none of these

(xxxvii) The gas produced in yeast leavened dough is

a) CO_2 , b) O_2 , c) H_2S, d) N_2 .

(xxxviii) The protein content of soft wheat is in the range of

a) 8-11%, b) 11-15%, c) 12-18%. d) 5-8%

(xxxix) The sugar in flour is mostly

a) glucose, b) maltose, c) fructose, d) sucrose

(xxxx) Durum Wheat Flour is used for the production of

(a) Bread, (b) Cake, (c) Biscuit, (d) Pasta

(xxxxi) Pyrethrin and Malathion are used to prevent or control

a) rancidity, b) acidity, c) infestation, d) none of these

GROUP - B

Short Answer Type Questions (SQ)

(Answer any three) (5 X3=15)

2.What is field heat? What will happen if it is not removed? How can it be removed? 5

3.Write short note on ant caking agent. 5

4. What are the differences between jam and preserves? What are the differences between jelly and marmalade?

5. Give the nutritional facts of Potato. How does acrylamide form during potato chips preparation? How it can be minimized? (2+2+1)

6. What is parboiling? Describe the hot soaking process of parboiling of rice? Explain the problems associated with conventional parboiling process. (2+2+1)

7. Compare the nutritive value of rice and wheat. What is Spaghetti? (4+1)

8. What are the causes of deterioration of a freshly-extracted fruit juice?5

9.Write a short note on humectant. 5

10.Which type of organisms mainly attack the jams and jellies and why? Discuss about weeping of jelly. 2+3=5

11. How gluten is formed and explain its role in cereal cookery. (2+3)

12. Write short notes on: (any two) (2 ½ x 2= 5)

a) Macaroni products

b) Agglomerated flour

c) Triticale

d) Breakfast cereals from corn

e) Function of break rolls and reduction rolls during milling of wheat

f) Parched rice product

13. Explain the role of ingredients used in bread making. (5)

14.What are lakes? What is Annatto? Why are the permitted synthetic colours known as coaltar dyes? 1+2+2=5

15. What is tomato ketchup? What are its specifications? What are the differences between tomato sauce and tomato ketchup? 1+2+2=5

16. What are the qualities which make a compound suitable to be chosen as an artificial sweetener? 5

GROUP - C

Long Answer Type Questions (LQ)

(Answer any three) (15X3=45)

17. What are the different components of tea extract? What are their functions? Name the main alkaloid present in tea. What are Fannings? Give the flow sheet of black tea processing. What is the range of ash content of tea? What are significances if the ash content of a tea sample is higher or lower than this value? What are the differences of between green tea and oolong tea? 1+3+1+1+3+1+3+2=15

18. How pectin can be produced commercially from apple pomace? What is the jelly grade of pectin? How can it be determined? What is tomato puree? What are the differences of tomato sauce and tomato ketchup? 7+2+2+2+2=15

19. What is the pigment present in sweet potato? How the bitter compounds is associated with potato due to rough handling and faulty storage? Discuss about the storage and handling hindrance of raw potato in West Bengal. Give the flow sheet of potato powder processing. Define and explain the terms retrogradation and syneresis of starch. 1+3+4+3+4=15

20. What is the importance of storage of cereals in keeping view of Indian climate? What are the problems associated with storage of cereals? As an industry person what are the measures you will take to increase the storage life of cereals? Explain the terms “Bin burning” and “Bin drying”. 3+4+5+3=15

21. a) What is jelmeter test?

b) What is alcohol test for pectin?

c) Discuss briefly about the theory of jelly formation.

d) Discuss about the commercial production of pectin from any one suitable source.
2+2+5+6=15

22.a) Suggest with explanation the name of the preservative used to preserve pomegranate juice.

b) What are the differences between fruit cordial and fruit nectar?

c) What are the specifications of a fruit squash?

d) Which types of materials can be used to make utensils for food processing?

e) Why does a squash require more quantity of preservative than jelly for preservation?

f) Calculate the sugar acid and preservative required to prepare an orange squash from 500 ml juice having 0.4% acidity and 80 brix. 2+2+2+2+1+6=15

23.Write Short Notes On: (any three) (3x5=15)

a) Durum wheat

b) Rice polish

c) Utilization of Rice bran

d) Lye peeling

e) Importance of Infestation control during storage of cereals

f) Importance of parboiling process of rice

24. Explain the modern rice milling process with a flow diagram. Discuss about the importance of extractive milling of rice-Explain the process briefly. Write a short note on the utilization of by-products of rice milling process. 7+4+4=15

25.a) What is tomato puree and tomato paste?

b) Compare hot pulping and cold pulping method of tomato.

c) What are the functions of acids and alkali in food processing? (2+2)+5+(3+3)=15

26. a) What is the function of roasting of coffee beans in coffee processing?

b) What is chicory?

c) Discuss whether the use if chicory in coffee is considered as adulteration or not.

d) Name the compounds which are responsible for the stimulant and bitterness of coffee.

e) Name the compounds responsible for the flavour and aroma if coffee.

f) What do you mean by staleness of coffee? 4+1+3+(1+1)+2+3=15

27. What is the purpose of using air classifiers and impact mills in flour milling process? Explain in short how air classifiers and impact mills work. Differentiate between patent flour and whole wheat flour. How tempering and conditioning improve the milling efficiency of wheat- discuss the processes briefly. 3+4+ 2+6=15

28. Explain the following Procedures: (any three) (3x5=15)

a) Extraction of kafirin from Sorghum

b) Industrial production of Corn flakes

c) Drying of cereal grains

d) Industrial production of Potato chips

e) Extraction of zein from Corn

29. a) Compare green tea with black tea.

b) What is oolong tea?

c) Discuss about the significance of ash content of tea.

d) Why cannot the cocoa mass be used directly for the preparation of beverages?

e) What are “nibs”?

f) How can you determine experimentally whether a jelly is natural or synthetic?

g) How can you remove the pesticide residues from an apple before processing?

h) Name the toxic compound present in potato? 5+1+2+1+1+2+2+1=15

30. Describe briefly about the wet milling process of corn. Name the different products and by-products obtained from corn by dry and wet milling process. Discuss about the traditional food products obtained from corn by extrusion cooking. 7+3+5=15

31.Define gelatinization of starch. Explain the factors affecting gelatinization. Bring out the importance of gelatinization temperature of starch. 3+7+5=15

32.a)From 20 pieces of oranges 800 ml. juice was extracted having 10 brix. The acidity of the juice is o.4%. Find the quantity of sugar acid and preservative needed and also determine the final volume of squash. (You have to keep the acidity 1.5%) 10

b)What is weeping of jelly? What are the reasons behind it? What are its after effect? How can it be checked? 1+2+1+1=5

33.a)What are the necessary qualities for a compound to be selected to be a low calorie sweetener? What are the disadvantages of saccharin? Write your comment on the safety of use of aspartame? 5+2+2=9

b)What are the functions of CO_2 in carbonated beverages? What are fruit juice and fruit punches? 2+2+2=6