Bakery RMs & Ingredients

Neha Bhavsar
Application Specialist
DuPont India Pvt. Ltd.

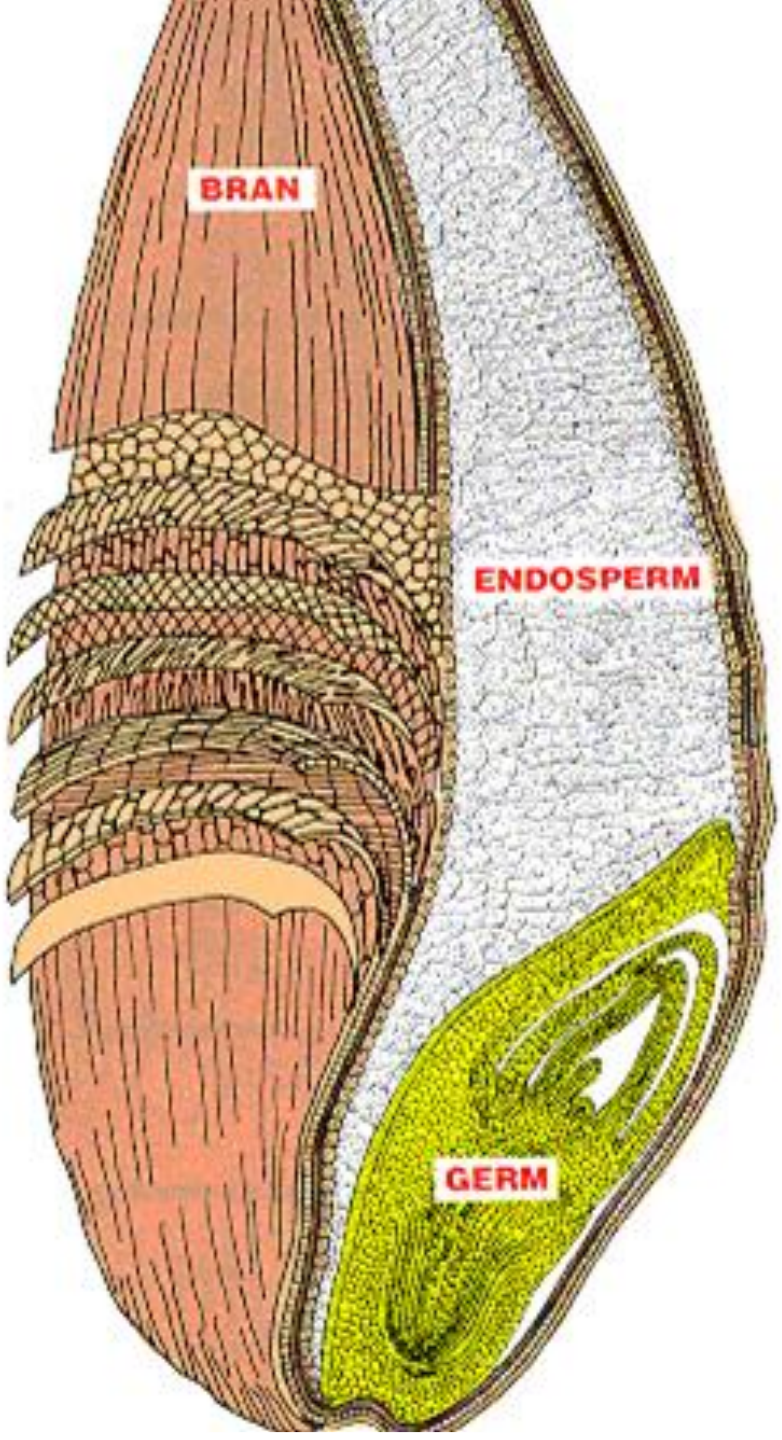
Content:

- Wheat Flour
- Sweeteners
- Shortening
- Leavening Agent
- Eggs
- Salt
- Water
- Emulsifiers
- Enzymes
- Flavoring and Coloring Agents

Wheat Flour:

Wheat components
Endosperm 83%
Bran 14.5%
Germ 2.5%

Wheat flour components
Starch 80%
Protein 10-18%
Non-starch polysaccharides 2-5%
Lipids 1-2%



Classification of Wheat:

Time of planting/season

- **Spring**
- **Winter**

Color

- **Red**
- **White**

Kernel hardness

- **Soft**
- **Hard**

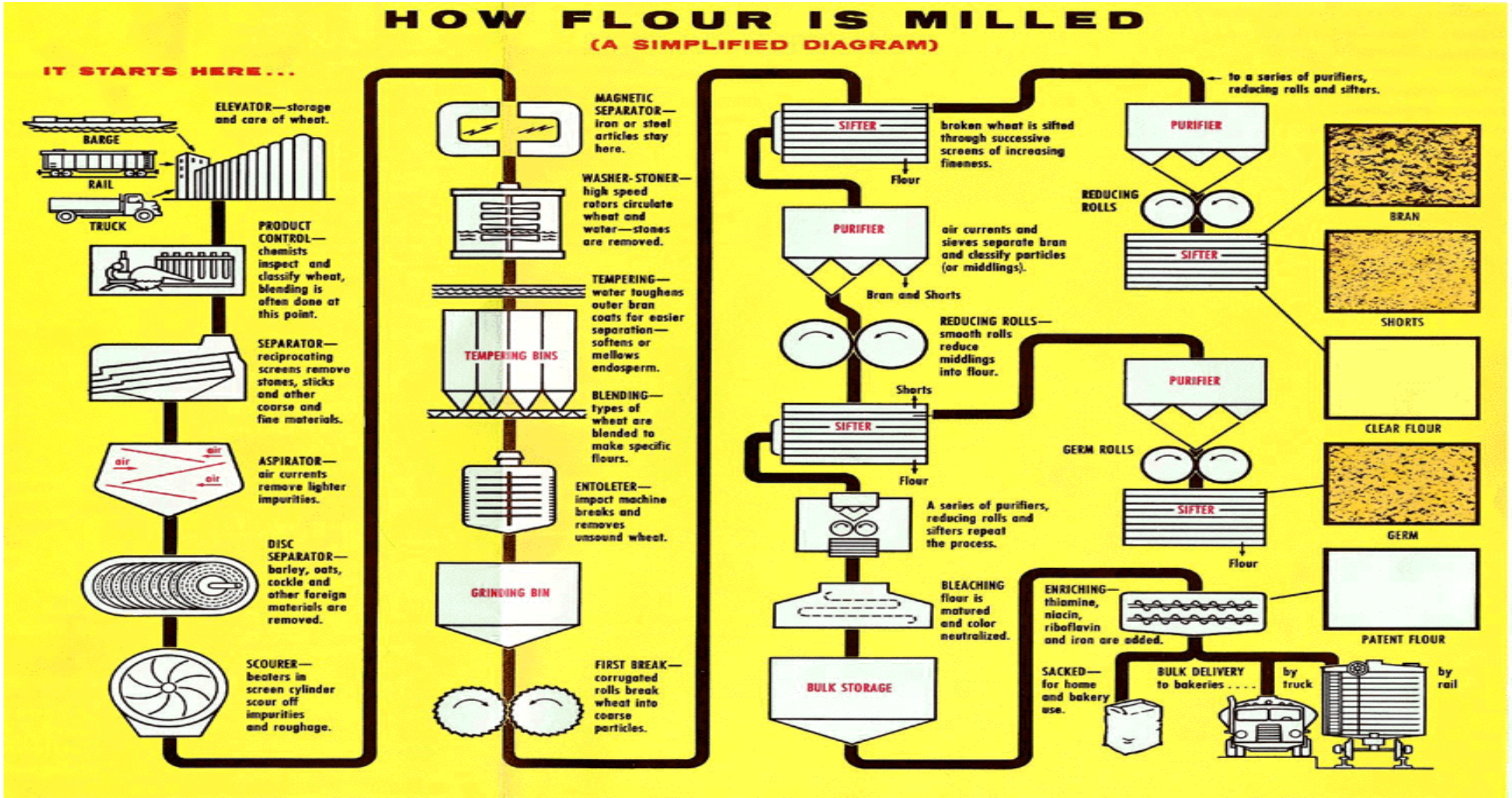
- **Wheat can be classified according to time of planting, color, and kernel hardness.**
  - **Time of planting, or season** classifications include spring wheat and winter wheat.
  - **Classification by color** includes red-kernel wheat and white-kernel wheat.
  - **Classification by kernel hardness** includes soft-kernel or hard-kernel.
- **INDIAN CLASSIFICATION**

  Three species of Wheat namely, (i) T. aestivum, (ii) T. durum and (iii) T. dicoccum are being cultivated in the india.

Application and specification:

- The harder the wheat, the higher the amount of protein in the flour.
- **Hard, high (11-12%) protein wheat** is used in breads as it produces the coarse flour used in breads.
- **Soft, low (8-10%) protein wheat** is used in cakes, pastries, biscuits and crackers because it produces finer textured flour.
- **Durum wheat (>12% protein)**, a hard wheat with high gluten* content, is used in pasta and egg noodles.
- Durum wheat is also used for making semolina.
- * Gluten is a high protein constituent of wheat.

Wheat Milling:



Products from Wheat Milling:

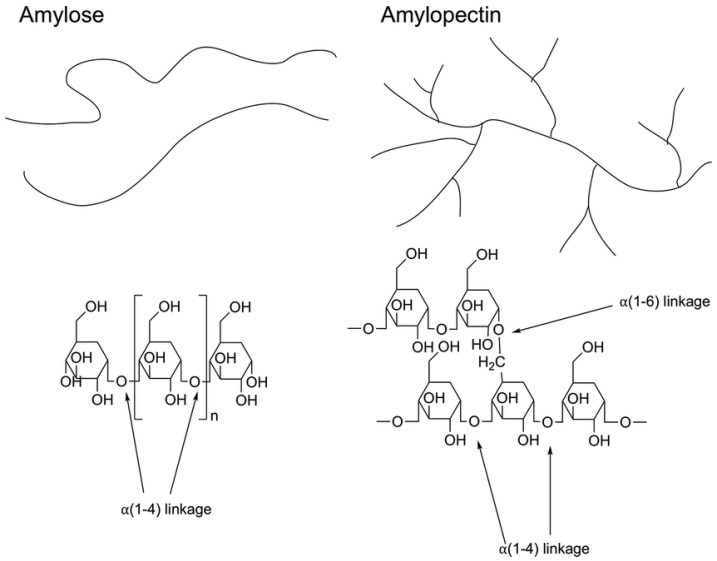
- **White flour**
- **Reconstituted flour:** made by blending of proper proportion of bran, germ and endosperm
- **Patent flour:** The most highly refined flour that is cut off flour (combination of flour streams) from the front of the mill, lower in ash and protein with good dress and color and marketwise is considered highest in value
- **Treated flour:** Flour to which some supplement has been added such as vitamins, calcium, iron, self-rising ingredients, etc.
- **Composite flour:** A flour made by blending varying amounts of non-wheat flour with wheat flour and used to produce baked goods that are traditionally made from wheat flour
- **By-products**: White germ, white feed and bran

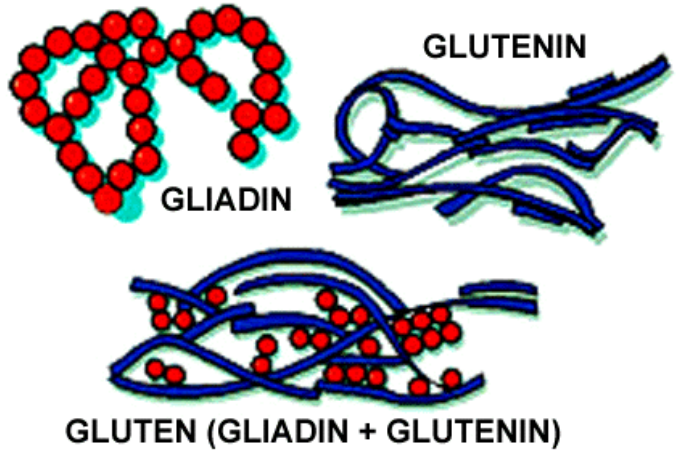
Wheat Flour Composition:

- Starch: Amylose (10-30%) and Amylopectin (70-90%), can absorb same amount of water

- Protein: Glutenin and Gliadin make Gluten (85% of wheat protein) Albumin and Globulin (15% of wheat protein) water soluble and non-dough forming. Gluten can take upto 1.5-2 times water

- Non Starch Polysaccharides: It is present as 2-3% of wheat flour and they interact with other flour components. Can hold 10times water of its weight





Flour Quality Analysis:

Physical	Chemical and Bio-Chemical	Rheological
• Color • Granularity	• Moisture • WAP • Ash content • Gluten • Sedimentation Value • Falling Number	• Farinograph Characteristics • Extensograph Characteristics

Flour Analysis:

- **Moisture Content**: Hot air oven or moisture meter is used.

Moisture content of flour indicates flour quality, storage condition

Very critical for millers

- **Ash Content:** Muffle furnace is used.

Indicates mineral content of flour.

White flour has lower mineral content, good for cakes and cookies.

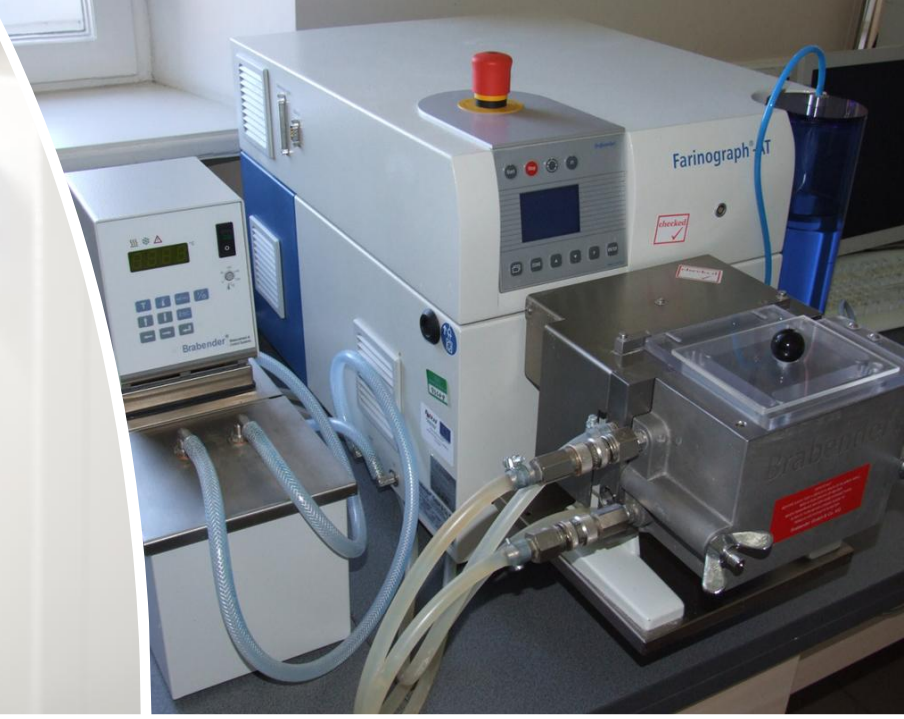
- **Protein Content:** Dumas Method used now a days.

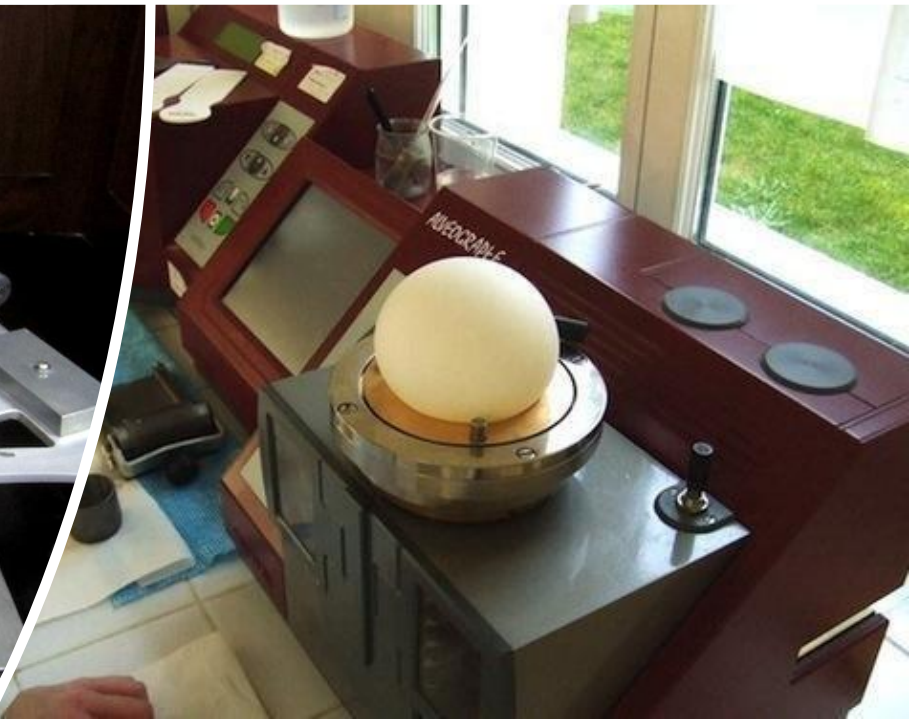
Protein content of flour related to water absorption, gluten strength and also final product attributes.

Flour Analysis:

- **Gluten Analysis:** The wet gluten test provides information on the quantity and estimates the quality of gluten in wheat or flour samples. Gluten is responsible for the elasticity and extensibility characteristics of flour dough.
- Wet gluten content is determined by washing the flour
- Gluten Index, which is an indication of gluten strength. A high gluten index indicates strong gluten.
- **Falling Number:** The FN of a flour is related to the amount and activity of cereal enzyme α-amylase, which is pre. sent in the wheat after harvesting.
- Falling number results are expressed in time as seconds.
- A high falling number (for example, above 300 seconds) indicates minimal enzyme activity and sound quality wheat or flour.
- A low falling number (for example, below 250 seconds) indicates substantial enzyme activity and sproutdamaged wheat or flour.

Rheological Analysis





Mixograph:

- The Mixograph is a dough testing equipment used to assess the baking quality of flours from soft, hard and durum wheat. It provides information on the mixing and absorption characteristics of flour.

- *Mixing Time (MT): It* is the time required for the mixing curve to reach the maximum height or peak.

- *Peak Dough Resistance (PDR): It* is the peak height from the base line to the center of the curve.

- *Bandwidth at Peak Dough Resistance (BWPR) :* It is the maximum width of the mixing curve at PDR. A narrow width is often taken as an indication of dough ‘weakness’.

Farinograph:

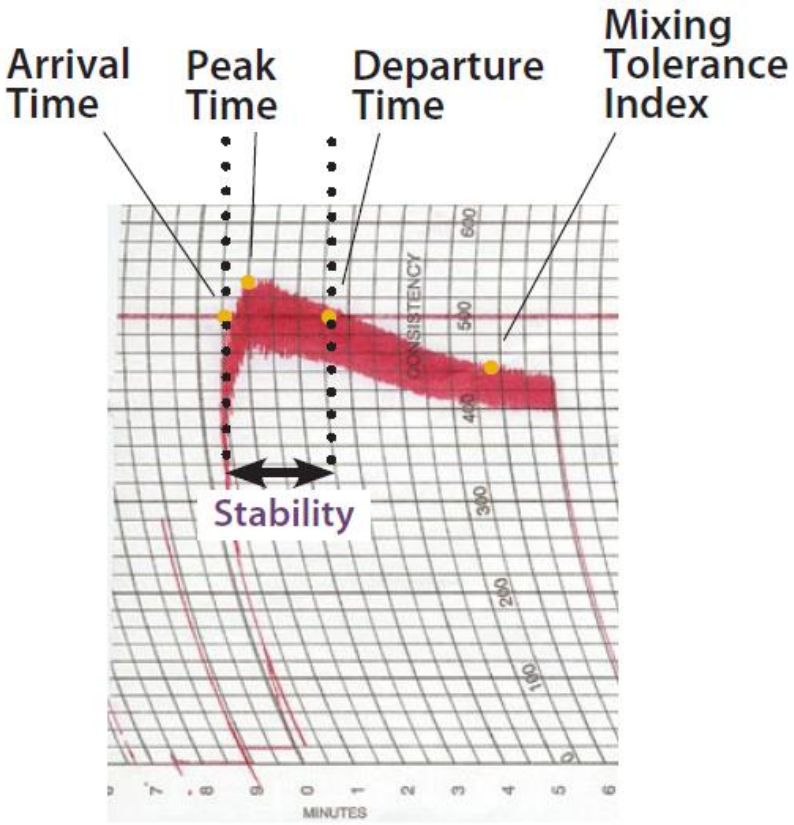
- Farinograph is a recording dough mixer. It measures and records the resistance offered by dough against mixing blades operating at a constant speed and temperature.

- Parameters obtained from the resulting curve relate to the amount of water required to reach a desired peak consistency.
- Farinograph water absorption value: The amount of water added to balance the curve on the 500-BU line, expressed as a percentage of the flour (14% mb)
- Dough development time or mixing time or peak time: This is the time between the origin of the curve and its maximum. The maximum of the Farinogram curve, or any mixing curve, is commonly considered the point at which the dough is optimally developed and best able to retain gas.

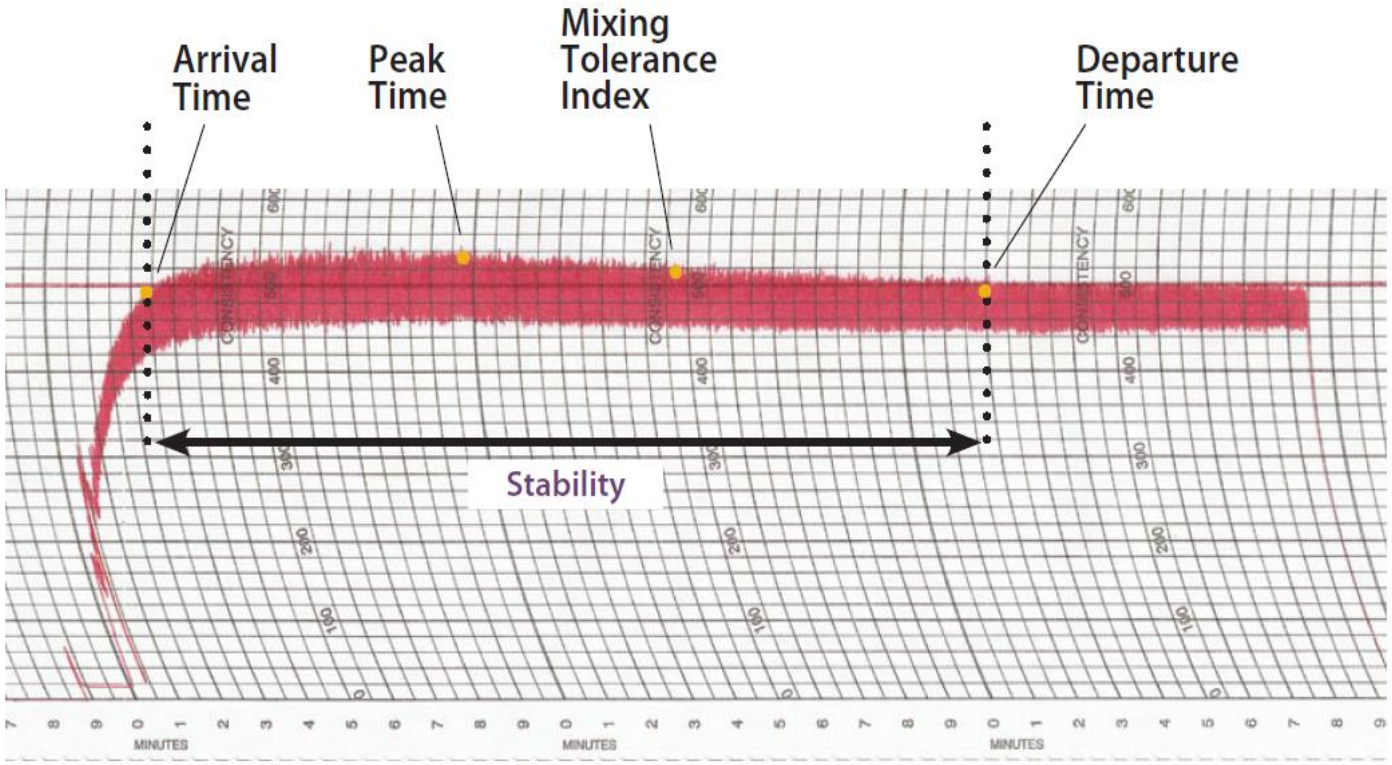
- Mixing tolerance index: It is measured as the difference (in Brabender units) between the top of the curve at the maximum and the point on the curve 5 minute later.

- Stability: It is defined as the difference in minutes between the arrival time and the time the top of the curve falls below the time 500 BU line (i.e. the departure time).

Farinograph



Weak Gluten Flour

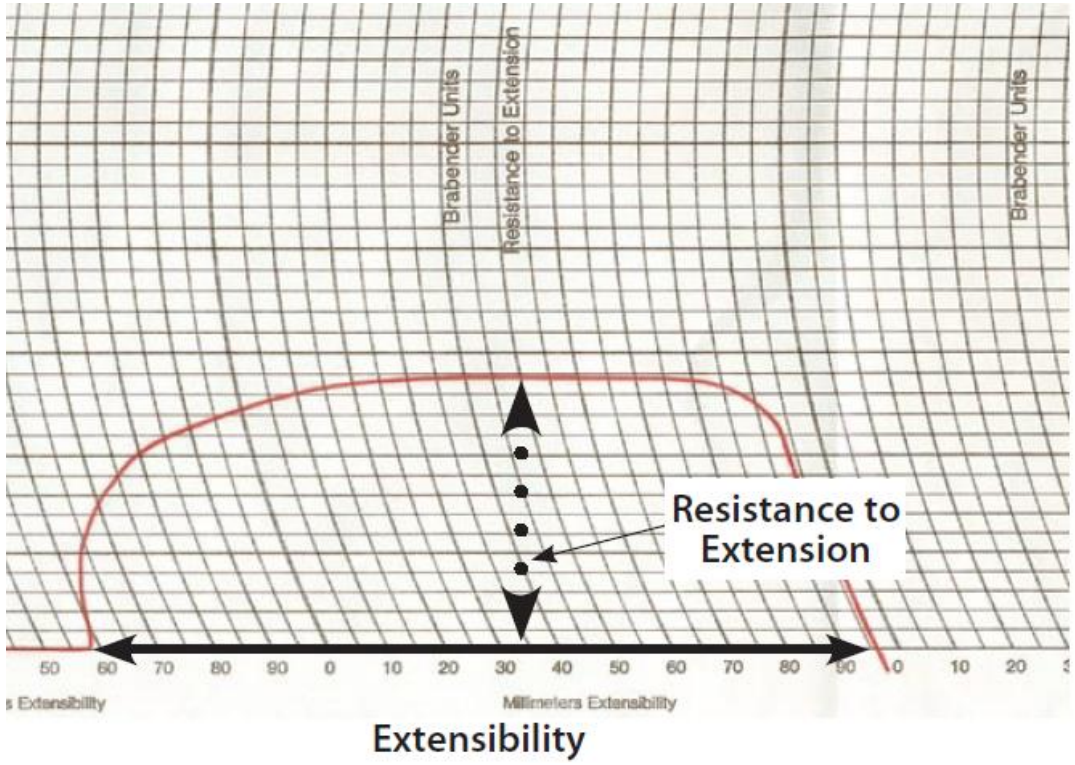


Strong Gluten Flour

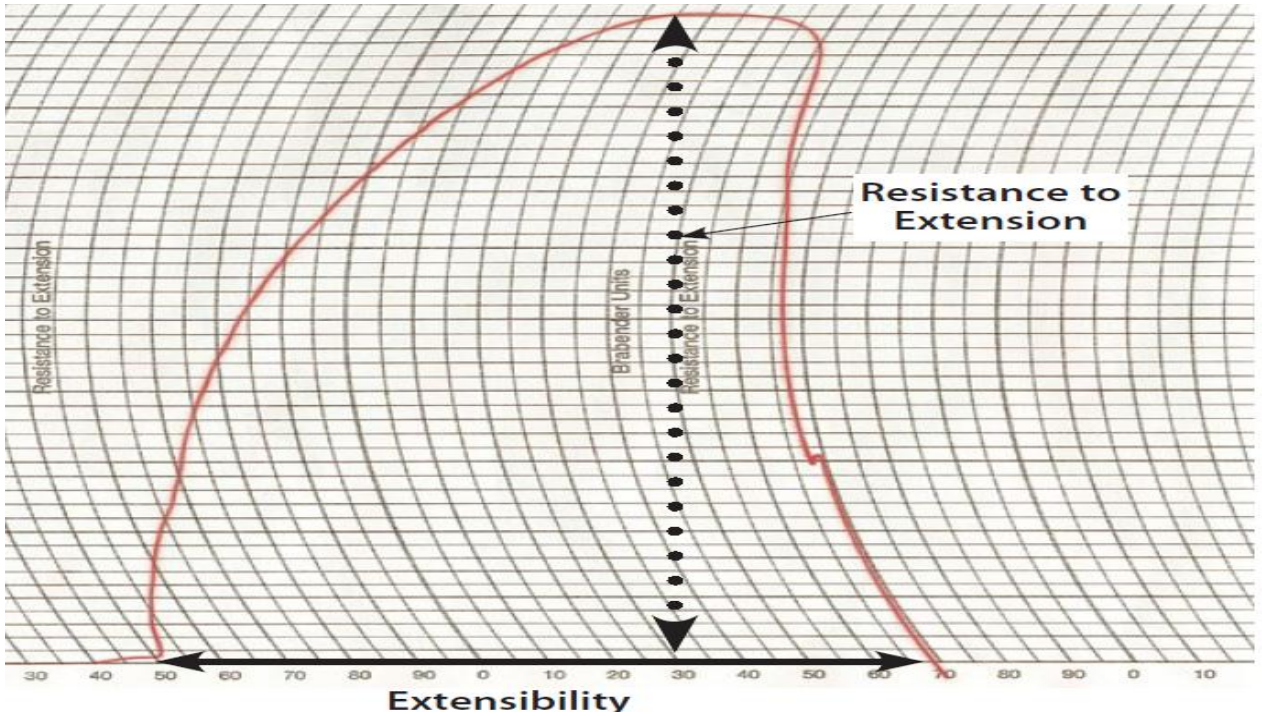
Extensograph:

- The extensograph measures the extensibility and resistance to extension of fully mixed, flour-water dough.
- The force required to stretch the dough is automatically plotted against the distance it stretches to give extensograph curve.
- Dough is stretched under constant load and there is constant speed of moving hook, which stretches the dough.
- Extensibility (E): Length of the curve in millimeters.
- Resistance to extension ®: Height of extensograph in B.U. measured 5 cm after the curve has started.
- Ratio figure: Ratio between resistance and extensibility i.e. R/E
- Strength value: Area of curve - Measured by Planimeter. More the area, strong is the dough.

Extensograph:



Weak Gluten Flour

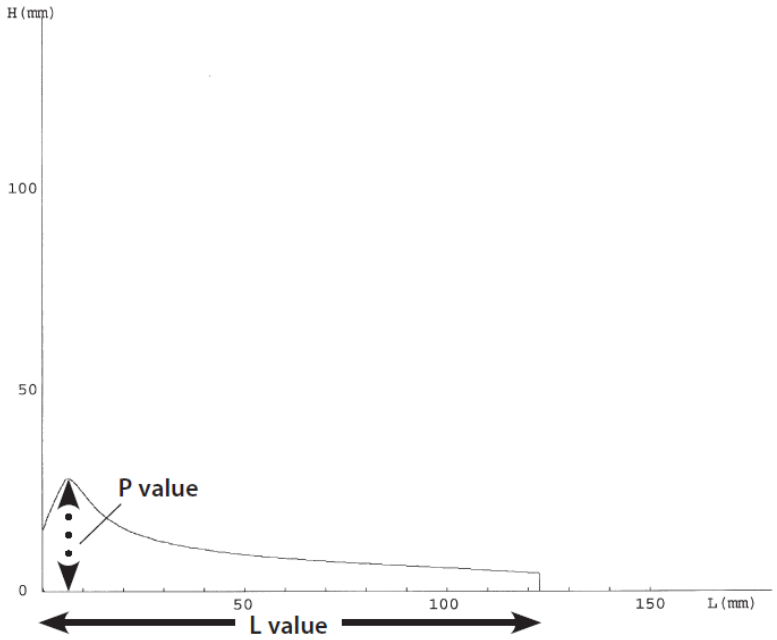


Strong Gluten Flour

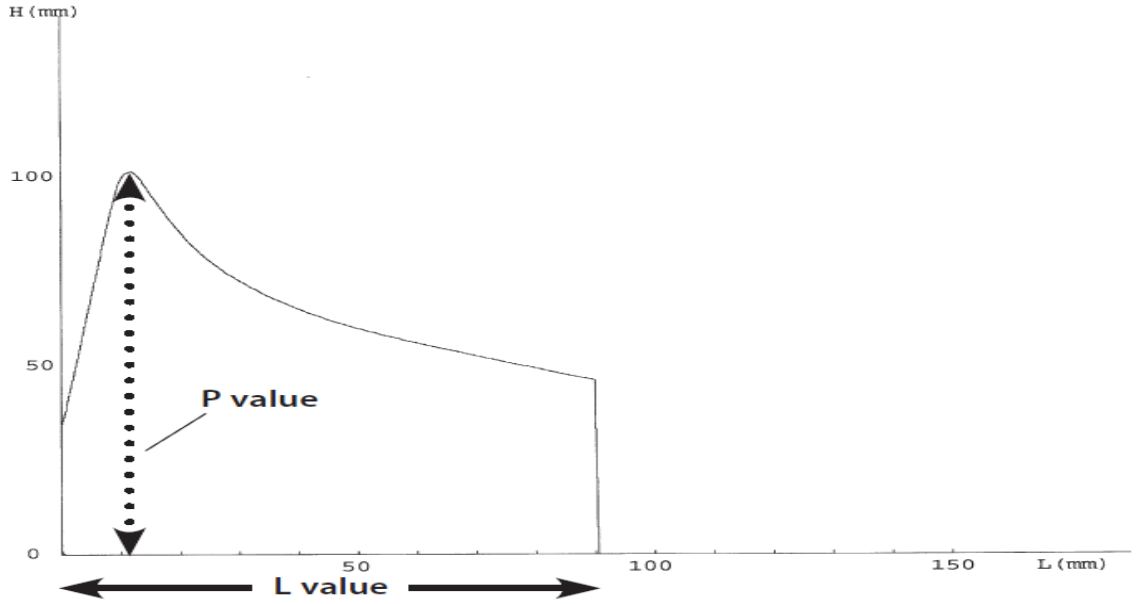
Alveograph:

- The alveograph determines the gluten strength of a dough by measuring the force required to blow and break a bubble of dough.
- The results include P Value, L Value, and W Value
- A stronger dough requires more force to blow and break the bubble (higher P value).
- A bigger bubble means the dough can stretch to a very thin membrane before breaking.
- A bigger bubble indicates the dough has higher extensibility;that is, its ability to stretch before breaking (L value).
- A bigger bubble requires more force and will have a greater area under the curve (W value).

Alveograph:



Weak Gluten Flour



Strong Gluten Flour

Sweeteners:

There are six types of sweeteners

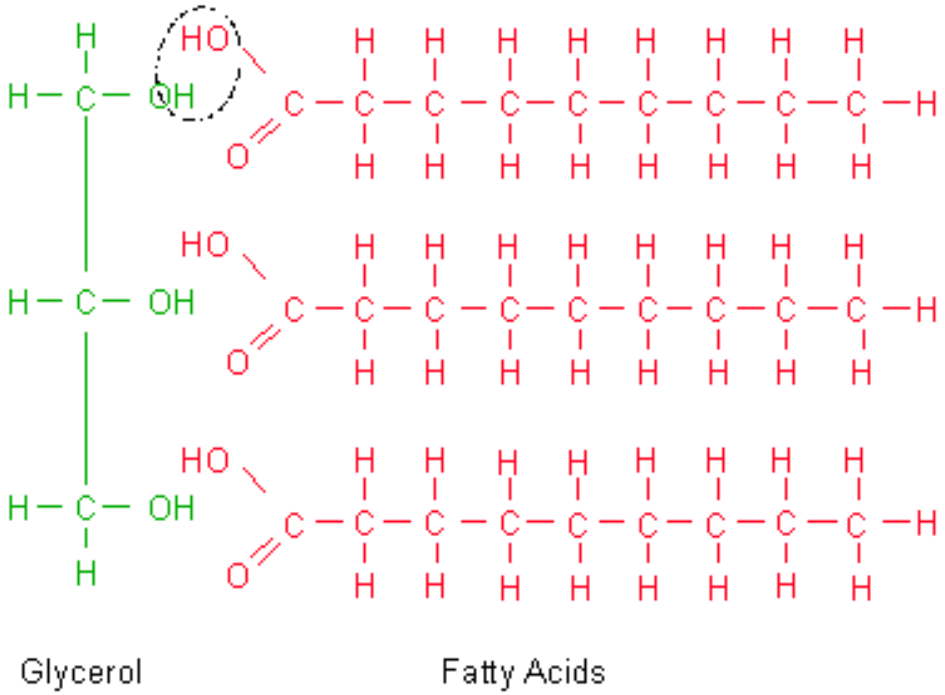
1. Sugars
2. Sugar Alcohols
3. Natural Caloric Sweeteners
4. Natural zero Calorie Sweeteners
5. Modified Sugars
6. Artificial Sweeteners

Functionality of Sugar in Baking:

- Sweetness and Flavour
- Browning and colour
- Creaming and foaming agent
- Shelf life improvement by holding water
- Texturizer and bulking agent

Shortening:

Structure:



Glycerol Fatty Acids

Fatty Acid Types:

Types of Fatty Acids	Examples of Sources	Health Impacts and Intake Recommendations
Saturated • No double bond • Straight structure • Solid at room temperature	Beef, Butter, Coconut oil	• Increase risk of heart disease • Less than 20g of saturated fats per day (for a 2000 kcal diet)
Trans • One or more double bonds in trans configuration • Straight structure • Semi-solid/Solid at room temperature	Margarine, Cream soup with puff pastry, Chicken pie	• Increase risk of heart disease • Less than 2.2g of trans fats per day (for a 2000 kcal diet)
Monounsaturated • One double bond in cis configuration • Bent structure • Liquid at room temperature	Olive oil, Canola oil, Peanut oil	• May reduce risk of heart disease • Moderate intake of monounsaturated fats
Polyunsaturated • Multiple double bonds in cis configuration • Even more "bent" in structure • Liquid at room temperature	Soybean oil, Corn oil, Fatty fish	• May reduce risk of heart disease • Moderate intake of polyunsaturated fats

Fat Functionality:

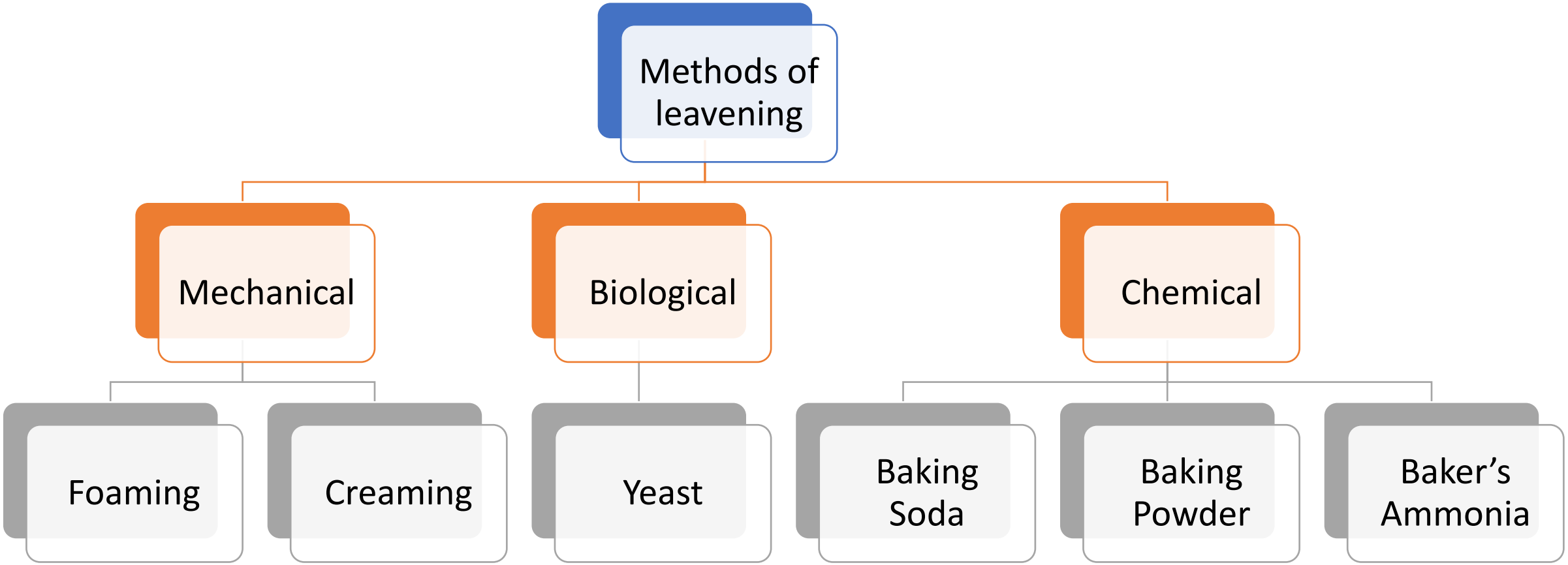
- Tenderizing agent
- Helps with Leavening
- Moistness and Mouthfeel
- Lubrication
- Heat Transfer

Leavening Agents:

- To lighten or raising action to aerate dough or batter during mixing/fermentation/baking
- Provides volume, shape, texture and make product palatable.

Type of Leavening Agents:

1. Common - Air (during mixing)
2. Biological - Yeast
3. Chemical – Baking soda, baking powder, ammonium bi-carbonate


Methods of leavening
Mechanical
Biological
Chemical
Foaming
Creaming
Yeast
Baking Soda
Baking Powder
Baker's Ammonia

Yeast (saccharomyces cerevisiae):

$C_6H_{12}O_6$	→	$2CO_2$	+	$2C_2H_5OH$
Simple sugar		carbon dioxide		alcohol

yeast acts on sugars and changes them into carbon dioxide gas and alcohol.

•Fermentation activity of yeast is made possible because of the combination of various enzymes present in its cytoplasm like:

- **Invertase**: convert sucrose into dextrose and fructose.
- **Maltase**: convert maltose into dextrose
- **Zymase**: convert dextrose into CO_2, alcohol. And other substances which give the flavour to the product.
- **Protease**: mellow the flour protein and give better stretch ability to acquire volume and form structure.

Yeast is sensitive to temperature

Forms Of Yeast: main difference is moisture content.

Compressed yeast: also called fresh yeast.

It is moist and perishable and is preferred by professional bakers.

Active dry yeast is a dry, granular form of yeast.

It must be rehydrated in 4 times its weight of warm water [about 110°F (43°C)] before use.

Instant active dry yeast is also a dry granular form of yeast, but it does not have to be dissolved in water before use.

Has higher % of live cells per unit volume.

Note: Dry yeast are good choice for longer term storage.

Chemical Leavening Agents:

Baking Soda

- sodium bicarbonate "$NaHCO_3$
- liberate carbon dioxide, a leavening gas, when heated or mixed with an acid.

- Na_2CO_3 is formed, the resultant products will be alkaline and may have a bitter, soapy after taste.

Baking Powder

- **baking soda** (CO_2 carrier) + one or more **leavening acids** (acidulants) + **filler (**Separating agents).
- Acidulant to be used in a system primarily depends on:
- **neutralizing value(**

$$\text{Neutralizing value} = \frac{\text{Grams of CO2 carriers}}{\text{Grams of leavening acids}} \times 100$$

),

- **rate of reaction**
- **pH requirement**

Baker's Ammonia

- **Ammonium bicarbonate** [$NH_4HCO_3 \rightarrow NH_3 + CO_2 + H_2O$]
- These molecules **break down into** the gases **ammonia, carbon dioxide** and (water) **steam** when heated to 60°C or higher
- No acid required to work

Eggs:

Egg is composed of three parts. They are as follows:

- Shell- 12%
- White/ Albumen-58%
- Yolk-30%

Available in various forms:

Fresh
Liquid
Frozen
Dried

	Whole egg	Yolk	White
Moisture	73 %	50 %	86 %
Protein	14 %	17 %	12 %
Fat	12 %	31 %	0.2 %
Sugar (glucose)	0	0.2 %	0.4 %
Ash	1.0 %	1.5 %	1.0 %

Functionality of Eggs:

- Leavening
- Form emulsions
- Build structure
- Tenderize
- Add moisture and nutritive value
- Improve flavor and add color
- Shortening

Salt:

Functionality:

- Flavor enhancer
- Control dough fermentation
- Tightening effect on gluten
- Effect on crust color

Role of water in Bakery:

- Interaction with flour- Gluten development, combine all ingredients together
- Major requirement for enzymes to activate and work with flour components, maintain dough viscosity and consistency
- Temperature adjustment of dough and batter
- Medium for leavening agents. Carbon dioxide produced by yeast during fermentation is dissolved into water present in dough phase. Which expands during fermentation and gives porous texture to final product.
- During baking, key transformation such as gelatinization and gluten coagulation happens due to presence of water.
- Water plays crucial role in organoleptic quality. High moistness in bread indicates fresher product.
- In cookies & biscuits, moisture content usually below 5% to keep product crispy.

Emulsifiers:

Emulsifiers are molecules that have two different ends:

- A hydrophilic end (water-loving) that forms chemical bonds with water but not with oils**.**
- A hydrophobic end (water-hating) that forms chemical bonds with oils but not with water.
- Although all surfactants are amphiphilic, they have different degrees of hydrophobic (***lipophilic) and hydrophilic character. This*** can be expressed as the ***hydrophilic/lipophilic balance, or HLB. An HLB scale has*** been developed, which goes from 1 to 20

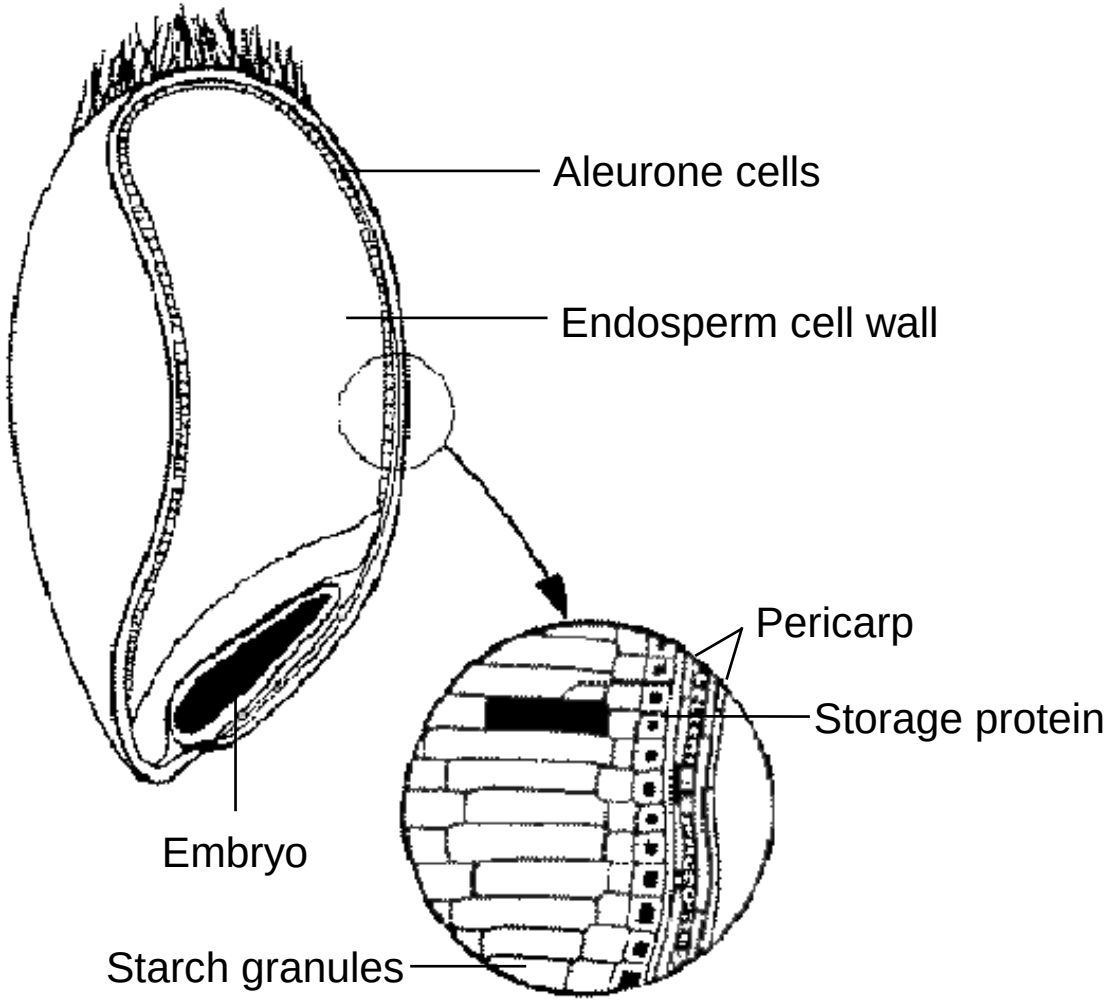
Functionality of Emulsifiers:

DATEM- Dough strengtheners. When added to dough, they improve mixing tolerance, gas retention, resistance of the dough to collapse, improves loaf volume.
SSL – crumb softener, shelf-life extension by reducing the rate of starch retrogradation
Distilled Mono Glyceride – Delay staling, batter stabilization

Enzymes:

Wheat flour components	Ingredients	Functionality
Starch 80%	Amylases	Flour conditioning Crumb softness Extended shelf life
Protein 10-18%	Proteases	Dough rheology
	Oxidative enzymes	Dough handling Dough stability
Non-starch polysaccharides 2-5%	Xylanases	Dough stability Volume
Lipids 1-2%	Lipases	Crumb structure Dough stability Volume

AMYLASES



Main Cereal Constituents	
Starch	**80%**
Proteins	7-15%
NSP	
Arabinoxylan	2-5%
Lipids	2-3%
Amylose	20-30%
Amylopectin	70-80%

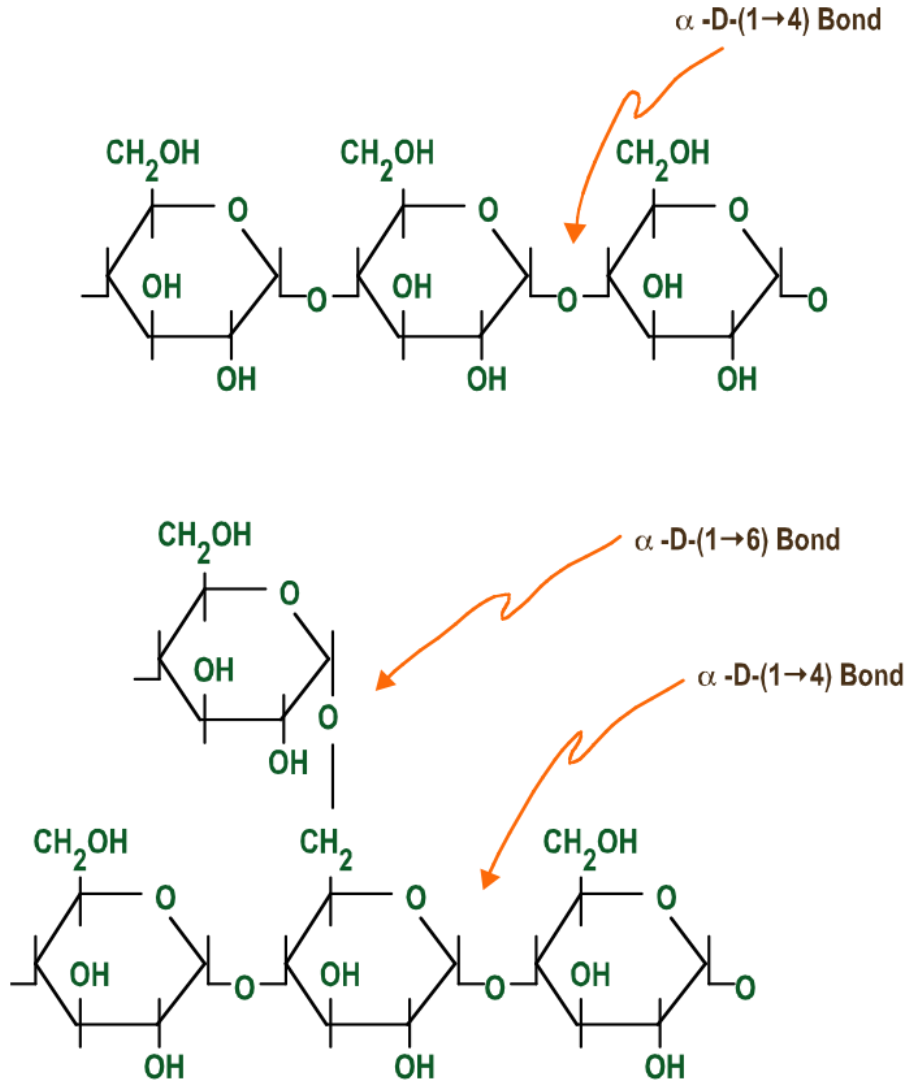
Damaged starch +/- 8 %, due to milling process

MOLECULAR STRUCTURE OF STARCH

Dextrose ($C_6H_{12}O_6$) MW = 180

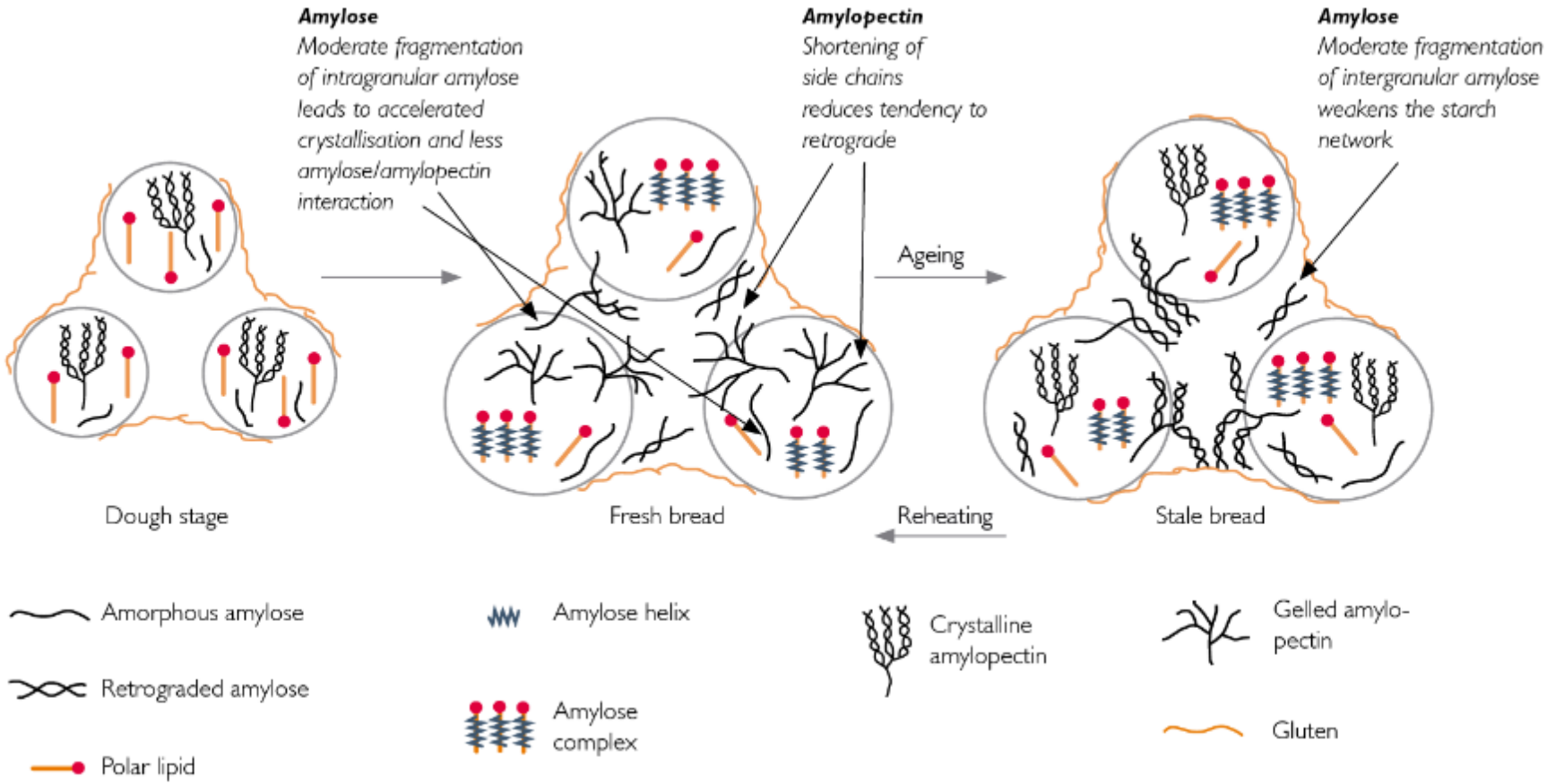
Amylose
20-30% of starch and composed of chains of dextrose are all linked at carbons 1 and 4

Amylopectin
70-80% of starch and chains are linked mostly by 1,4 carbons, but 5 to 8% are also linked by 1,6 carbons



Each hexagonal shape represents one dextrose (glucose) molecule

Theory on staling

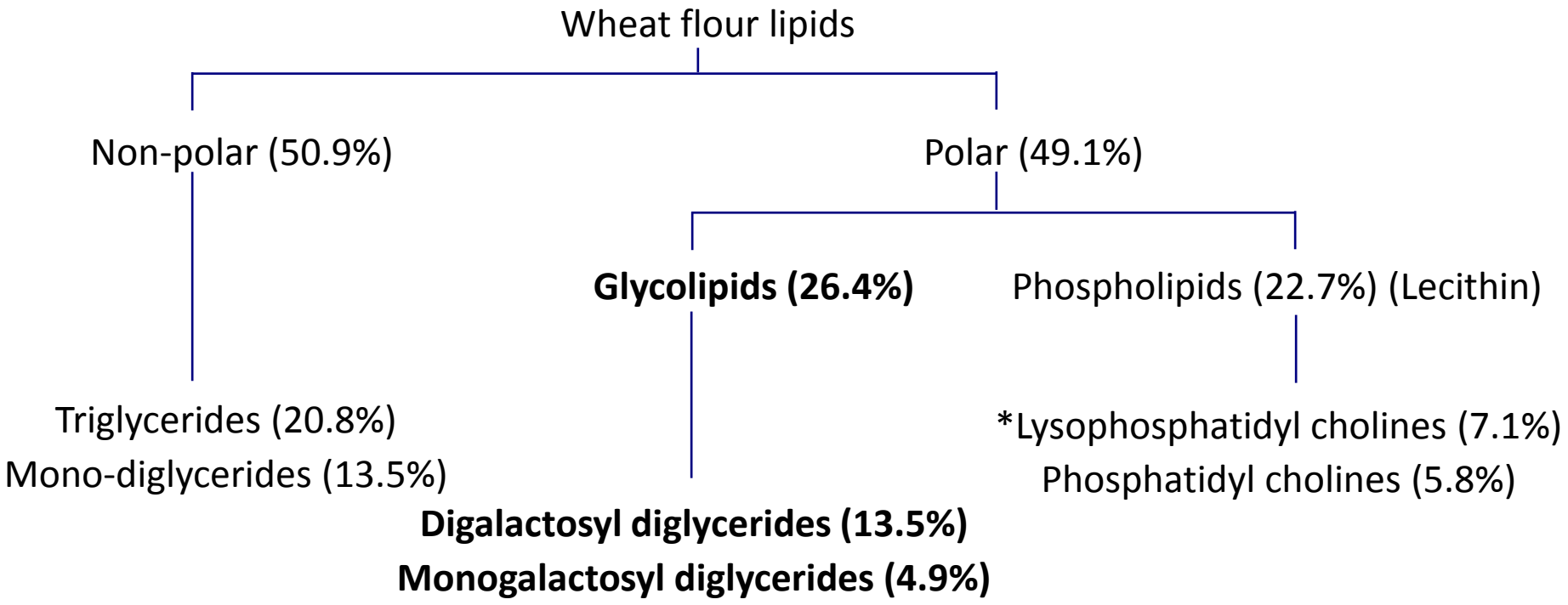


AMYLASES AND BAKING

- Amylase Functions in Baking
- Provides sugar for continued yeast fermentation and crust color development: alpha amylase, beta amylase and glucoamylase
- Gives better volume for yeast-raised baked goods via improved gas production and “relaxation” of starch during baking: alpha amylase, glucoamylase, G4 and G+, maltogenic
- Specific amylases greatly extend shelf life: POWERFresh® G4/G+ and Maltogenic

- Signs of Amylase Overdose
- Sticky/Gummy bread crumb: caused by excessive medium chain dextrins; extreme cases result in loaf collapse
- Poor resilience
- Open bread crumb: caused by excessive break down of starch structure
- Excessive crust color: caused by excessive sugars

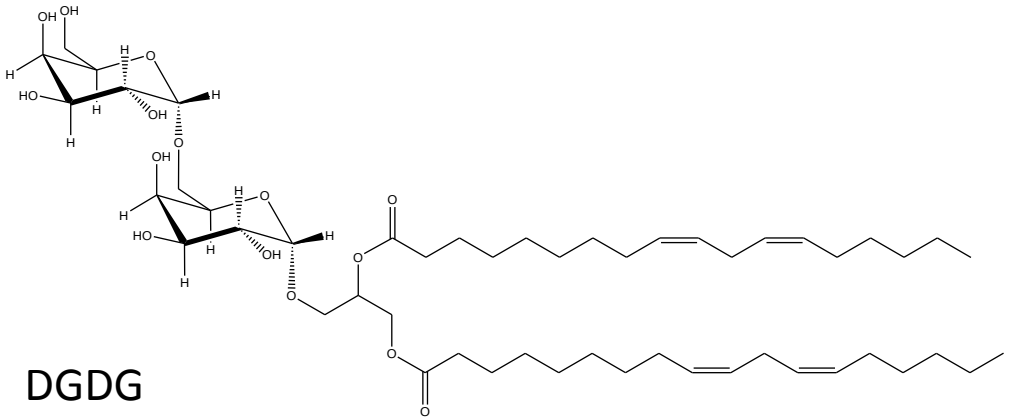
Lipase:



(Pomeranz, Y. (1987) in Modern Cereal Science and Technology. VCH)

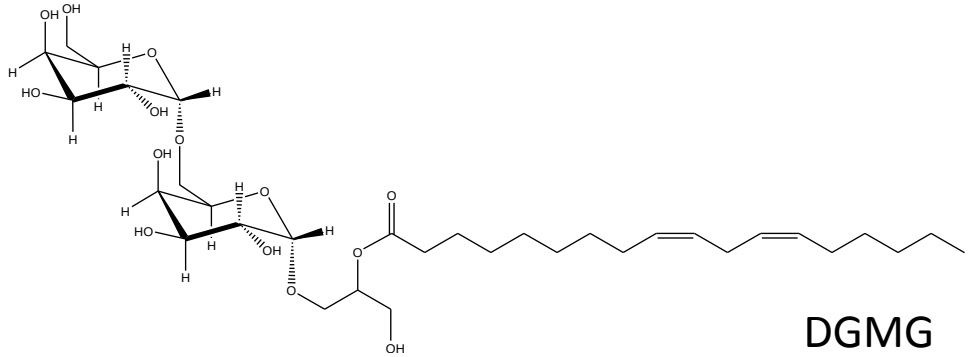
*Starch-bounded lipids – less available

Hydrolysis of Digalactosyldiglyceride, DGDG



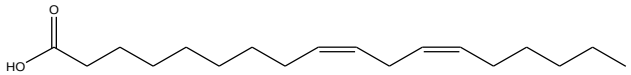
DGDG

+ H_2O Glycolipase →



DGMG

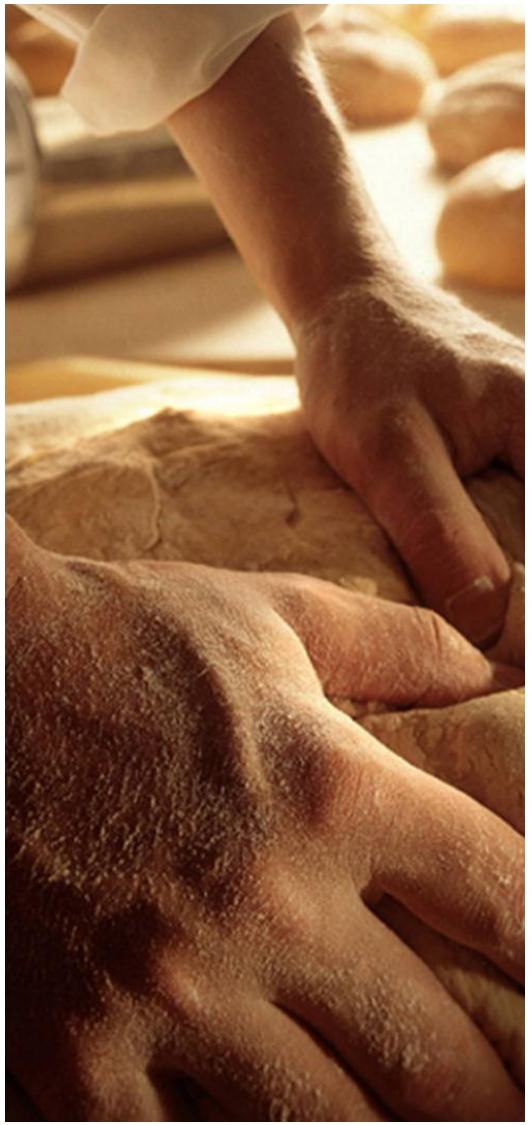
+



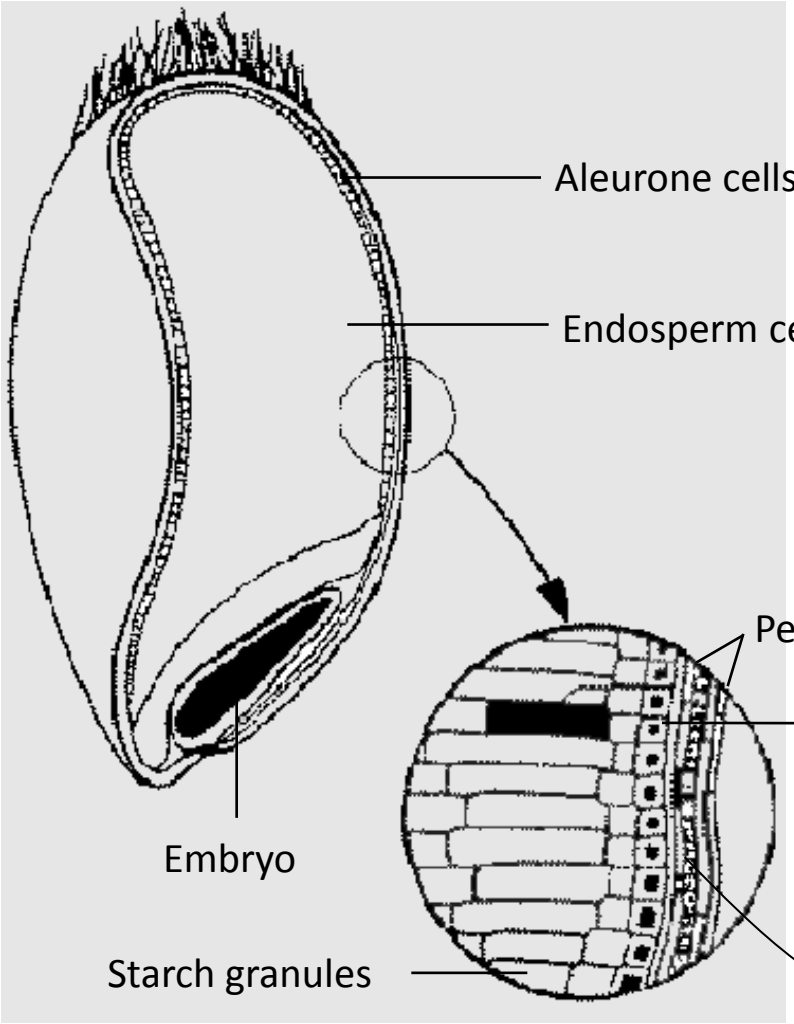
FFA

LIPASE FUNCTIONALITY IN BAKING

- Formation of emulsifier during dough mixing
- Complexing with gluten proteins
- Stabilization of air/water interface
- Strengthening of the dough resulting in increased volume
- Improves tolerance to processing variations and raw materials
- Improves crumb structure
- Whitening effect
- Good volume increase especially combined with deoiled lecithin

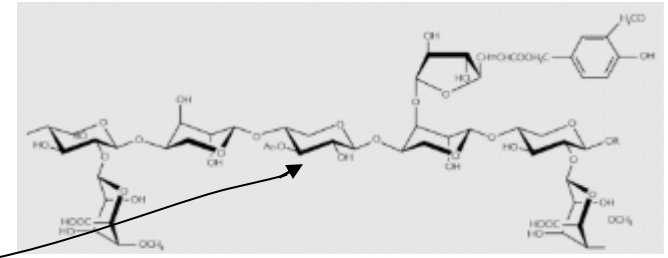


Arabinoxylan (AX)



Main wheat constituents:

Starch	80%
Proteins	7-15%
NSP	
Arabinoxylan	2-5%
Lipids	2-3%

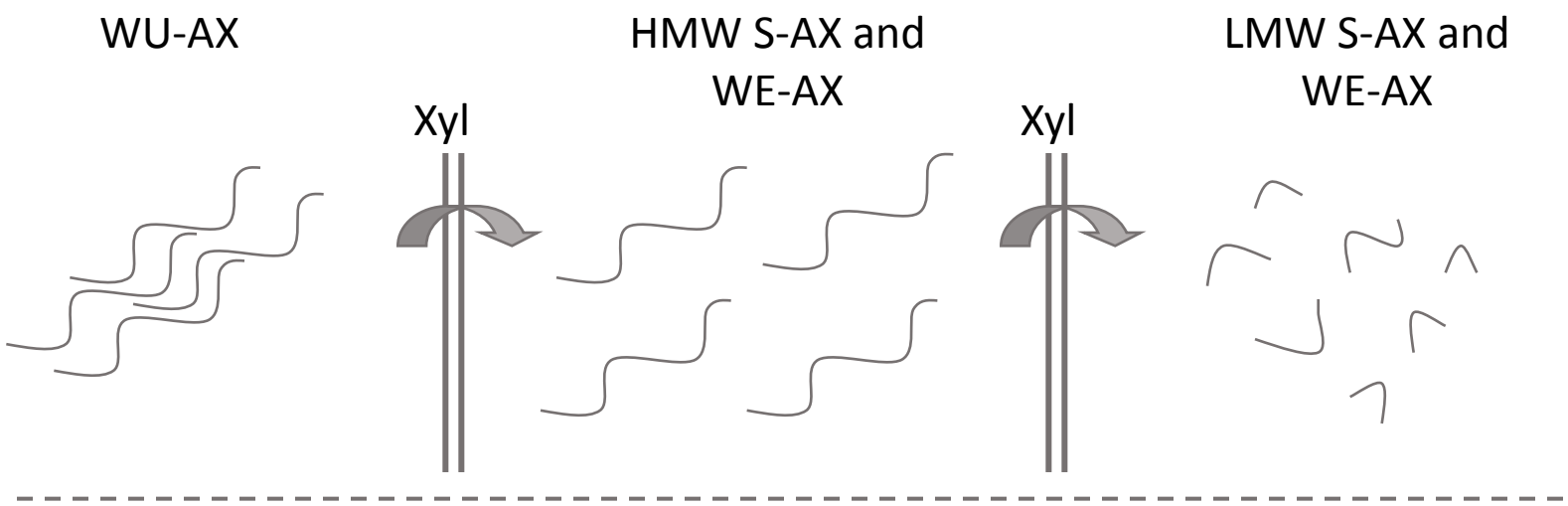


ARABINOXYLAN: WATER BINDING CAPACITY

Main Cereal Constituents		Water Holding	Typical Whole Wheat Dough
Starch	73%	0.3X	30%
Damaged Starch	7%	1.0X	7%
Proteins	7-15%	1.5X	18%
Arabinoxylan	**2-5%**	**10X**	20%
Lipids	2-3%	NA	0%
		Total	75%

Functionality of AX and Xylanase in baking

AX Populations:



Functionality in bread-making:

- Detrimental to gluten strength and, consequently, dough strength

- Viscosity increase
- Hydrocolloid effect
- Less sticky dough
- Dough stability

- Viscosity decrease
- Loss of hydrocolloid effect
- Stickier dough
- Dough stability?

Xylanases: Functionality In Bread Making

PRACTICAL: Function of Xylanases in Baking

- Beneficial in pretty much all baked goods.
- Great for frozen dough: reduce water without starving protein for water.
- Better dough machining.
- Better volume via transfer of water to protein and reduced negative impact of water unextractable AX.
- Better bread symmetry due to pan flow.
- 10-15% improvement in crumb softness by bacterial xylanase due to hydrocolloid effect. Additive effect with anti-staling amylases.

PRACTICAL: Overdose of Xylanase

- Wet, sticky dough
- Excessively slack dough
- Wet dough in proofer

GOX & HOX:

Hexose oxidase reaction

Glucose + O_2 ⟶ δ -gluconolactone + H_2O_2

or

Maltose + O_2 ⟶ γ-maltobionolactone + H_2O_2

Oxidation in gluten

2 RHS + H_2O_2 ⟶ RS -SR + $2H_2O$

R: Protein molecule	HS: Thiol groups	S-S: Disulfide bonds

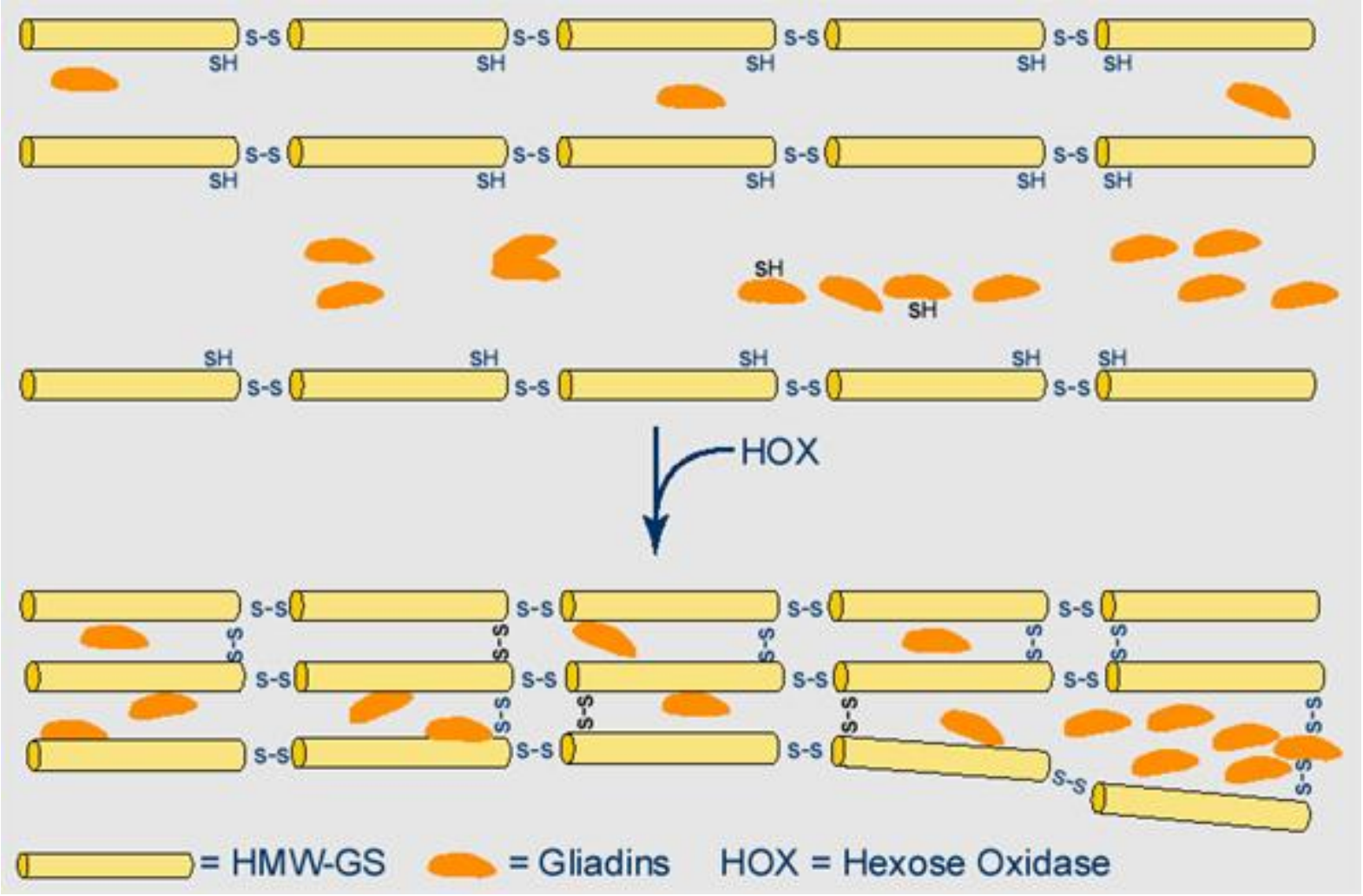
Oxidative Enzymes: Functionality In Bread Making

Maltose + O_2 → lactone + H_2O_2

Gluten Oxidation

2 RHS + H_2O_2 → RS -SR + $2H_2O$

R: Protein molecule
HS: Thiol groups
S-S: Disulfide bonds



Oxidizing Enzymes provides:

- Better dough handling properties
- Improved dough tolerance
- Improved bread quality
- Improved crumb structure
- Improved bread volume
- Can supplement chemical oxidants
- Possible cost savings

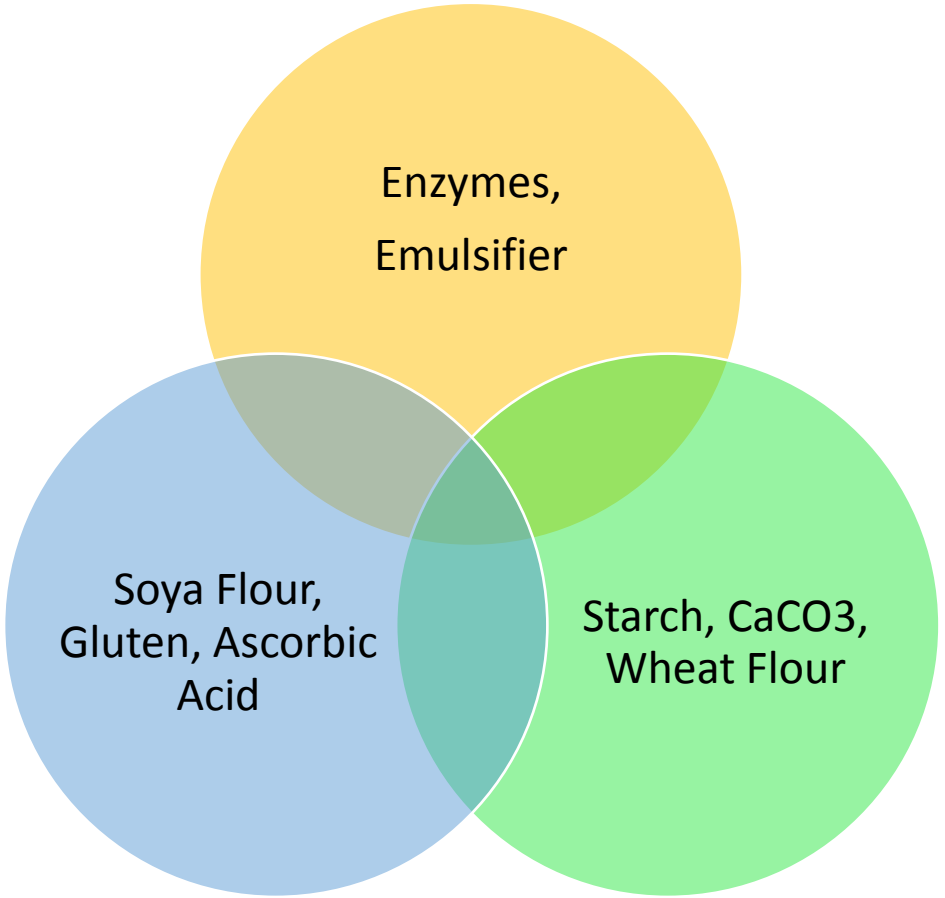
Flavoring and Coloring Agents:

- Flavoring and coloring agents been added to impart aroma and taste and make product more appealing.
- **Natural:** Extracted from plant, animals, herbs and microbial fermentation. Can be in form of essential oil, oleoresin or extract. More sensitive towards light and have shorter shelf life
- **Artificial:** chemically developed, easily available and less expensive.
- **Natural identical:** Obtain by synthesis or isolated through chemical process. There chemical make-up of artificial flavoring is identical to their natural counterparts. These flavoring agents cannot contain any artificial flavoring substances.

- Provide color and improve existing color.
- Flavoring agents improve palatability of products. Enhance the available flavour.

Improvers:

- To enhance bakery products quality (texture, appeal, eating attributes) various functional ingredients can be added with basic ingredients. This includes addition of emulsifiers, enzymes, soya flour, gluten, acids, preservatives etc.
- Ascorbic Acid: help increase the volume of bread and provide better tolerance to variable processing conditions, such as dough temperatures and proofing times.
- Soya Flour: increase protein content, more water absorption, whiteness improvement
- Gluten: For addition dough strength, improve machinability, high water absorption, volume improvement
- Preservatives: Calcium Propionate and acetic acid to reduce microbial contamination in baked fermented goods.




Thank you

EQUIPMENT SELECTION…

- It is common knowledge amongst processing technologists that often technological expertise alone does not yield the desired quality of results as the equipment deployed may not cater to the outcome.
- Hence, it is imperative that the correct equipment is used for different functions of Bakery operations.
- The best of products are consistently produced wherever the fusion between technology and equipment is in total sync.

BAKERY MACHINERIES

- Preparation Hall
  - ✓ Flour sifter
  - ✓ Sugar grinder
  - ✓ Milk emulsifier
  - ✓ Invert syrup preparation
  - ✓ DMG / Lecithin fat preparation
  - ✓ Color & Flavor Preparation
  - ✓ Creamer
  - ✓ ABC,SBC dispersion equipment

PREPARATION HALL MACHINERY

Flour Sifter → Selection based on Output, Ease of maintenance/Cleaning.

Sugar Grinder → Should have provision for fitting Magnets / Magnetic grills

Pin Mill

Can be of either type based on final product requirement.

Hammer Mill

Selection based on Particle size of powdered sugar requirement, Output, Fine dust collection, Ease of maintenance / Cleaning.

OTHER TYPICAL EQUIPMENT

Milk Emulsifier with the whisker

Creamer

NEED TO AUTOMATE....

CRITICAL FACTORS IN PREPARATION OF INGREDIENTS..

- Elimination of Extraneous matter
- Use of Ingredients with proper particle size
- Ensuring correct input of Ingredients

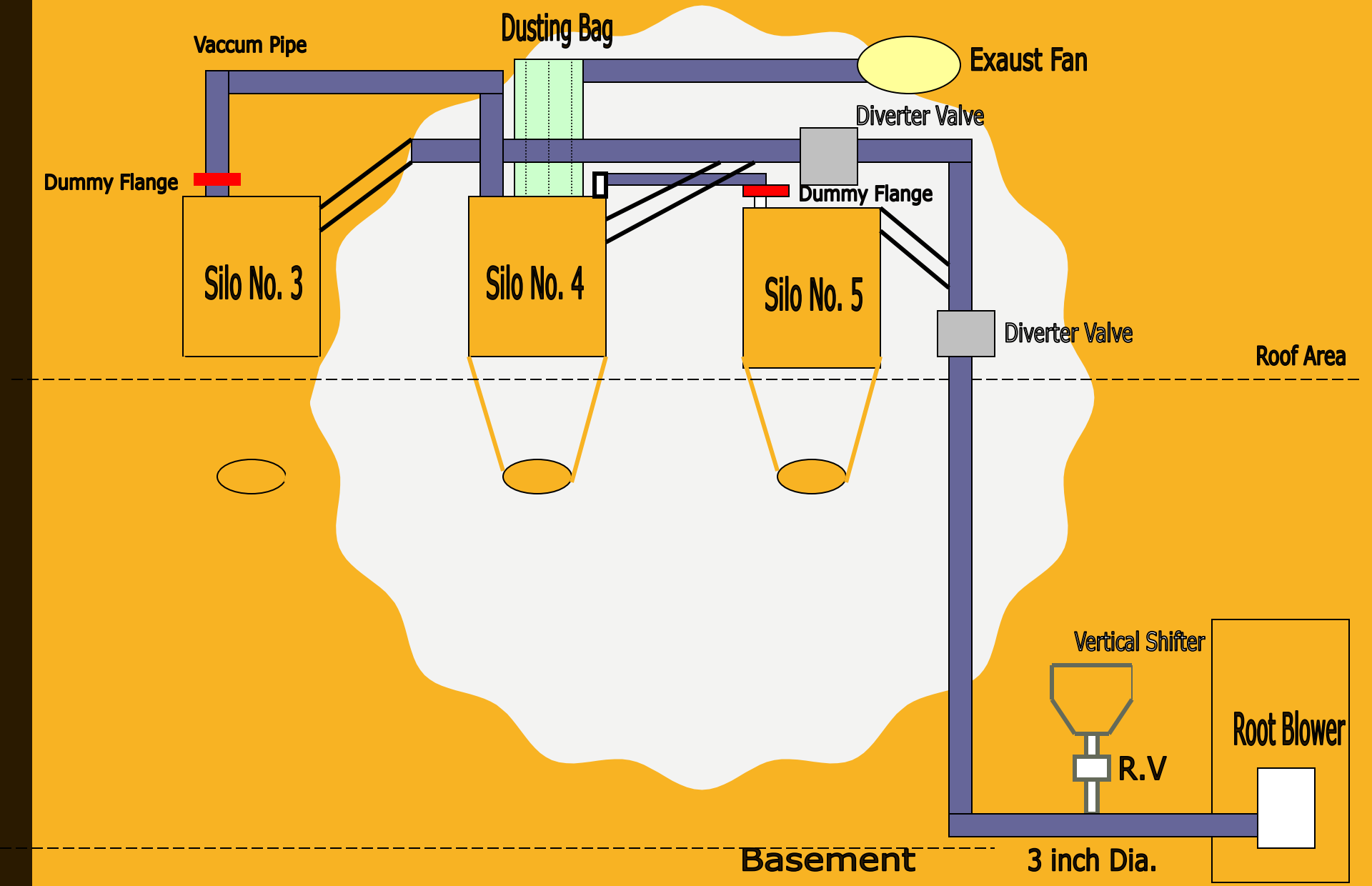
As the most critical factor in achieving constancy in consistency of dough is correct input of Ingredients in the mix, it is advisable to eliminate human error through automation.

ADVANTAGES OF AUTOMATION

- Eliminates human supervision and errors
- Controls process parameters
- Maintains high standards of hygiene
- Consistent product quality
- Data interface
- Increases productivity and reduces cost by eliminating losses.

Ingredient : Flour

Automation : Flour Handling System



Ingredients

The Tank ideally should either be cladded with stainless steel or Epoxy coated inside with Provision for Heating and Temperature control.

Automation

- Liquid Fat/Palm Oil

Bulk Handling

Ingredients

Pulverized Sugar – Sugar handling system

Ingredients

- Butter

Automation

Butter handling system

The need is to make a pulp of Butter without any lumps at Room Temperature. As Butter is stored in Cold stores, the equipment (essentially the Blade) should be so designed to meet the above need.

Ingredients

- Invert syrup / Sugar Solution Handling System

Preferably a Jacketed vessel to enable circulation of Steam/Hot water along with a blade capable of ensuring a complete solution of Sugar. Solution should pass through Magnetic grill. Ideally attached to a filter press to ensure complete removal of extraneous matter.

Water Dosing system

Water, being a critical component affecting the consistency of the dough, needs critical control in addition. Dosing the same using a Flowmeter ensures uniform addition of water to the Mix and minimizes the variation in consistency of the dough.

Chemical Dosing system

As these are Minor Ingredients in terms of quantities added, the system should be robust enough to deliver.

Liquid Dozing System

Criteria for BISCUIT Mixer selection

Type of Dough to be processed is the foremost aspect to be kept in mind.

- **Drive style : Single or double end, sprocket and chain, belt drives, geared motor.**
- **Canopy action : Ingredient inlets, view door, canopy scraper etc.**
- **Capacity : Range 1 – 900 Kg – Continuous mixer**
- **Small scale : 10 – 120 Ltr bowl mixers**
- **Larger scale : Normally horizontal mixers with sigma type mixing blade or vertical spindle mixer**
  - **Based on Type of dough**
  - **Blending action or Kneading requirement**
- **Mixer to be jacketed through which some type of medium can flow to maintain the dough temperature which plays an important role in the product consistency**
  - **Liquid like brine, water or glycol can be used**
  - **Direct expansion gases like freon or ammonia**

- **SIGMA MIXERS**
  - **Single Arm**
  - **Double Arm**
  - **Single spiral**

- **SPECIALITY MIXERS**
  - **Variable speed mixer**
  - **High speed mixer**
  - **Sprag & Durmol Mixer**
  - **Twin spindle mixer**
  - **Planetary Mixer**

HORIZONTAL MIXERS

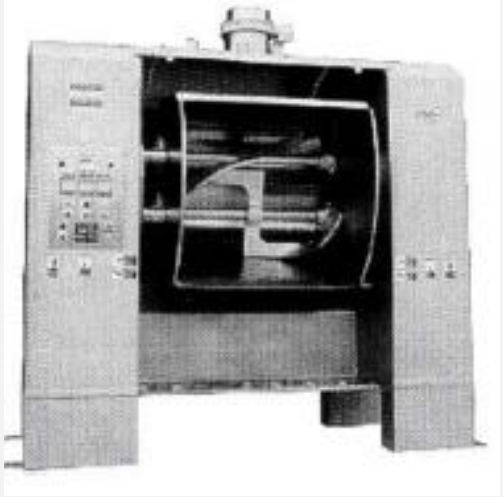
- **Single sigma arm mixer:** Uses a folding action to ensure optimum blending of ingredients. Is used for crackers & hard dough variants.
- **Double arm sigma mixer:** The versatile agitators move in perfect synchronization in a rounded "w" shaped bowl with a saddle to accommodate the separate radii of the agitators. Used for wire cut, deposit & short dough.
- **Triple roller bar mixer:** Used for Bread dough & yeast-raised sweet dough.

SIGMA MIXERS -

Sigma type mixers ensure thorough mixing in minimum time

SIGMA MIXER – SINGLE ARM

SIGMA MIXER – DOUBLE ARM



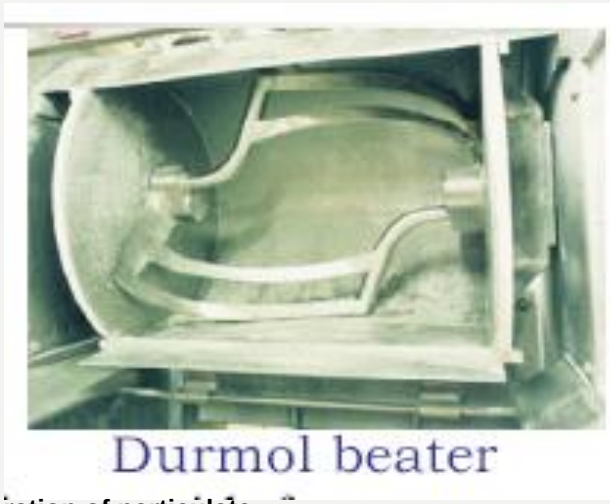
SIGMA MIXER – SPIRAL ARM

High Speed mixer with complete safety features

VARIABLE SPEED MIXER

HIGH SPEED MIXER

TRIPLE ROLLER BAR MIXER



The sprag configuration allows rapid incorporation of particulate ingredients e.g. chocolate chip, dried fruit, etc without degenerating the additives. I.e. melting, damaged fruit.

PLANETARY MIXER

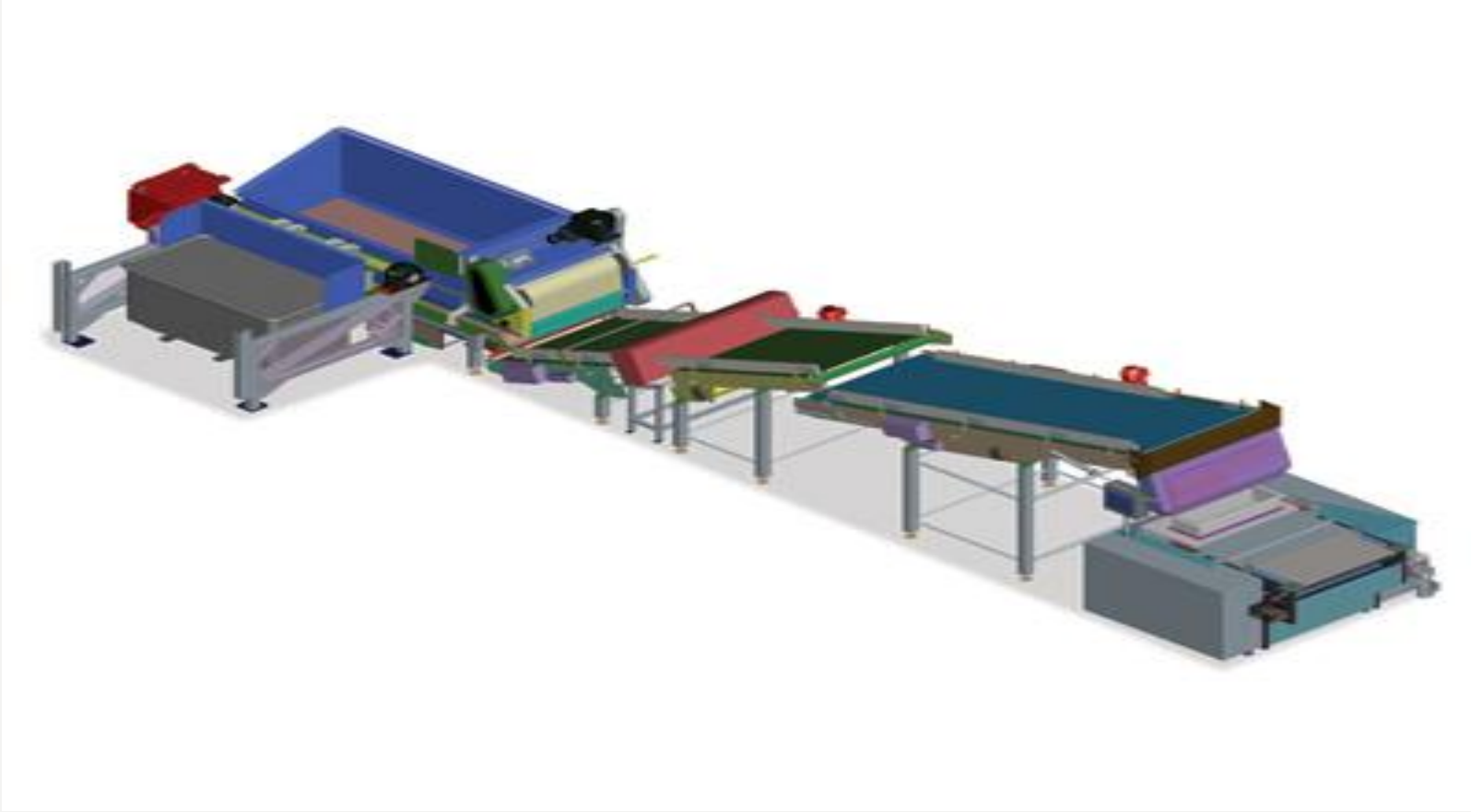
VERTICAL -TWIN SPINDLE MIXER

Vertical Mixer is the most suitable for Fermented dough (Sponge & Dough process) including Bread

PROCESSING LINE

- Dough lifter
- Kibbler
- Distributor
- Hopper
- Metal check
- Moulding unit
- Gauge rollers

DOUGH LIFTER /KIBBLER/ METAL DETECTOR



DOUGH LIFTER

Safety aspects, apart from technical needs are critical in selection

KIBBLING OF DOUGH DIRECTLY FROM MIXER

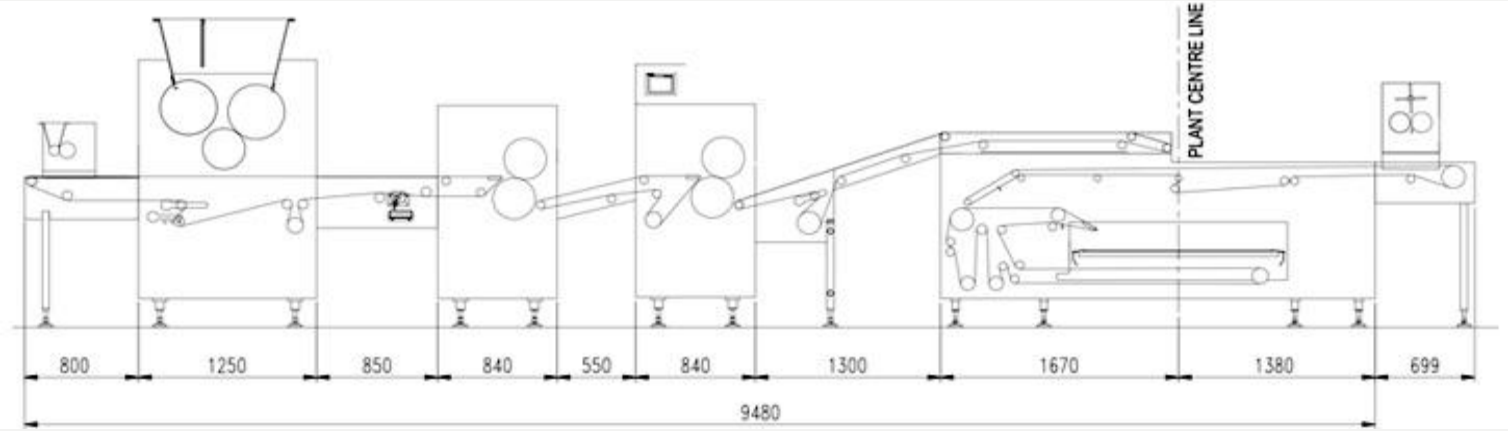
Kibbler should be able to provide dough pieces ideally below 50 mm width.

LAMINATOR

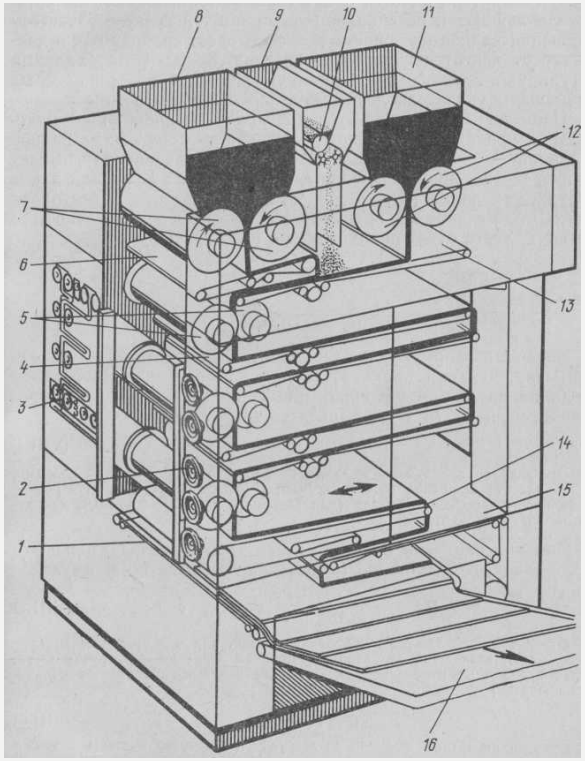
- Horizontal / Vertical
- 90/180 degrees turn
- Scrap and fresh dough hopper.
- Dough distributor
- Flour / Fat spreader

Selection based on available space, Flour-fat sprinkling requirements, required sheet thickness, number of layers and sync with the sheeting section.

HORIZONTAL LAMINATOR



VERTICAL LAMINATOR



FAT/FLOUR DUSTING UNIT

Should be able to provide uniform and required amount of Dusting with even spread across the width of the sheet.

SETS OF GAUGE ROLLERS

4 gauge rollers are preferred if the plan is to make High Count Crackers..

The gauge rollers should be smooth and be of

- **Robust construction**
- **Chilled cast iron or stainless steel material**

The rollers should

- **Be Fitted with Quick release roller scrapers**
- **Have Heavy duty roller bearings**
- **Ideally have Twin screw jack gauge adjustment**
- **Have Self tracking inter-conveyors**

✓ **The Bottom gauge rollers should be able to run at marginally higher speed than the Top Gauge rollers**

✓ **The Final Gauge roller should ideally be of a Higher Dia than the initial gauge rollers.**

FINAL GAUGE ROLLER

ROTARY CUTTER

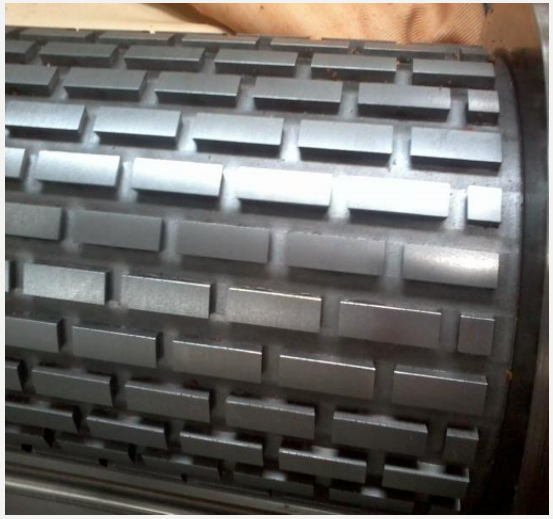
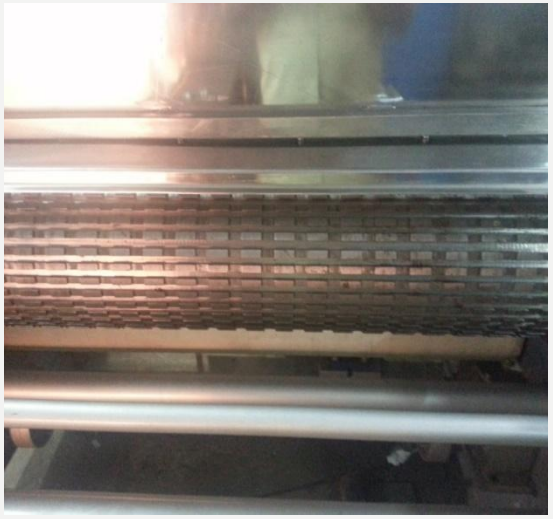
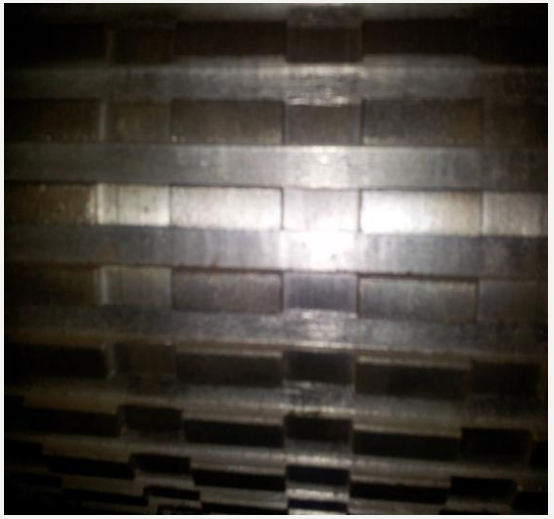
Wherever secondary operations like Milk spray are planned, it is preferable to use PU Based transfer/panner webs with provision for washing/cleaning the surface.

ROTARY MOULDING UNIT

Salient features to be considered are…

- **Individual drive mechanism**
- **Line weight adjustment for Knife**
- **Adjustable Forcing Roller speed**
- **Quick changeover facility**
- **Avoidance of dough falling out of the moulder edges.**

FORCING ROLLER / RUBBER ROLLER

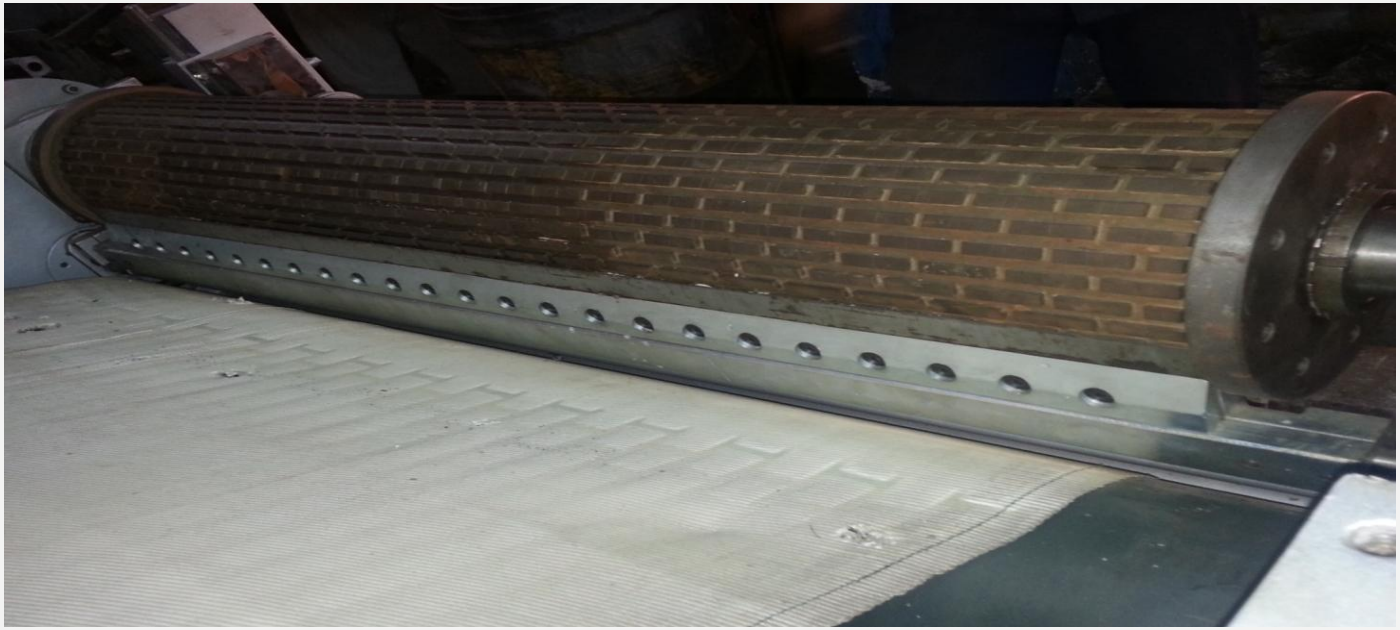




Depth and the pitch between castellations need to be critically looked into.

RUBBER ROLLER

- ✓ **Use of correct Rubber to sustain shore hardness over a long period.**
- ✓ **Required Shore Hardness and uniformity across the width.**

KNIFE…



- **Should be made of Robust Stainless steel with a Tapering angle suiting the moulding unit, to enable "scrapping' the excess dough from Moulder and to facilitate smooth blanket formation in Forcing roller.**
- **Double- angled knife is preferred, as the second tapering increases the life of the knife.**

ENDLESS WEBS

A seamless belt is preferred in order to achieve uniform extraction and continuous biscuit molding quality.

Natural fibers such as cotton certified as food-grade are standard materials due to their excellent extraction behavior, based on the absorption of fat and moisture from the biscuit dough. To improve the life, Nylon or Polyester are added generally.

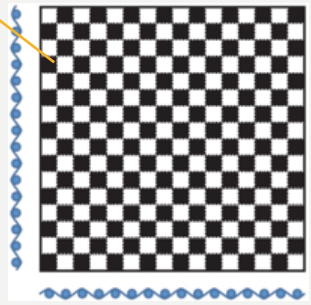
Conditioning of a new extraction web with steam rather than water is a more effective way of treating the web, which is normally applied uniformly across and around the complete circuit of the extraction web. This may only be required just prior to start up of production and thereafter, the oil and water continuously expressed from the dough maintains the adhesive properties of the web.

Plain Weave
The versatile solution for

most biscuits

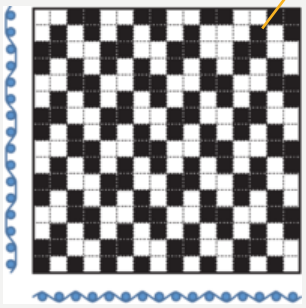
The most commonly used weave type, a plain weave gives a consistent performance making it universally suitable for many common

applications.



Cross Twill Weave
An enlarged surface to handle larger biscuits or dough with a higher fat or moisture content

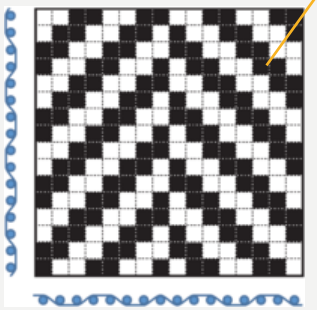
The design of cross twill pattern allows for air pockets to form, reducing the contact area with the dough and enabling an easier release from the belt



Herringbone Weave
The ultimate solution for most short and heavy doughs with demanding

extraction needs

This has more surface contact with the dough so that it can generate stronger extraction from the mould.



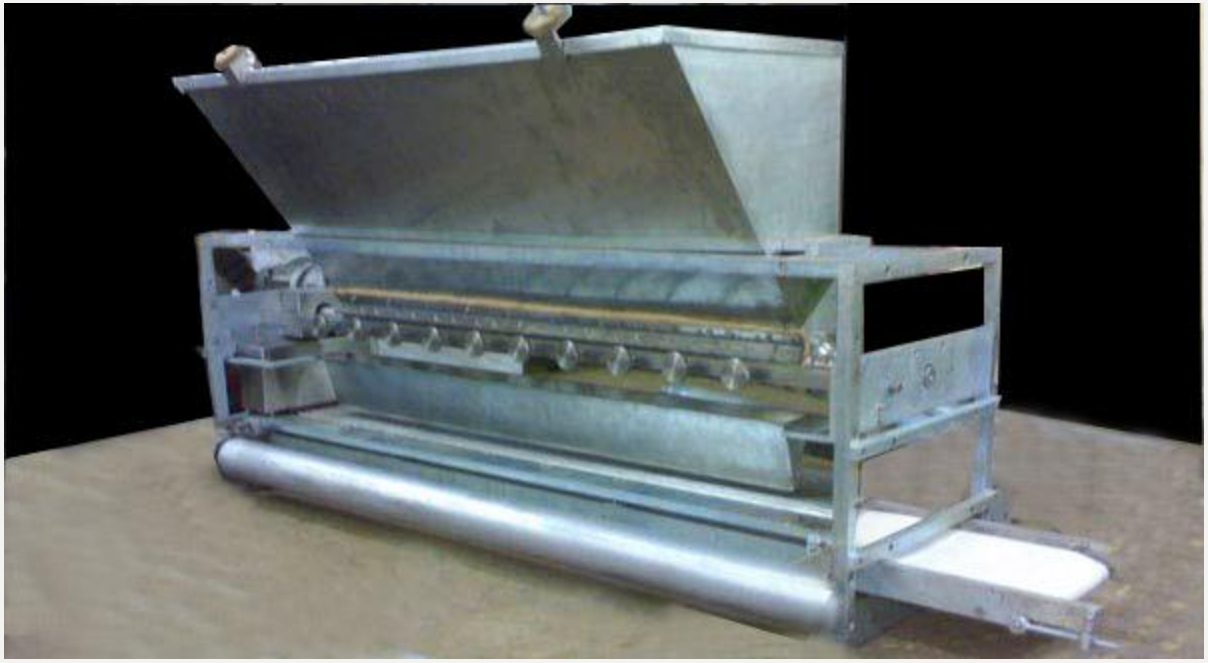
The material of construction, the number of strands along warp and weft and longevity of the web need to be considered while selecting the web.

PROCESSING LINE

- Panner web
- Sugar/ salt sprinkler
- Cashew sprinkler
- Scrap lifter
- Long scrap return conveyor
- Distributor in the laminator

SWIVELING PANNER WEB

SUGAR SPRINKLER



Should be fitted with fine adjustments to provide uniform sprinkling across the width and to handle different particle sizes of sugar.

CASHEW SPRINKLER

Should have provision to sprinkle variable sizes of Nuts without hassle. Should have adjustable guides to direct cashew pieces to the desired moulder cavities as required.

SCRAP PICK UP WEB

Wrong

Right

LONG SCRAP RETURN CONVEYOR

Preferable to use a PU Material to avoid loose threads contamination.. If Cotton canvas is used, ideal to have both the sides with Polyester or Nylon material.

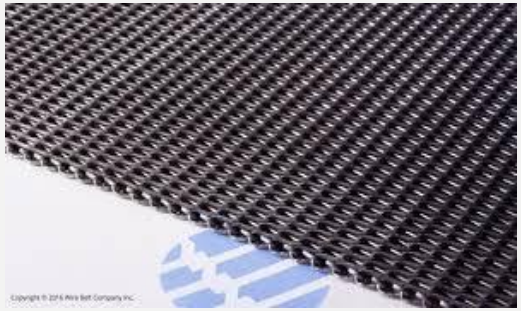
COMPLETE CUTTING LINE

PROCESS LINE
CONTD……

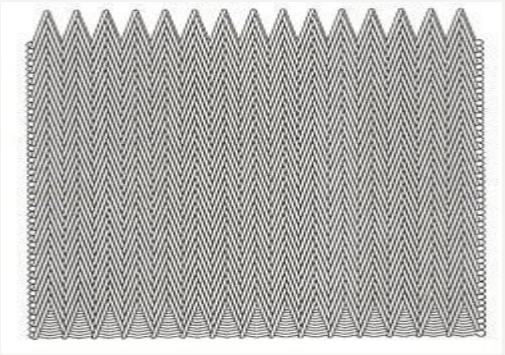
- Band
- Oven
- Centering device
- Return band
- Band cleaning device
- Pre Heaters
- Oven Chimney

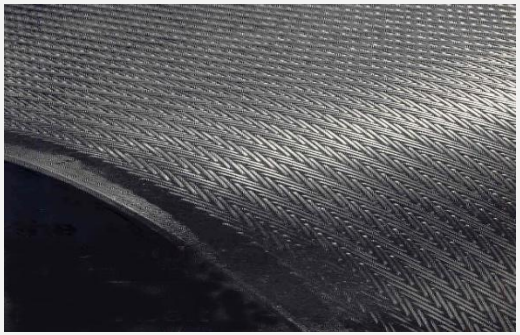
OVEN BAND OPTIONS

- Z47



- C5B





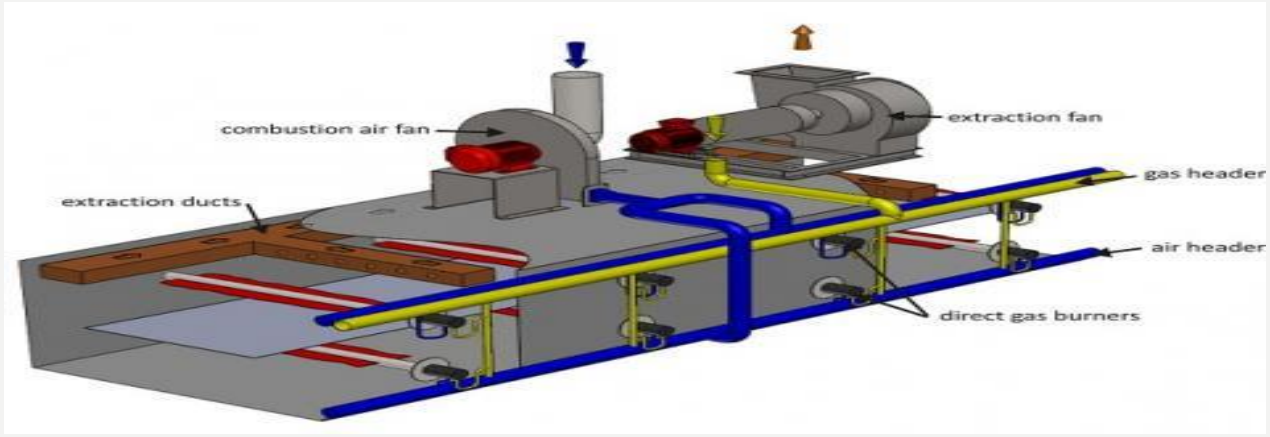
- Steel Band

OVEN

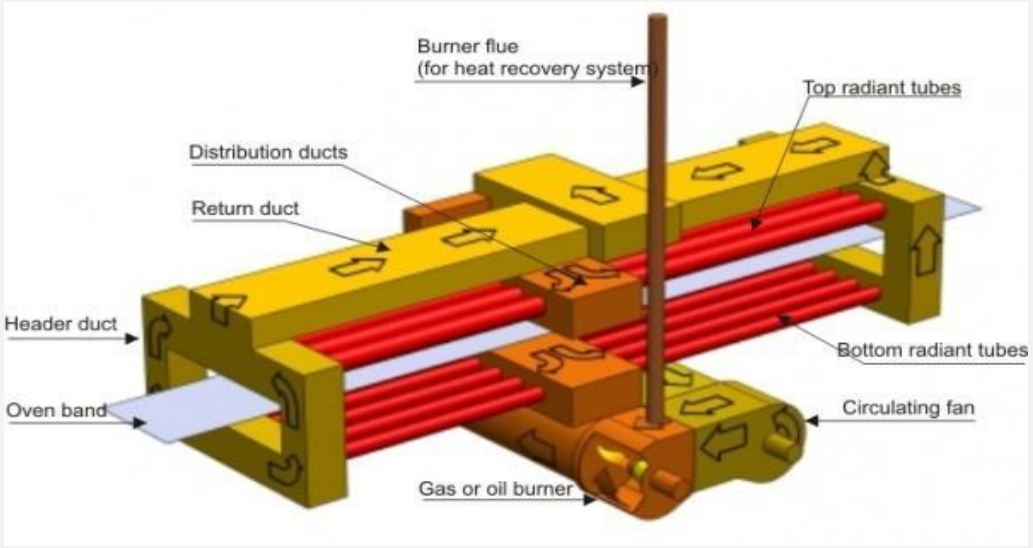
Selection to be influenced by

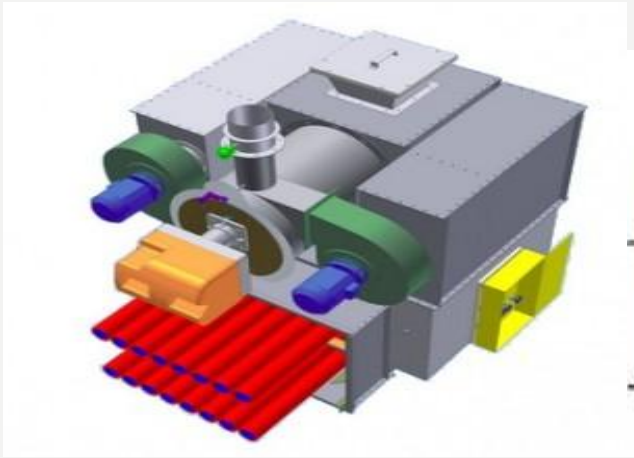
- **Type of Product to be baked**
- **Efficacy of baking**
- **Effectiveness of Heat transfer**
- **Response time to changes in Baking profile**
- **Effectiveness of insulation**
- **Efficacy of Steam suction / discharge**
- **Oven / Fuel Efficiency**
- **Ease of maintenance/ cleaning**

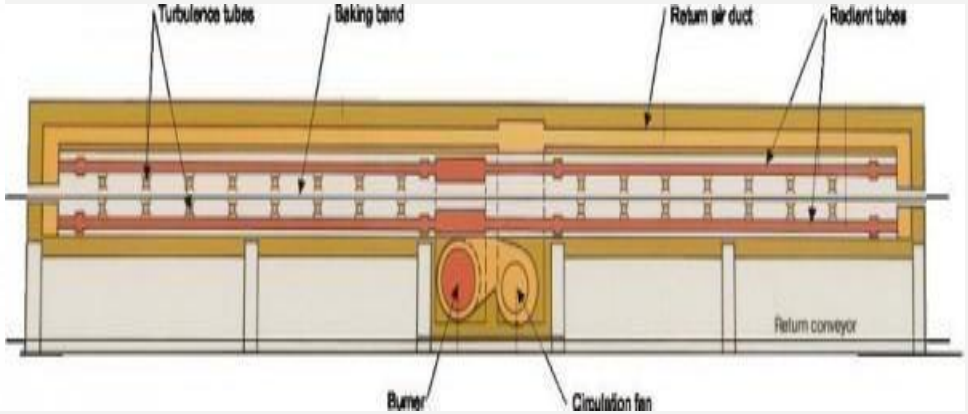
DIRECT FIRED OVEN



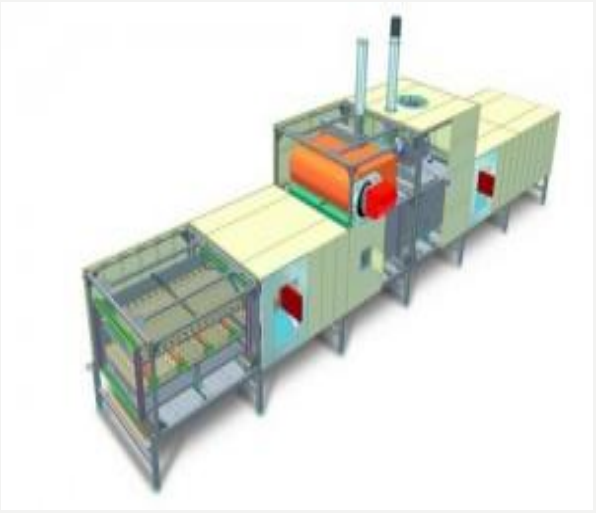
CYCLOTHERM OVEN

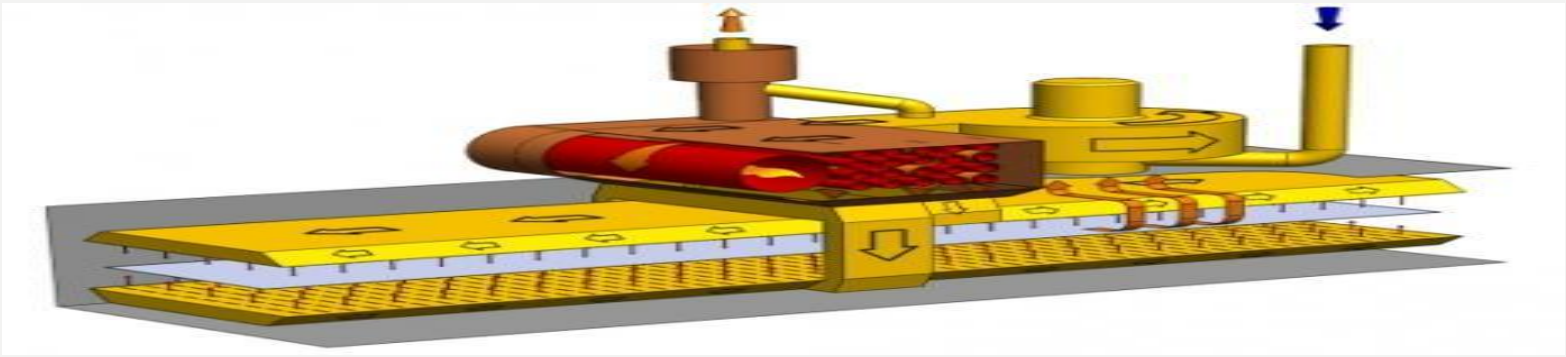






FORCED CONVECTION/ IMPINGEMENT OVEN





HYBRID OVEN

- ✓ **Probably the most ideal option**
- ✓ **The best option is to have Direct fired Gas ribbon burners in the initial zones followed by Cyclotherm or Forced convection in the middle and End zones**
- ✓ **Forced convection in the end zones allows quick drying, uniform color and minimum Edge darkness**

INSULATION

- Materials such as mineral wool, normally used for oven insulation, have a low thermal conductivity. Mineral wool is manufactured from molten rock, stone, glass or slag, which is spun into fibres. The mineral wool is supplied loose or compacted into mattresses. The mineral wool typically has a thermal conductivity, **k**, measured in watts per metre kelvin of 0.06 – 0.10 W/(m.K) at baking temperatures and is used at densities of at least 60 kg/m^{3}upto 144kg/m^3

OVEN & COOLING CONVEYOR

- Fuel
- Insulation
- Hybrid
- Knife transfer
- Cooling Conveyor
- Power turn conveyor
- Transfer
- Stacker
- Guide line
- Guide line separator
- Sandwich line diverter

FUEL

- Natural Gas
- LPG
- CNG
- LDO
- HSD
- Electrical

Availability, Fuel efficiency & Cost influence selection. However, if Gas is available, it is the best option as it also ensures complete burning and is environment-friendly.

OVEN END KNIFE

- Bakelite---- Popular in India. Require the correct width as otherwise the biscuits curl up
- Brass ---- When the band edges are maintained properly with band centering device and proper tracking ,then this can be used. The width of the knife being shorter, helps in easy transfer .
- If Spring system from the top can be introduced, then the Bakelite width too can be shortened and used.

COOLING CONVEYOR TURNING POINT

COOLING CONVEYOR

COOLING CONVEYOR TRANSFER

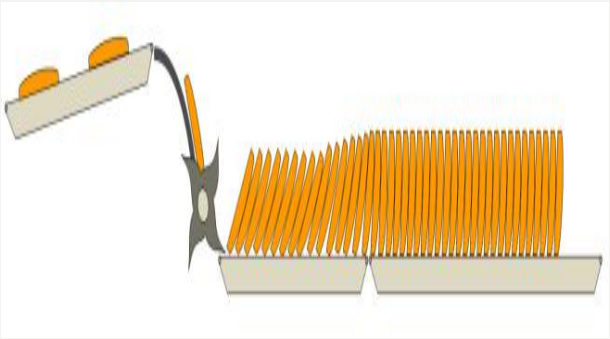
STACKERS

STAR WHEEL STACKER

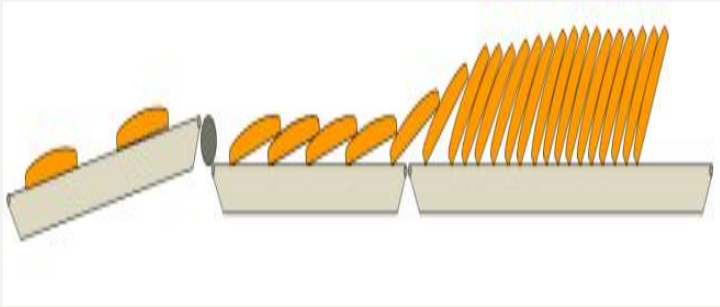
Selection of Stacker should be based on type of Pkg. machine and ability to stack without reversal consistently.

Two-fall magnetic stacker

ROTARY STACKER



PENNY STACKER

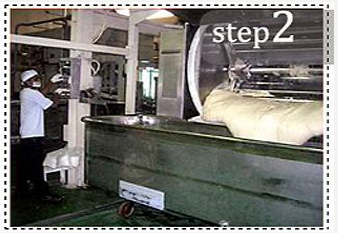


BREAD EQUIPMENT

BREAD PROCESS FLOW

Recipe balancing & weighment

Sponge Preparation



Bulk Fermentation

Final Dough Mixing

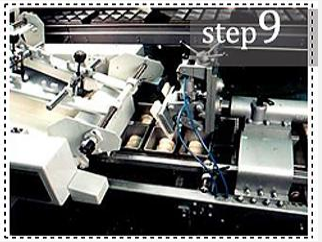
Scaling & Dividing

Rounding

Intermediate Proofing

Check weighment

Moulding



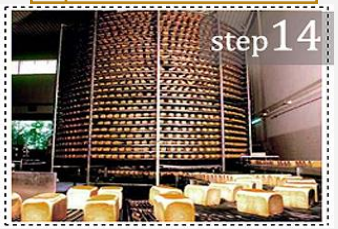
Lidding

Final Proofing

Baking

De-lidding

Cooling



Slicing & Packing

Distribution

INGREDIENT PREPARATION

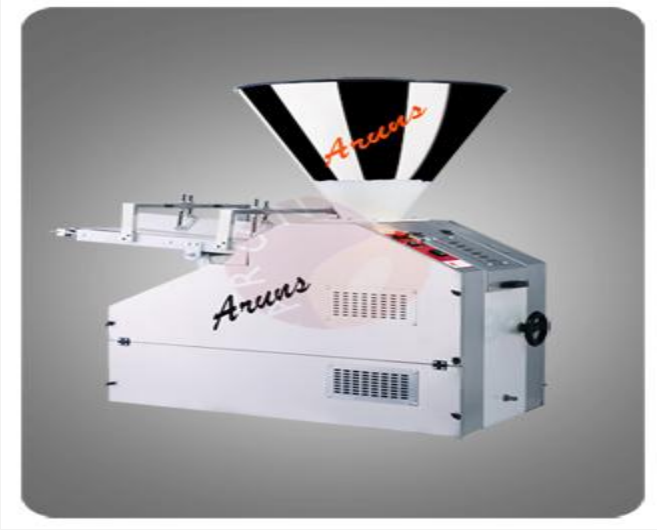
- The equipment requirement of Flour sifting and Fat handling depends on the scale of operation and the planned volume of production.
- Choice of flour sifter can accordingly be semi automatic or automated.
- As only Crystal sugar is required for Bread production, passing sugar through a magnetic grill is only required.
- Fat handling also can be manual or automatic depending upon the scale of production.
- Emulsifier preparation and minor ingredients usage can follow the similar lines given in Biscuit manufacturing equipment.

BREAD MIXERS

- ✓ Traditional Bread Mixers are generally vertical Mixers with Hook arm blades that help in Kneading the Dough. Average Mixing time required is around 30 minutes.
- ✓ Mixers with Spiral arm are nowadays widely used as it helps in reducing the Mixing time to around 15 minutes.
- ✓ Breads made using Chorleywood process require High speed mixers. However, controlling the Dough temperature in these mixers need special consideration.

SCALING & DIVIDING

- The criticality for selection is the consistently accurate scaling of the dough.
- Due to the large amount of air incorporation in the dough, the variation in Dough Density can influence the variability in scaling.
- Rotary Knife arrangement suits the best for dividing.



INTER PROVER

ROUNDER UP

Provision for Air spray and/or Flour sprinkling to be checked.

BREAD MOULDER

Bread moulder needs

- **The pressure board should be adjustable as needed to get proper moulding.**
- **The feed end of the pressure board should be slightly closer to the conveyor than the discharge end, or at least no higher than the discharge end.**
- **The guides at the discharge end should be the same distance apart as the width of the bottom of the baking pan in which the dough will be deposited**
- ***Ideally,* Two curling chains are suggested. The first chain should be of just the length to meet the second chain. The second chain should extend just to the pressure board.**

FINAL PROOFER

- Should be capable of consistently maintaining **Temperature** – A range of 37– 42°C **-& Humidity** – relative humidity (RH) of 80–95%.

BREAD DEPANNING & COOLING

- Preferable to use pneumatic principle based de-panning units capable of de-panning without damaging the Bread.
- The unit can be stand alone or on-line depending upon the volume of breads produced and cost implications.

- Cooling of Bread : Rack cooling, spiral coolers or passing through cooling tunnel are the norms. The cooling unit or area should have clean, humidified air.

SLICERS

- Can be stand alone, but preferably be attached to the pkg. machine.
- Should be easy to adjust the knife positions as required.

OVENS

- Deck Oven, Rack Oven, Contray Oven or Tunnel oven can be used
- Choice depends upon the scale of production.
- For automated plants, Tunnel ovens are the most suitable.
- The new generation Rack ovens have controls over Steam and can be programmed to have different temperature and steam controls similar to Tunnel ovens.

PM –Formalisation of Micro Food Processing Enterprise (PM-DME) Scheme

ONLINE TRAINING FOR MASTER TRAINER'S ON BAKERY AND CONFECTIONARY PROCESSING

COCOA, TOFFEE, FUDGE, CARAMAL AND FONDANT PROCESSING

Presented by

Dr. Anurag Singh

Introduction

- Raw cocoa (***Theobroma cocoa)*** has bitter and astringent taste, lacking chocolate flavor as well and on processing develops about 600 different chemicals.
- Cocoa tree is small tree native to American tropics and now it is growing all over the world
- West African countries Ghana, Nigeria, Ivory Coast, Brazil and Brazil produces about 70% of world cocoa beans.
- India also started producing cocoa beans but primarily as an intercrop in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh

History of cocoa

- The emperor of Aztec (Mexico) had regularly consumed a drink called "**Chocolatl**"- made by roasting and grinding the cocoa nibs and mixed with water, maize and spices.
- They believed it to have divine origin and later the Swedish botanist Linnaus gave the name **Theobroma – "Food of the Gods"**.
- This drink had high esteem as a nuptial aid during wedding ceremonies.

Cont….

- The cocoa tree measures about 4-5 meters with large branches and flowers directly on the trunk producing 10-80 fruits (also called as pods).
- The pods are 10-18 cm in diameter, having thick leathery rinds containing 20-50 beans inside in rows
- The seeds are embedded in white or pinkish pulp
- Seeds are the principal source of cocoa or cocoa powder highly prized as a nutritious beverage, and chocolate used as food all the world over

FRESH POD WITH PULP

Cocoa pods when mature, are yellow in some varieties and red in others

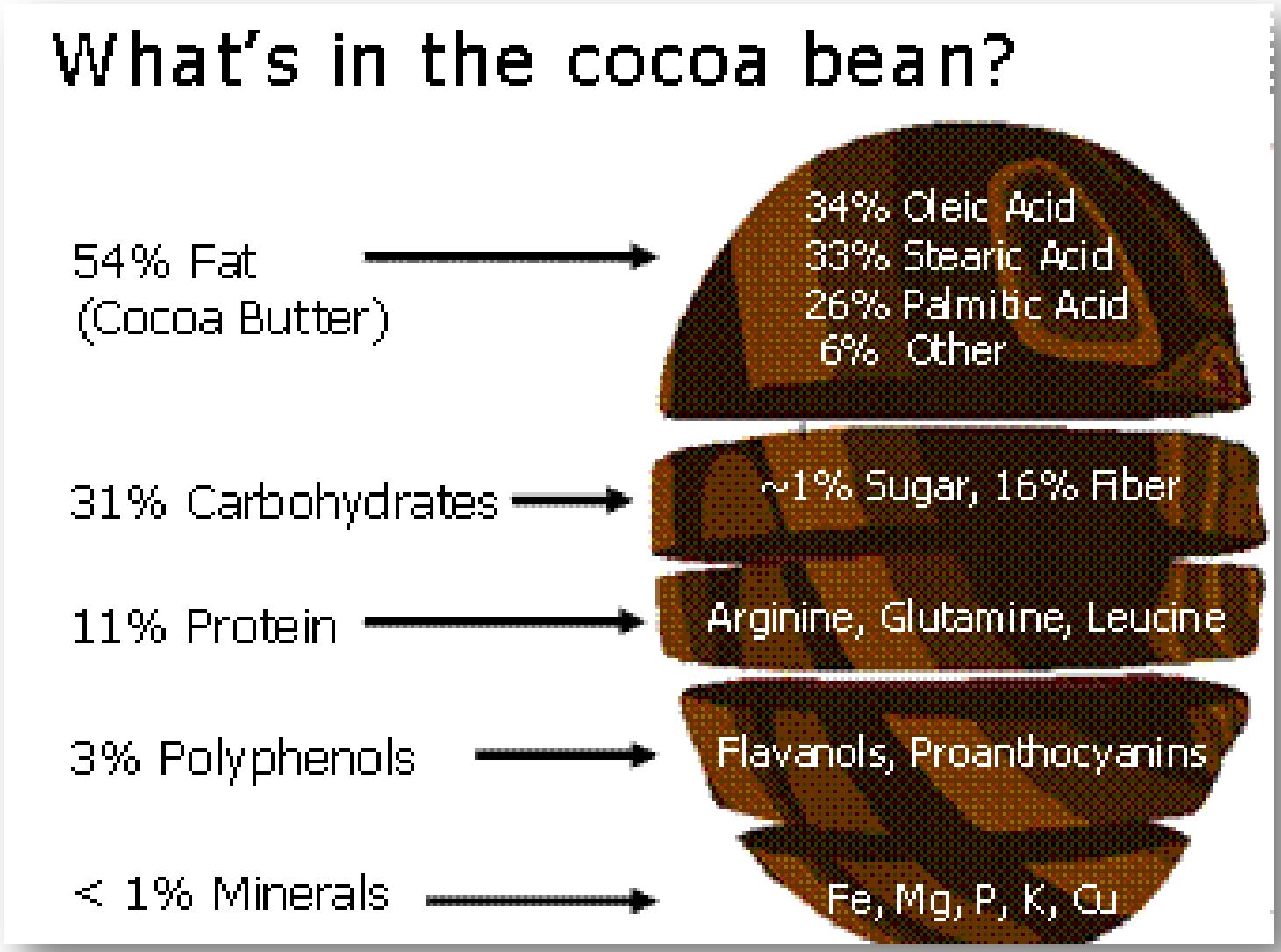
Cont….

- Caramel, Fudge & Toffee candies preparation needs different quantities of butter, sugar and cream.
- Toffees basically made from sugar and butter, cooked to high degree of temperature (300 degrees Fahrenheit) to which we then add nuts and chocolate after cooking. To make it crunchy and nutty candy.
- Caramel is generally made from sugar and cream or milk, with butter and cooked to 248 degrees Fahrenheit to form it chewy and flavorful. Caramel has no chocolate.
- Toffee and caramel are similar in color and flavor, but are different in two main ways—butter content and final cooking temperature.
- Fudge is made from abundance of chocolate and along with added cream, butter and condensed milk to make it smooth and keep it away from hardening.
- Fudge is cooked only enough to melt the chocolate.

Cont….

- Fondant is called many things – wedding cake icing, rolled icing, plastic icing, white icing, ready to roll icing (RTR), which is rolled out using a rolling pin & gives a fantastic finish to a decorated cakes.
- Fondant is made by mixing it with sucrose (sugar) in water at room temperature

Composition of cocoa



Cont….

Post harvest processing

A. Primary processing

B. Secondary processing

Value added products

A. Cocoa mass/liquer

B. Cocoa butter

C. Cocoa Powder

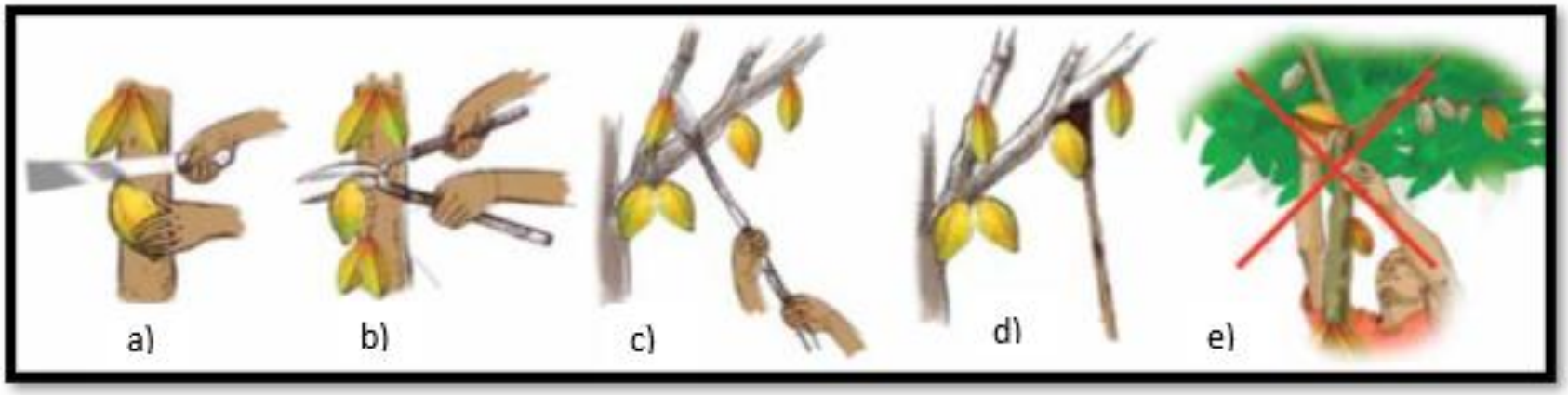
D. Chocolate

HARVEST

Pod color of different varieties during the harvest

Only ripe pods are harvested

Cont….

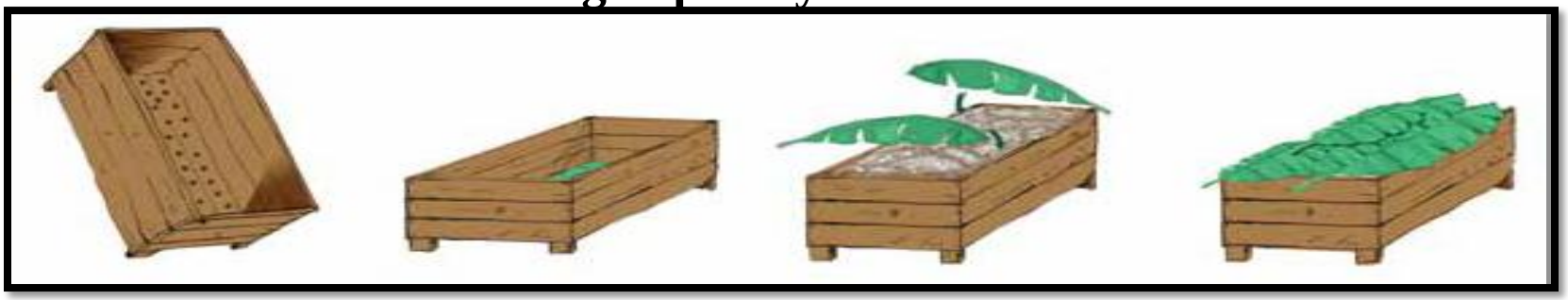


Types of harvesting of pods. a) Machete, b) Pruning shears, c) Pruning pole, d) Sickle, e) Never harvest by hands

Primary Processing

- Matured pods are removed from the tree by machetes or by a similar knife attached to a long pole for the higher branches
- After a day or two, the pods are split open with the machete and the beans and pulp removed by hand or by hand implements
- Beans are subjected to natural fermentation to assist in removing the adhering pulp and to prepare the beans for drying
- Fermentation generally takes for 5-10 days
- **At the end of fermentation, the pulp breaks down and there is a change in color of the seeds from pale yellow or violet to brown**
- The **endogenous enzymes**, activated by the heat of fermentation bring about **changes in proteins and polyphenols** in the Kernel and there is also a reduction in the astringency of the kernel
- The beans are then dried to 6-8% moisture level in sun or in artificial dryers
- The bean is then ready for export or further processing to manufacture cocoa products

Breaking of pod by hand



Fermentation

a) Basket fermentation

b) Box fermentation

c) Heap fermentation

Types of fermentation methods for cocoa

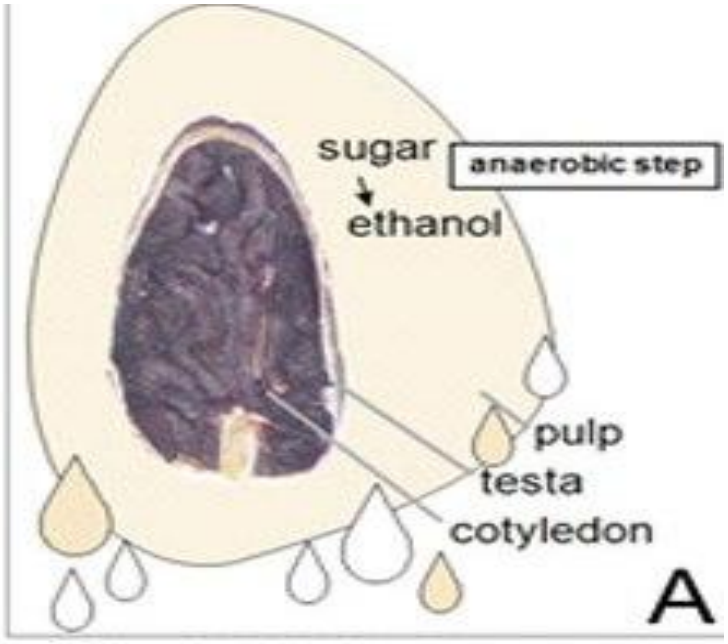
Cont….

Stages of fermentation :

- Mostly anaerobic yeasts, lactic acid bacteria and acetic acid bacteria are responsible for fermentation due to which the fermentation process is divided into 3 stages depending upon its action.
- The pulp is an excellent medium for the growth of micro-organisms since it contains 10-15% of sugars

Stage A : Action of Anaerobic yeasts

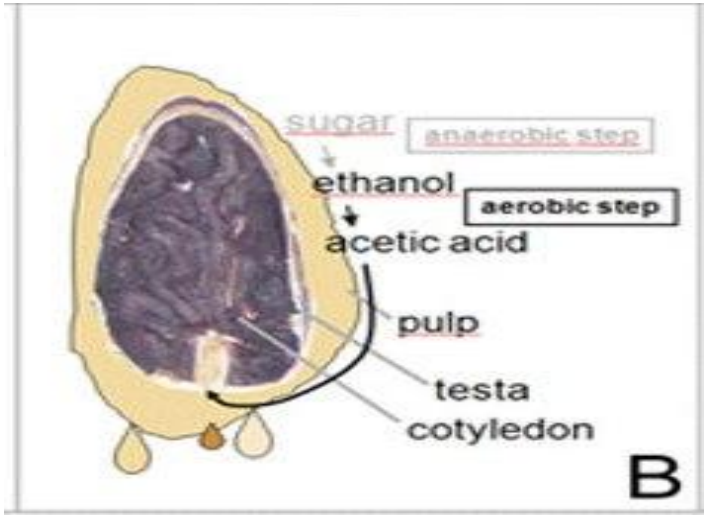
Yeast coverts sugars present in beans to alcohol and carbon dioxide within 24-36 hrs causing rise in temperature and lowering in pH.



Cont….

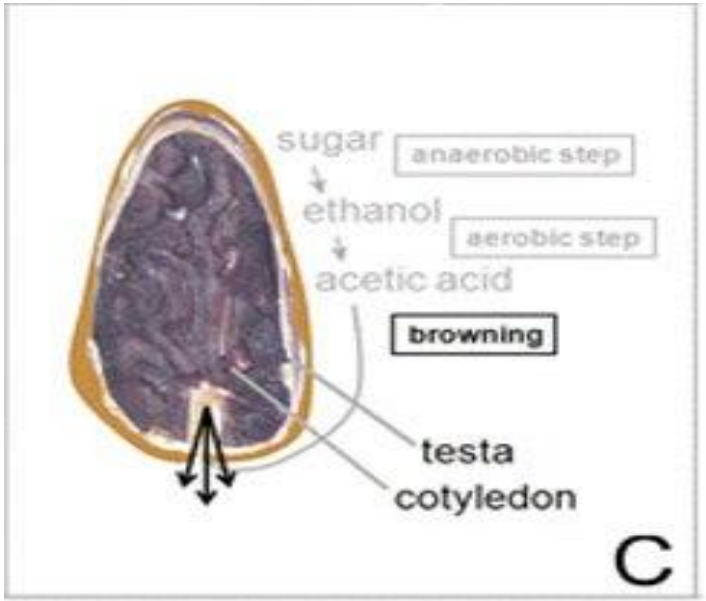
Stage B : Action of Lactic acid bacteria

This converts sugars and acids to lactic acid. Acetic acid enters from husk into cocoa beans



Stage C : Action of acetic acid bacteria

It converts alcohol to acetic acid and the temperature rises up to 50 ℃ due to this exothermic process



Aromatic compounds in fermented cocoa beans

The most important aromatic compounds in fermented cocoa are the following classes:

- Pyrazines
- Aldehydes
- Alcohols
- Ketones
- Esters

✓ Some of these compounds are influenced by fermentation time, others are not.

✓ All are affected by the temperature and time of the roasting protocol.

Cont….

Beans after fermentation. Purple colored are slaty and underfermented while brown are properly fermented cocoa

End point of fermentation

1. Bean colour changes to brown, becomes plump and filled with a reddish brown exudate
2. Testa becomes loose and detached from the cotyledons
3. Longitudinal halves of cotyledons show bleached appearance in the centre with a brownish ring at the periphery
4. When 50 % of beans show these signs, the lot can be taken out for drying

Factors Influencing Fermentation

- ✓ **Pod maturity**
- ✓ **Pod storage**
- ✓ **Quantity of beans**
- ✓ **Quantity of pulp**
- ✓ **Type of cocoa**
- ✓ **Duration**
- ✓ **Turning**
- ✓ **Seasonal effects**
- ✓ **Pod diseases**

Cont….

Drying

- After fermentation, remove the remains of the pulp by washing the beans or mixing them with sawdust and dry banana leaves
- The beans are then dried naturally or artificially to get final moisture content of 6-7%.
- Sun drying is the best as it ensures lower acidity, astringency, bitterness and better chocolate flavour
- The beans are to be skin dry in first 24 hours
- 3-4 days drying is desirable
- Temperature of the dryer should not exceed 600°C
- Avoid contamination by smoke

Sun drying of cocoa beans

Mechanical drying of cocoa beans

Cont…

- Mechanical drying can be roughly divided into 2 types:
  using rotating drums using trays, platforms or endless belts

Advantage:

✓ Independent on weather
✓ Need shorter time (14-48 hrs)
✓ Saving in labor
✓ No contamination by foreign matter (sticks, stones, etc.)
✓ Less possibility of mold growth

Importance of cocoa drying

- Significant lowering of strong acid/sour flavor:
  volatile acetic acid evaporates through husk during slow drying. Non-volatile lactic acid is partly transported by water from the bean to the husk
- Strong oxidative browning of polyphenols leading to reduced astringency and bitterness
- Flavor forming reactions occur

Cont….

Storage

- Storage involves keeping the cocoa completely dry to avoid mould, insect damage and the formation of free fatty acids.
- The dried cocoa beans are placed in jute bags lined with polyethene on a pallet to avoid contact with the ground and walls.
- The storage location must be dry, clean, well-aerated and protected from rodents and humidity (less than 80%) to ensure the quality of the product.
- Remove flat beans, foreign matter and broken beans.

Secondary Processing

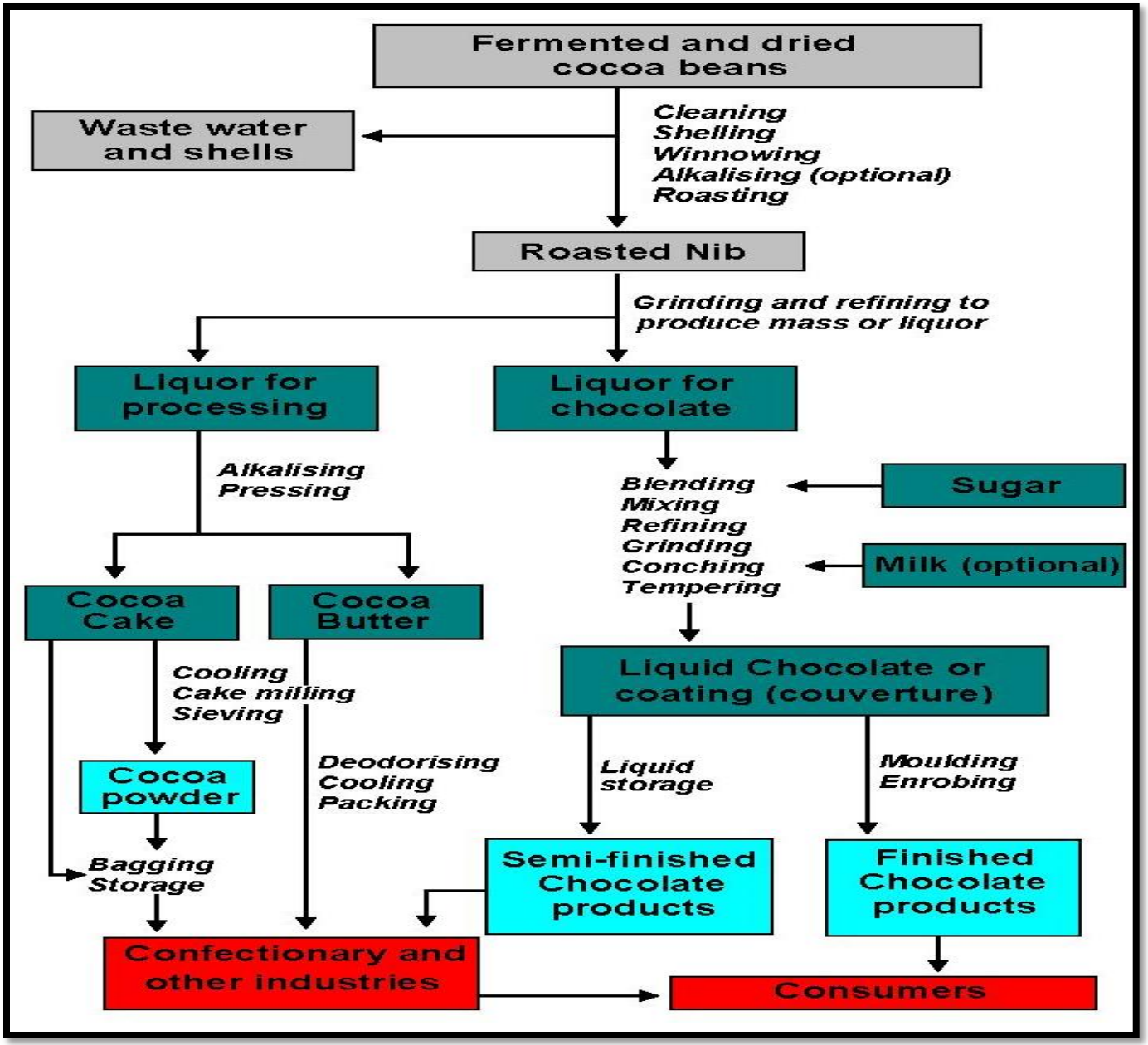
a) Alkalization

b) Roasting

c) Winnowing

d) Grinding

e) Processing of cocoa liquor



Cont….

a) Alkalization

- ✓ Reduces acidity by treating of cocoa beans with a food-grade alkali solution
- ✓ Imparts attractive colour and flavors to cocoa powder
- ✓ Improves dispersability of cocoa powder

Alkalizing Ingredients Used in Alkalizing Cacao

CFR-Code of Federal Regulations Sec. 163.110-114

	Potassium	Sodium	Ammonium	Magnesium
Carbonate	K_2CO_3	Na_2CO_3	$(NH_4)_2CO_3$	$MgCO_3$
Bicarbonate	$KHCO_3$	$NaHCO_3$	NH_4CO_3	
Hydroxide	KOH	NaOH	NH_4OH	
Oxide				MgO

Cont….

b) Roasting

- ✓ Roasting of cocoa beans are generally done at temperatures between 105-120℃/20-30 minutes depends on whether the end use is for cocoa or chocolate.
- ✓ During roasting, organic acids, volatile astringent compounds gets evaporated along with chemical modification on tannins which reduces the bitterness
- ✓ Development of pleasant aromatic complex
- Elimination of excess moisture
- Loosening the shell from cotyledon

Small scale roasting

ROASTING (20-30 MINUTES)

Large scale

Roaster

Winnower

Small scale

Uruli roaster

Cont….

c) Winnowing

REMOVAL OF SHELL

Cont….

d) **Grinding**

- The roasted nibs are ground in stone mills or other suitable mills to a fine paste or liquor
- The heat produced during grinding due to the friction and causes cocoa fat to melt, the melted fat carries with it, in suspension, and a thick chocolate-coloured liquid, known as 'mass' or ‘Chocolate liquor’ or ‘Bitter chocolate’.
- It contains 50-55% cocoa butter and solidifies (at about 30°C) on cooling.
- This is the basis of all chocolate and cocoa products

Large scale

Small scale

Cont….

e) Pressing of Cocoa Liquor

- Filter-pressing to separate out a major part of fat (cocoa butter)
- The amount of fat left in the pressed cake can be varied by the conditions of pressing
- The pressed cake is used for producing cocoa powder

According to ISI specifications, cocoa used for beverage should contain 20 % cocoa fat. Medium fat cocoa, containing between 10 – 20 % fat, and low fat cocoa, containing less than 10 % fat are made

- The lower the desired fat content in cocoa, the larger is the pressing time so it is usually uneconomical to press to cocoa fat content less than 10-12%

Cont….

(1) Cocoa butter

It is pale yellow colored, chocolate flavoured, brittle below 25°C containing Palmitic, Stearic, Oleic and Linoleic acid

Types :

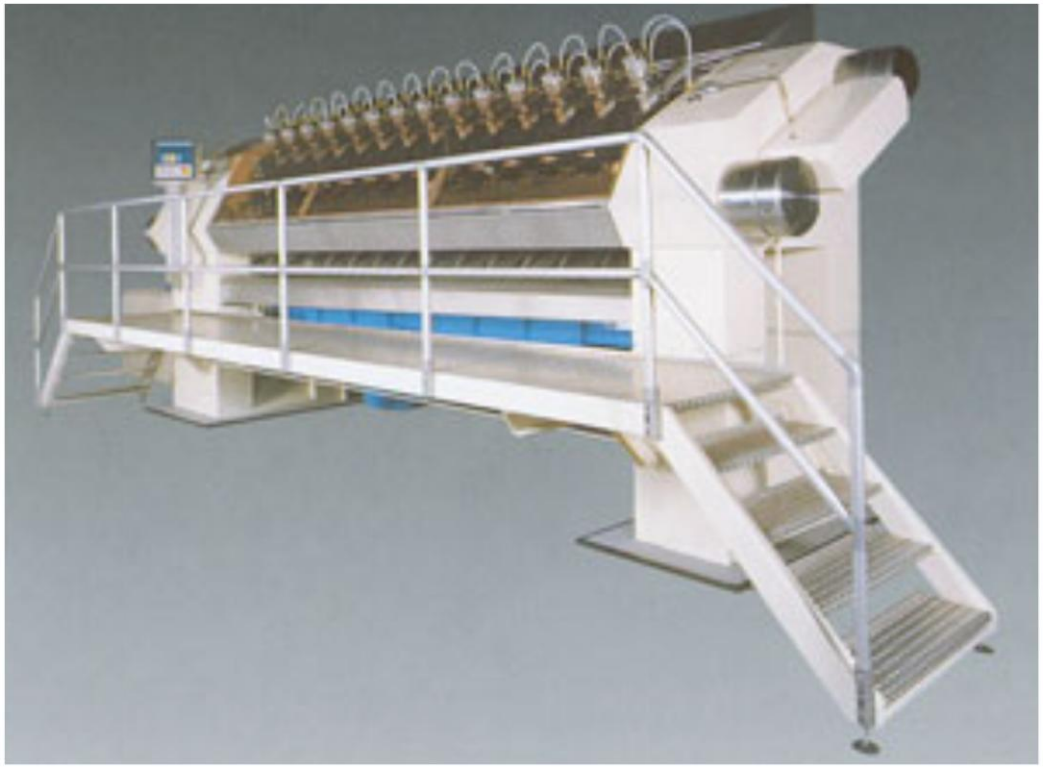
1. Prime pressed cocoa butter – Obtained from nibs by mechanical (hydraulic) pressing without any refining.
2. Expeller pressed cocoa butter – Nibs undergoes steaming and further use of expeller. The obtained product has very mild.
3. Solvent extracted cocoa butter – It is extracted from the cake residue after expeller pressing and subjected to refining such as degumming and deodorization precesses.

(2) Cocoa powder :

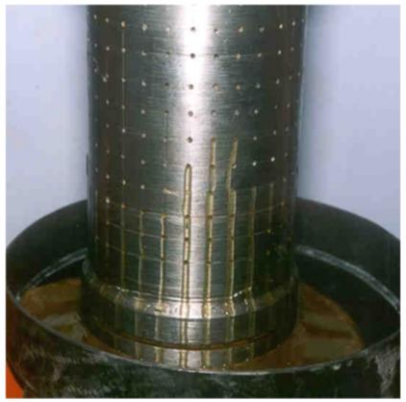
- Cocoa cake further converted to cocoa powder by removing (pressing) the fat using hydraulic, mechanical pressing at pressure of 400- 500 bar and temperature of 90-100 ℃.
- Cocoa powder is widely used in the manufacture of other products e.g. cake fillings, icings, pudding powders , ice creams, and cocoa beverages.

EXTRACTION OF COCOA BUTTER

Large scale



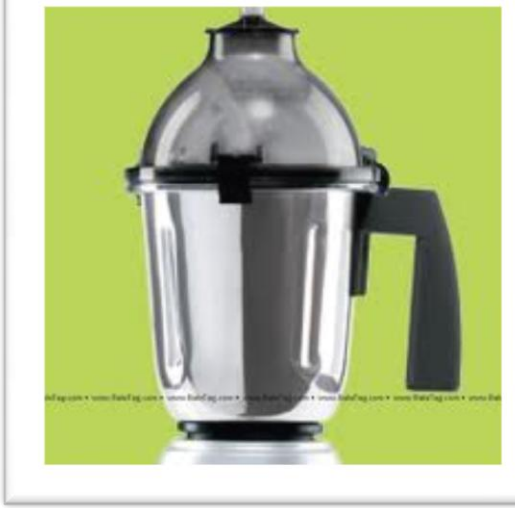
Small scale



PULVERIZATION OF CAKE AND SIEVING

Large scale

Small scale



Cont….

Generally, Natural and Dutch process are used to manufacture cocoa powder

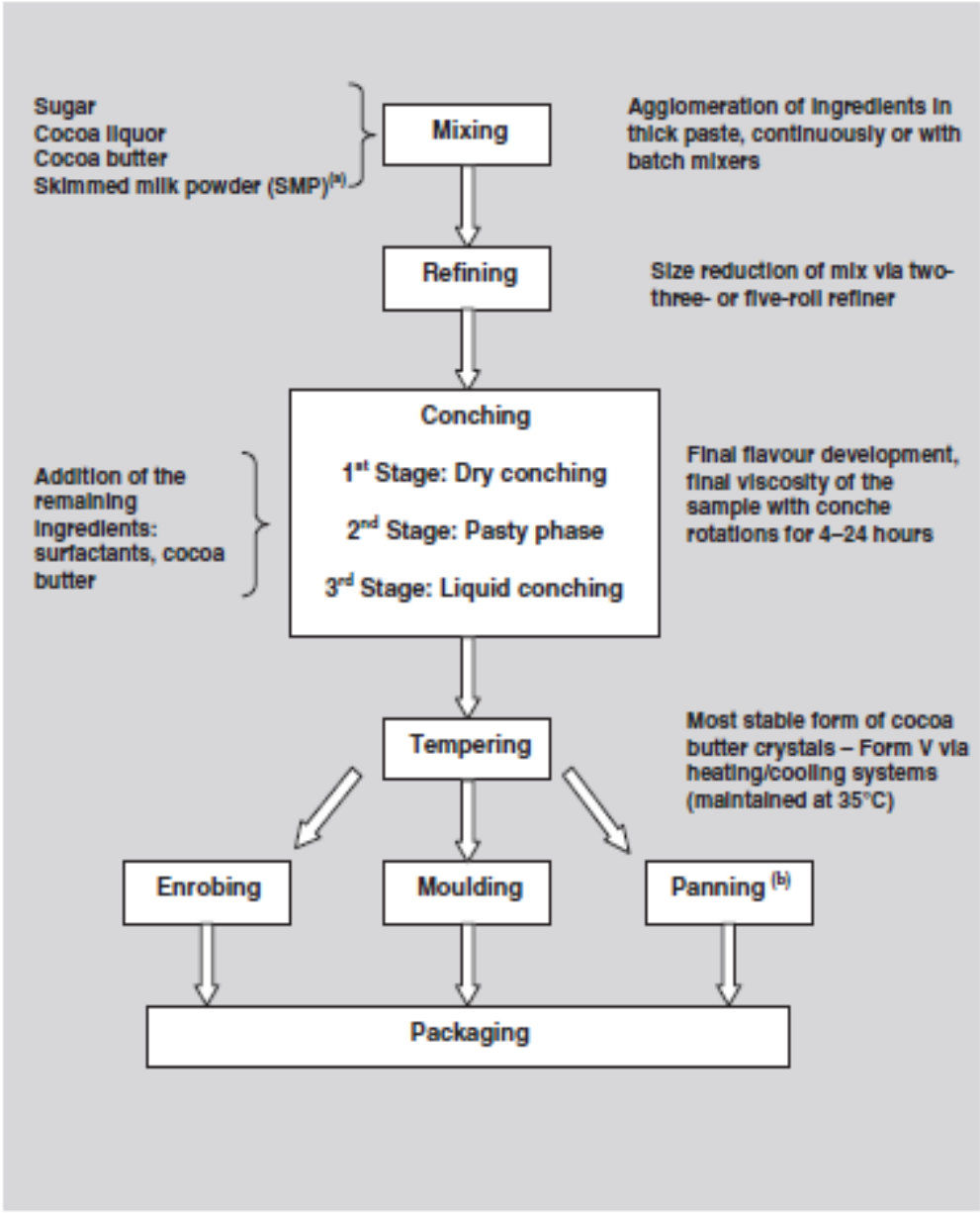
Natural process cocoa powder

Dutch process cocoa powder

Cont….

NATURAL PROCESS	DUTCH PROCESS
The process involves use of simply **unsweetened** cocoa powder.	The process involves use of **alkalized** unsweetened cocoa powder.
No treatment given. Cocoa beans are directly pulverized into fine powder.	Cocoa bean Treated with potassium solution to neutralize acidity
Cocoa powder **reacts with baking powder** used in recipes	**Doesn't react** with baking powder So not used in recipes
Lighter in colour than dutch process powder.	Neutralization of acidity makes **it dark in colour**
Strong cocoa beans taste	**Milder taste** compared to Natural process cocoa powder
Flavonols content **greater** than that in dutch processed powder.	**Lower** amounts **of flavonols**

Chocolate Preparation



Note: (a) Skimmed milk powder is only used in milk chocolate manufacture;
(b) Panning means that the chocolate is used as coating for hard centres such as nuts.

Fig. 3.1 Processing steps for chocolate manufacture (Afoakwa *et al.*, 2007a).

Cont….

- Cocoa mass or liquor which was not treated with any alkali is used to prepare chocolate.
- It is generally prepared by mixing cocoa butter, sugar, milk and other ingredient depending upon type of chocolate required.
- Plain and milk chocolates are popular among people of every age.

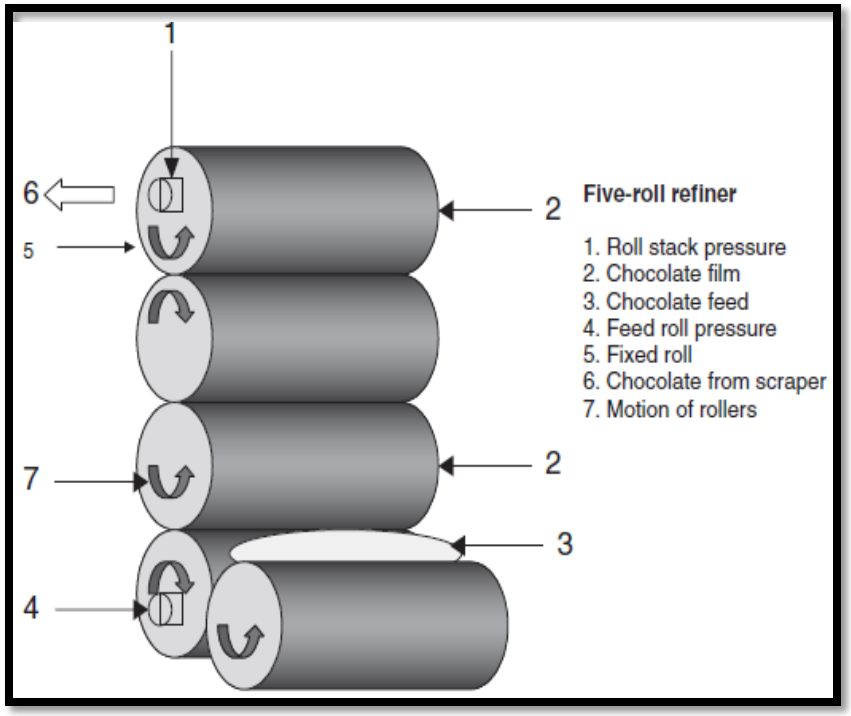
a)Mixing

- Mixing of ingredients during chocolate manufacture is a fundamental operation employed using time–temperature combinations in a continuous or batch mixers to obtain constant formulation consistency (soft, plastic, pliable and flowable).
- During this, cocoa liquor, sugar, cocoa butter, milk fat and milk powder (depending on product category) is thoroughly mixed normally for 12–15 minutes at 40– 50℃.
- The process prepares the mass for further step of chocolate manufacturing i.e., refining

Cont….

b) **Refining** :

- Refining of chocolate is important to the production of smooth texture that is desirable in modern chocolate confectionery.
- Mixtures of sugar and cocoa liquor (and milk solids depending on the type of chocolate) at an overall fat content of 8–24% are refined to particle size of less than 30 μm normally using five-roll refiners to obtain required particle size.



Five roller refiner

Cont….

c) **Conching**

- Conching is regarded as the endpoint or final operation in the manufacture of chocolate.
- It is a balance of temperature, time, agitation, and aeration.
- Longitudinal conche and Rotary conches are popular.
- Conching is normally carried out by agitating chocolate at more than50◦C for few hours.
- The process develops dark colored, chocolate flavor with lowered moisture content.

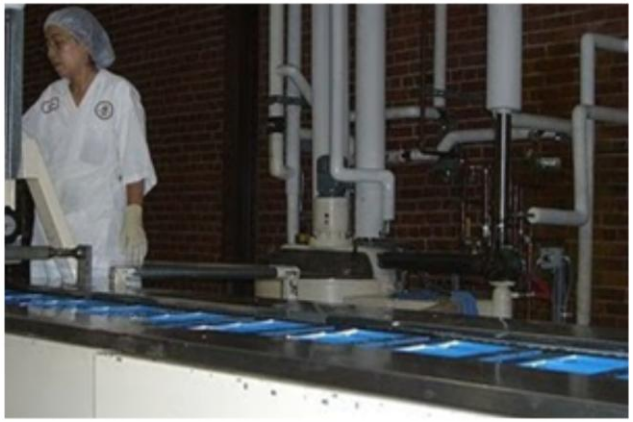
Conching machine

d) **Tempering**

- The final process is called tempering.
- Uncontrolled crystallization of cocoa butter typically results in crystals of varying size, some are even can be seen with the naked eye.
- This causes the chocolate of improper texture.
- The uniform sheen and crisp bite of properly processed chocolate are the result of consistently small cocoa butter crystals produced by the tempering process. The primary purpose of tempering is to assure that only the best form is present.

Cont….

- A well-tempered chocolate will have the following properties: good shape, colour, gloss, contraction from the mould, stable product – harder and more heat resistant (fewer finger marks during packaging) and longer shelf-life



Cont….

- Tempering involves pre-crystallisation of a small proportion of triglycerides, with crystals forming nuclei (1–3% total) for remaining lipid to set in the correct form.
- Tempering has four key steps: melting to completion (at 50◦C), cooling to point of crystallisation (at 32◦C), crystallisation (at 27◦C) and conversion of any unstable crystals (at 29–31◦C)

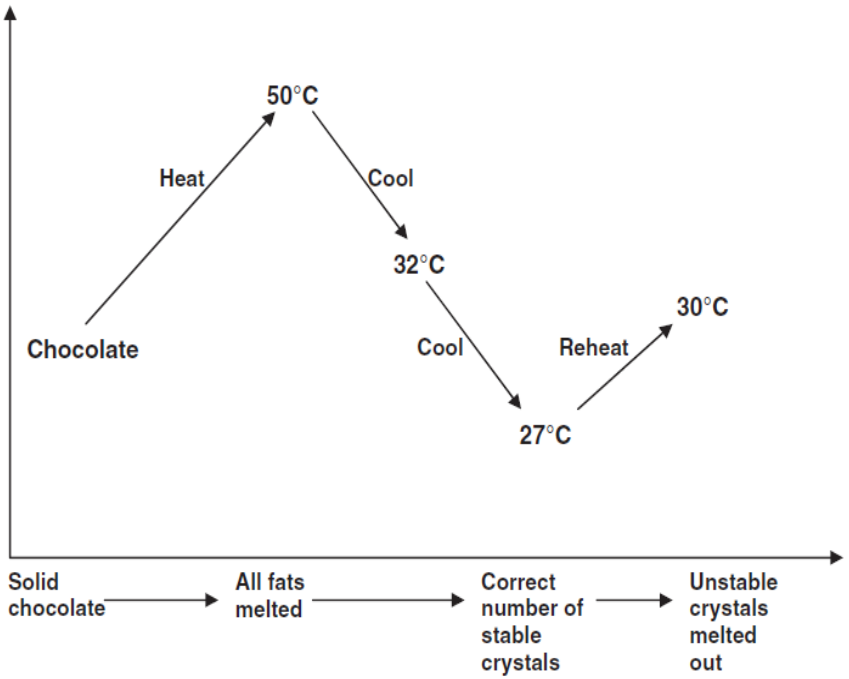


Fig. 3.5 Tempering sequence during lipid crystallisation in chocolates.

Cont….

e) Moulding

- The process gives required size and shape to the chocolate using different moulds.
- One can add dry fruits even at this stage if required.
- After solidification of chocolates moulds, it is packed and stored

f) Enrobing

- Enrobing means to apply a coating of, usually, chocolate (although it could also be a chocolate-flavoured coating or, indeed, a coating of any other flavour) to the outside of a product.
- The coating is usually applied by means of an enrober.
- the products to be coated pass through a continuous ‘curtain’ of the coating.
- As they pass through, they are coated on the top, sides and bottom.
- Excess coating is removed and the remaining coating is crystallised by passing the coated product through a cooling tunnel.

Cont….

- Some products are dipped into the coating and removed before again allowing the coating to crystallise and harden.
- Products that are typically dipped are ice creams on a stick (where the coldness of the ice cream begins to harden the coating even before passing into a blast freezer) and some hand-made confectionery products.
- Other products, particularly small items such as nuts and raisins are coated by panning.
- In this process the centres are continually moving in a rotating ‘pan’ (similar to a cement mixer) and the coating is sprayed on to them gradually building up in a number of layers.
- In other products, particularly where a thin coating is needed, the coating will be sprayed on to the surface of the centre. This is often used to apply thin barriers to reduce moisture and alcohol migration.
- The ‘coating’ can be applied to cover the complete centre (full coating) or on the bottom only (half-coating) or on the bottom and the lower sides (shoulder dipping).

Types of enrobing machines

Full coating enrobers

- Bottoming
- Top Coating
- Blowing
- Shaking
- Licking
- Anti-tailing

Fig. 17.2 Gravity flow pan for top coating.

Fig. 17.4 Enrober blower unit.

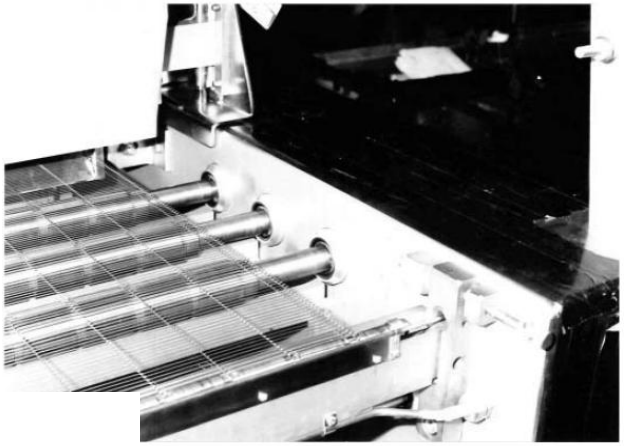


Fig. 17.5 Licking rolls.

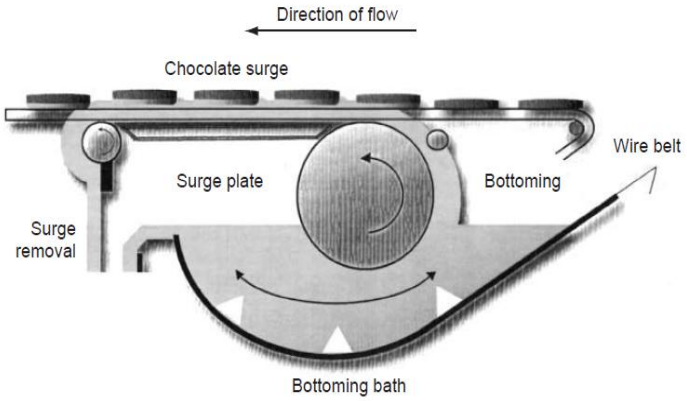


Fig. 17.1 Bottoming of enrobed centres.

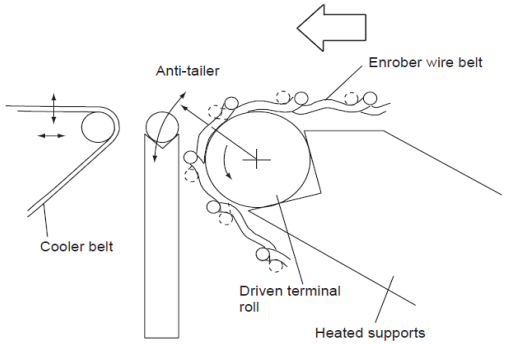


Fig. 17.7 Enrober anti-tailer.

Types of Half-coating enrober

Half-coating enrober

- Bottoming
- Licking rolls
- Transfer to cooling tunnel
- Biscuit turnover

Fig. 17.9 Turn-over of half-coated (bottomed) biscuits.

Cont….

g)Storage of chocolate

- Chocolate ideally stored between 15 to 19℃ at 50% RH.
- It should be kept separate from other food materials as it can absorbs the different aroma from foods.

Chocolate defects

- Typically, two main types of defects occur in chocolates during post-processing handling, storage, warehousing and distribution. These include fat and sugar blooms.

a) Fat bloom :

- Fat bloom occurs when fat crystals protruding chocolate, or chocolate-flavored coating surface, disturb the reflection of light and appears visible as a whitish film of fat, usually covering the entire surface, making the products unacceptable for marketing and consumption.
- Although fat-bloomed chocolate does not pose any public health or safety hazards to consumer, the process renders the product unappealing, and therefore renders it inedible.

Fat bloom can be caused by the following

1. Insufficient crystallisation during tempering
2. Recrystallisation without appropriate tempering
3. Inhomogeneity of the chocolate or chocolate-flavoured coatings
4. Differences in temperature between the chocolate and the centre
5. Incorrect cooling conditions
6. Fat migration
7. Inappropriate storage conditions, i.e. humidity and temperature

Cont….

b) Sugar bloom :

- Sugar bloom occurs through either poor storage conditions (high humidity) or rapid transition of products from an area of low to high temperature. Both conditions result in sweating of the chocolate, which consequently dissolves sugar.
- As the surface water evaporates, sugar crystals remain on the surfaces, producing a white appearance.
- The difference can be established microscopically or whichever is simpler by heating the chocolate to 38◦C.

Structure of different types of candies

❖**Structure of caramels**

- It is complex structure of highly concentrated sugar and emulsified fat. Also it contains milk protein.
- The caramel texture depends on the moisture content (6-20%), which may vary from semi-hard to hard. Milk ingredient has the major influence on the texture (1-4%).
- As the coagulated milk protein gives texture on cooking and it gives stand-up properties i.e. prevent cold flow. But at low end of moisture content range, protein is less important than total solids

Cont….

❖ **Structure of fudge**

- It is two phase system-sugar crystals form surrounds the continuous syrup phase, to provide characteristic short texture of fudge.
- Moisture content mainly influence on hardness.

❖ **Structure of toffee**

- It is an amorphous glass like state of hard candy, which is basically made from fat emulsified into syrup.
- The higher fat content gives it a friable, crunchy texture. Toffees very often have nut or other inclusions added e.g. the almonds in English Toffee.

Major Raw Materials in candies preparation

Sugar

- Sucrose is the mainly used as sweetener and texture former.
- In fudge, sugar content must be high enough to allow crystallization.
- Some time it is partially replace with brown sugar or other sugar to added flavor in candies.

Invert sugar

- It is hydrolyzed sucrose, which help in forming the tender texture and humectancy (5%).
- Invert sugar helps in controlling the crystal size in candies.

Corn syrup

- Corn syrup, provides bulk, body texture to candies.
- It prevents crystallization in case of caramel and control the crystallization in case of fudge.

Cont….

- Generally 42DE (Dextrose equivalent) high fructose corn sugar is most often used in confectionery.
- The lower dextrose equivalent sugar used then it make the product tough, chewy texture and high dextrose equivalent sugar used then it makes sticky and lack of textured product.
- High Fructose corn syrup (42%) is very similar to invert sugar in composition, can be used as a 1:1 replacement.

Milk

- It is the major ingredient of caramel production, as milk protein reacts with reducing sugar in maillard reaction a major factor in developing a typical caramel flavour and colour.
- The milk generally used for flavour and texture improvement.
- The caramel generally contain 1-4% of milk protein. Milk protein is generally composed of casein (80%) and remaining (20%) whey protein.

Cont….

Milk products

- **Fresh milk:** it contains 13% solid and rarely used due to high moisture content.
- **Sweetened condensed whole milk:** It is mostly used and consist of 27% water, 44.3% added sugar,8.1% protein, 8.7% milk fat, 11.4% lactose.
- **Sweetened condensed skim milk:** It contains 28% water, 42% added sugar,10% protein, 0.3% milkfat, 16.3% lactose.
- **Condensed milk, evaporated milk:** it is concentrated solid product contains 33% solid. It is generally consisting of 9% protein, 9% fat, and 1.4% lactose. Also it is available in fat free form. Condensed milk generally sold in truckloads for large scale operation and evaporated milk sold in can. Evaporated milk is a favorite in retail candy kitchens, gives a rich creamy flavor, must be added slowly to boiling batch to avoid curdling.
- **Milk powder:** It is dried milk powder (skim milk or whole milk), generally used in caramel and fudge. Reconstitution of milk powder needs careful attention. It requires 24 holding period after premixing to ensure maximum hydration. Milk powder use may form the rough texture and inferior flavor. Milk powder can be prepared by using spray drying, roller drier.

Cont….

- **Whey powder and protein concentrate:** It contains protein 12.9% Lactose 73.5% Ash 8.0%. it is used as partial replacement od milk in caramel and fudge. But it can produce the inferior quality of product due to poor flavor, lack of body as protein contain no casein.

Fat

- It provides a “creamy” mouth feel, influences the firmness, and provide lubricity to prevent sticking to equipment during production and teeth during consumption.
- In fudge, caramel, and toffee, it mainly contributed to flavor and texture.
- It is generally added as part of milk ingredients as dairy butter or as anhydrous milk fat. Other fats are also used in the formulation of candies such as soybeans, palm kernel, palm, coconut and cottonseed. Vegetable fat do not contribute to the flavour of the product.
- The fat should have melting point in between the range 32-42 °C to be used in the product to avoid a waxy mouthfeel on consumption. hard fat contributes to the texture of caramel.

Cont….

Emulsifier

- The substance when added to enhance the emulsification.
- Milk contains a natural emulsifier. Soya lecithin (0.25%) is the most commonly used emulsifier in food.
- Mono-glycerides and/or Di-glycerides (1-2%) are sometimes used as emulsifiers, they also help to improve lubricity and are useful in low-fat content formula.

Starch protein gum gelling agent

- It is generally added to provide body to low protein food.
- In caramel, egg whites, soy proteins, wheat flour,gelatin and alginates are some time used**.**

Cont….

Salt

- It enhances flavor to other raw materials.
- It is used at 0.25-1%. For pH adjusting, in caramel or fudge as pre-mix should have neutral pH.
- The low pH cause curdling of milk and granular texture. Sodium bicarbonate is generally used ~0.3%per batch

Flavour

- Vanilla extracts, Vanillin or other synthetic flavors are generally added to caramel and fudge recipes. Other some natural and artificial flavor are added such as Licorice, Peppermint, Raspberry

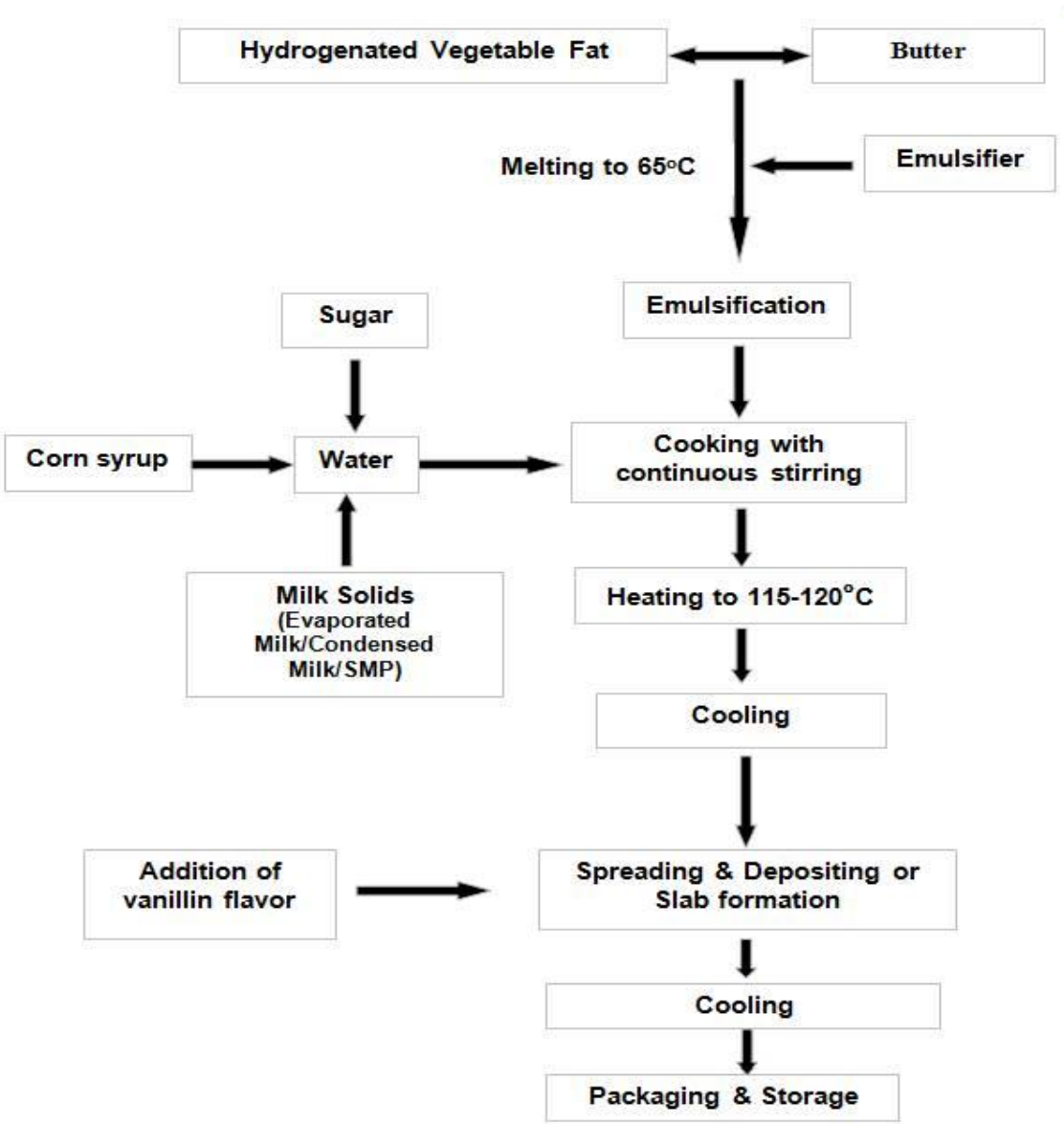
Caramel and Toffee Processing

- It is done by using a simple technique, by using an open kettle which is heated by steam and gas.
- The kettle should be made from copper or stainless steel and fitted with scrapers to prevent scorching caused by milk protein burning on the sides of the kettle.
- Copper metal provides the best heat transfer and stainless steel provides better sanitation.
- But the major disadvantage of use of copper is, causes the oxidation of less stable fat and reduces shelf life.

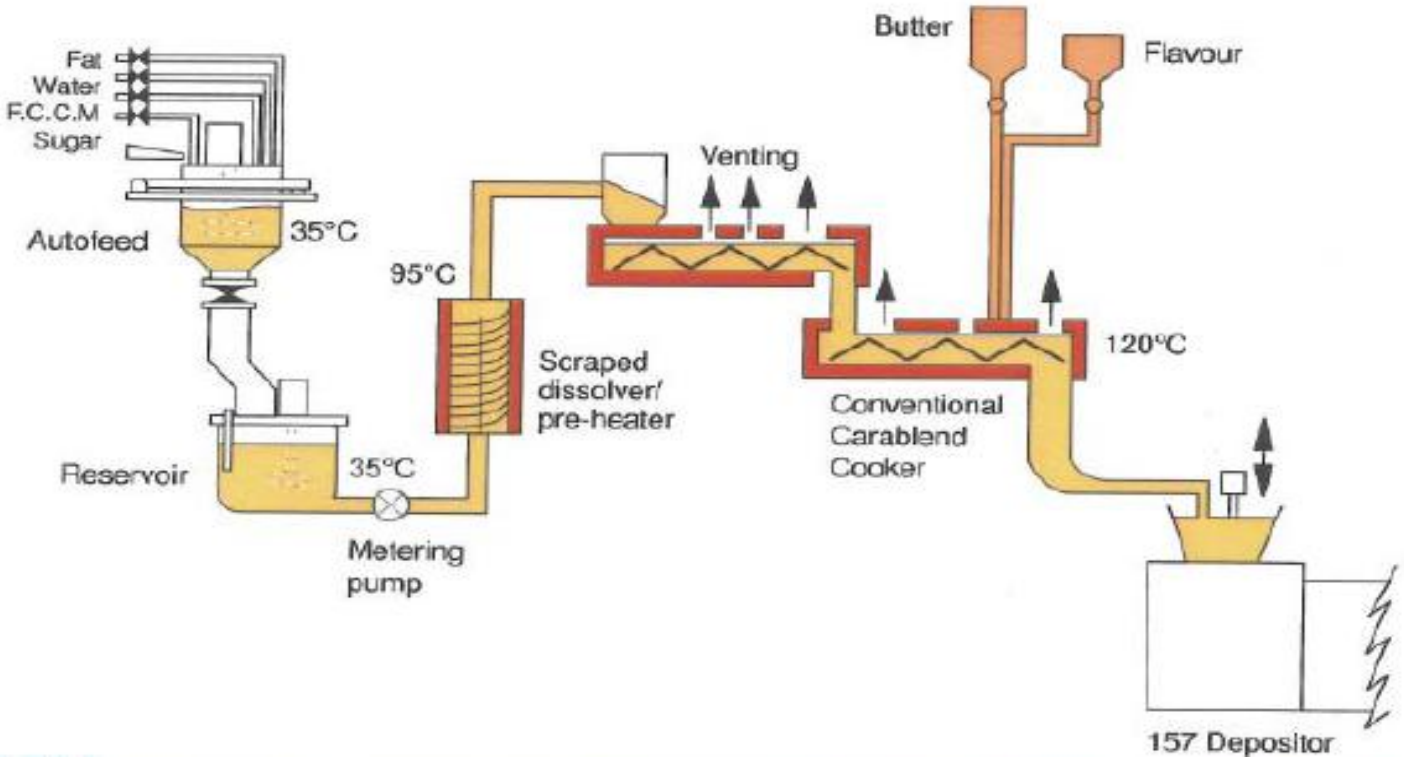
The five basic unit operation is done during the caramel/ Toffee processing

- **Pre-Mixing**
- **Emulsification**
- **Cooking / Caramelizing**
- **Cooling**
- **Forming**

Caramel processing



Toffee Plant



Cont…

Pre-Mixing

- The sugar, corn syrups, condensed milk, fats, emulsifiers and salt are required in caramel preparation. But sometime water may be added depends on the requirement.
- All the ingredients are blended and heated enough to melt sugar and fat.
- The heating temperature should be near to melting point of fat/ emulsifier + 10°F. the premixing is generally done at 70-72 °C.

Emulsification

- It is an important step in caramel preparation, to prevent phase separation as well as flavors development.
- It is done by using high shear homogenization, ultrasonication.
- The emulsification process is generally done between the pre-mixing and cooking process (160-180°F /10-20 min).

Cont…

Cooking / Caramelizing

- Caramelization is an important process to develop the colour and flavour during cooking at 248°F (120°C).
- It is generally based on cooking time and temperature.
- Cooking process is done after emulsification with constant scraping to final temperature required to give the final moisture content 6-7%.
- This processing generally takes 20 min to complete the cooking. While toffee is cooked to 300°F (150°C), to make it crunchy.

Cooling

- In case of batch processing, it is generally poured out onto a water-cooled table and tempered with occasional folding to the desired plasticity.
- While in case of continuous process, is usually passed over a water-cooled wheel for lowering the temperature.

Cont…

Forming

- The forming is depending on the product being made. It can be done by various machineries such as **batch roller / cut & wrap, extruder, depositor (not pre-cooled),bar former.**

Fudge Processing

- Fudge is basically made form chocolate, along with added cream, butter and condensed milk to make it smooth and keep it away from hardening.
- The cooking process of fudge is similar to caramel process.

Graining

- It is important process of formation of grain structure of fudge.
- The sucrose crystallization must be induced by cooling without agitation (200-130°F) in water cooled kettle, then add fondant to seed crystallization.
- In case of flat bed beater, the cooked batch pour into the cream beater and cooled to 100°F.
- The mass will thin at end of process due to heat of crystallization.
- Fudge can also be made using equipment based on continuous beaters or heat exchangers designed for fondant production.

Forming

- There are many ways toform fudge into a finished producti.e.Extruder, Bar Forming, Depositing (starch or starchless), Filling into plastic or foil trays, Cut and wrap, Stamping into shapes.

FONDANT

- Fondant is made by mixing it with sucrose (sugar) in water.
- At room temperature, water can only contain so much sugar. Even when heated to boiling point, water can hold over twice as much sugar.
- The best fondant is made by mixing boiling water and sugar together until it forms a soft ball.
- Cream of tartar is sometimes for extra stability. Once it is ready, mix it up with corn syrup to produce poured fondant or roll into sheets to produce rolled fondant.
- Fondant is very pliable and can be kneaded and molded into all sorts of shapes.
- It can also be colored with various dyes. These features make it ideal for decorating cakes.
- Many cake artists drape sheets of rolled fondant over their basic cakes to cover them before decorating with finishing touches.

Cont…

- Fondant consists of minute sucrose crystals suspended in saturated sugar syrup with sufficient invert sugar or glucose to prevent the growth of crystals.
- In preparing fondant for use it should be heated in water-jacket pans with the appropriate amount of stock syrup to produce the desired consistency. Thermostatically controlled pans are desirable.
- The temperature should not greatly exceed 38°C if a good gloss is to be retained.
- If overheated, the crystals redissolve and, on cooling, recrystallise into larger crystals, which do not reflect as much light, and the result is that the gloss will be spoiled. If it is under-heated the fondant will not set firm, but will be sticky and runny.

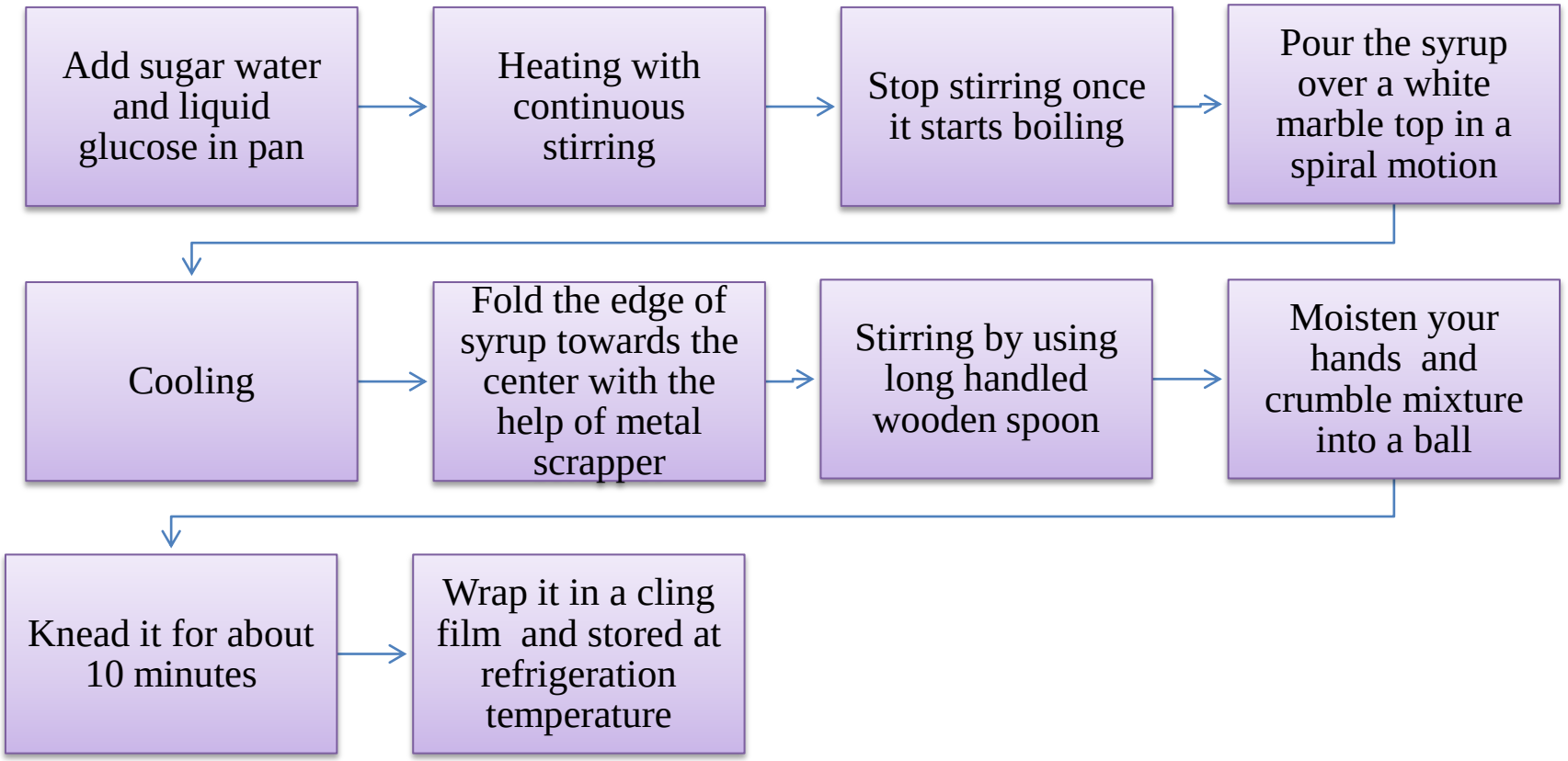
Fondant can be thinned down by the addition of any of the following:

- Sugar syrup
- Alcohol or liquid flavouring or colouring
- Egg white

Preparation of fondant

Ingredients (for 1 kg cake)

1. Grain sugar: 450 gm
2. Liquid glucose: 1 table spoon
3. Water: 150 ml.



Cont…

- Fondant can be rolled on a marble top with the little icing sugar in the shape of the cake. Cover the cake with it after rolling.
- It can allow it can also be thinned down by adding a little water and cook on a slow fire.
- When it melts and has pouring/ running consistency, it can be pulled over the cake and allowed to set.

Types of Fondant

There are two main types of this kind of fondant: poured and rolled.

a) Poured fondant

- It is creamy and liquid, and is often used as a filling or coating for cakes, pastries, candies, and other desserts.
- Poured fondant is made mainly of sugar, water and corn syrup.

b) Rolled Fondant

- **It** is the most common fondant, which looks like smooth pie dough and is often wrapped on top of the cake to cover them, as well as cut into strips or shapes for decoration.
- Like poured fondant, it is made with sugar, water and corn syrup. To make pliable dough, gelatin and/or glycerine is added. It's then rolled out into sheets that can be colored and used to decorate cakes.

Packaging for Better Living

भारतीय पैकेजिंग संस्थान
Indian Institute of Packaging
An autonomous body under the Ministry of Commerce & Industry, Govt. of India

Packaging, Labeling & Branding

By

Dr. Babu Rao Guduri

Joint Director & Head: T & E Division
Indian Institute of Packaging
E-2, MIDC Area, Andheri East, Mumbai – 400 093

Packaging in modern life

- Packaging is the science, art and technology of enclosing and/or protecting products for distribution, storage, sale and use.
- Packaging is a coordinated system of preparing goods for transport, warehousing, sale and use.
- Packaging helps the consumer quickly understand what the product is all about
- Packaging is a silent salesman

Packaging

Packaging may be defined as a **mean** of ensuring the **safe delivery** of a product to the ultimate **consumer** in a **sound condition** at a minimum **overall cost**

Packaging Functions

TO PROTECT

- The packaging protects the contents, allowing the contents to arrive at the shop or at home undamaged.

TO PRESERVE

- Foods are packaged to prevent them from going rotten.
- It also keeps them hygienic and allows them to be bought conveniently.

TO TRANSPORT

- Items are packed into boxes or trays called 'Outers' so that they can be moved, and stacked easily.

- Packaging usually tessellates to allow more to be transported in a smaller lorry, reducing costs.

TO INFORM

- Labels provide information about the product to the customer or shop.
- They can be used as a marketing tool.

- They can make claims to a customer.
- They can carry information for shops in barcodes.

Different packaging levels

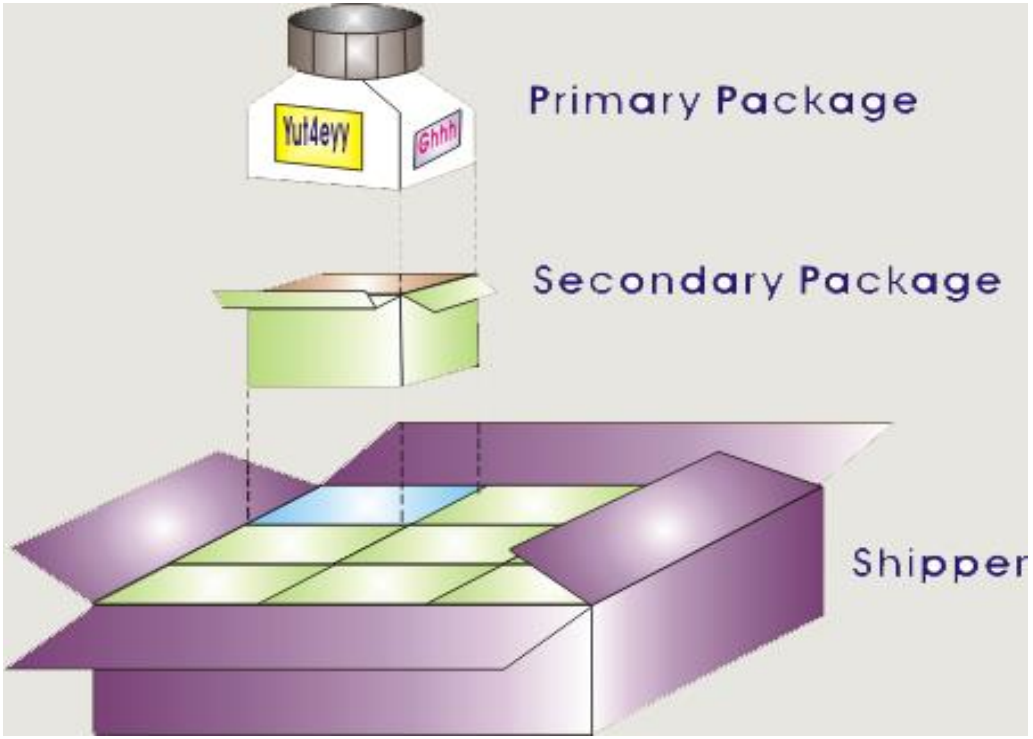
- **Primary package:** The first wrap or containment of the product that directly holds the product for sale.

- **Secondary package:** A wrap or containment of the primary package.

Different packaging levels

- **Distribution package (shipper):** A wrap or containment whose prime purpose is to protect the product during distribution and to provide for efficient handling.
- **Unitload:** A number of distribution packages bound together and unitized into a single entity for purposes of mechanical handling, storage, and shipping.

Different packaging levels



Packaging can have many levels. All levels of the system must work together

Packaging Developments – Product wise

Some Package Materials

Package Preference

Role of Packaging.

- Facilitates product delivery from manufacturer to consumer.
- Good packaging gives consumer confidence about product quality.
- Decides fate of the product.

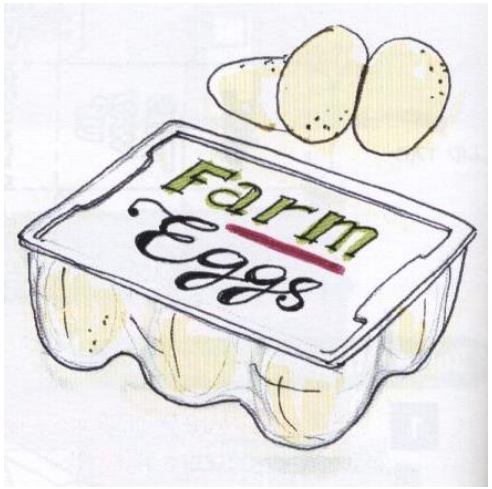
Role of Packaging.

- Packaging converts commodity into a brand.
- Packaging adds value.
- Packaging avoids wastage.

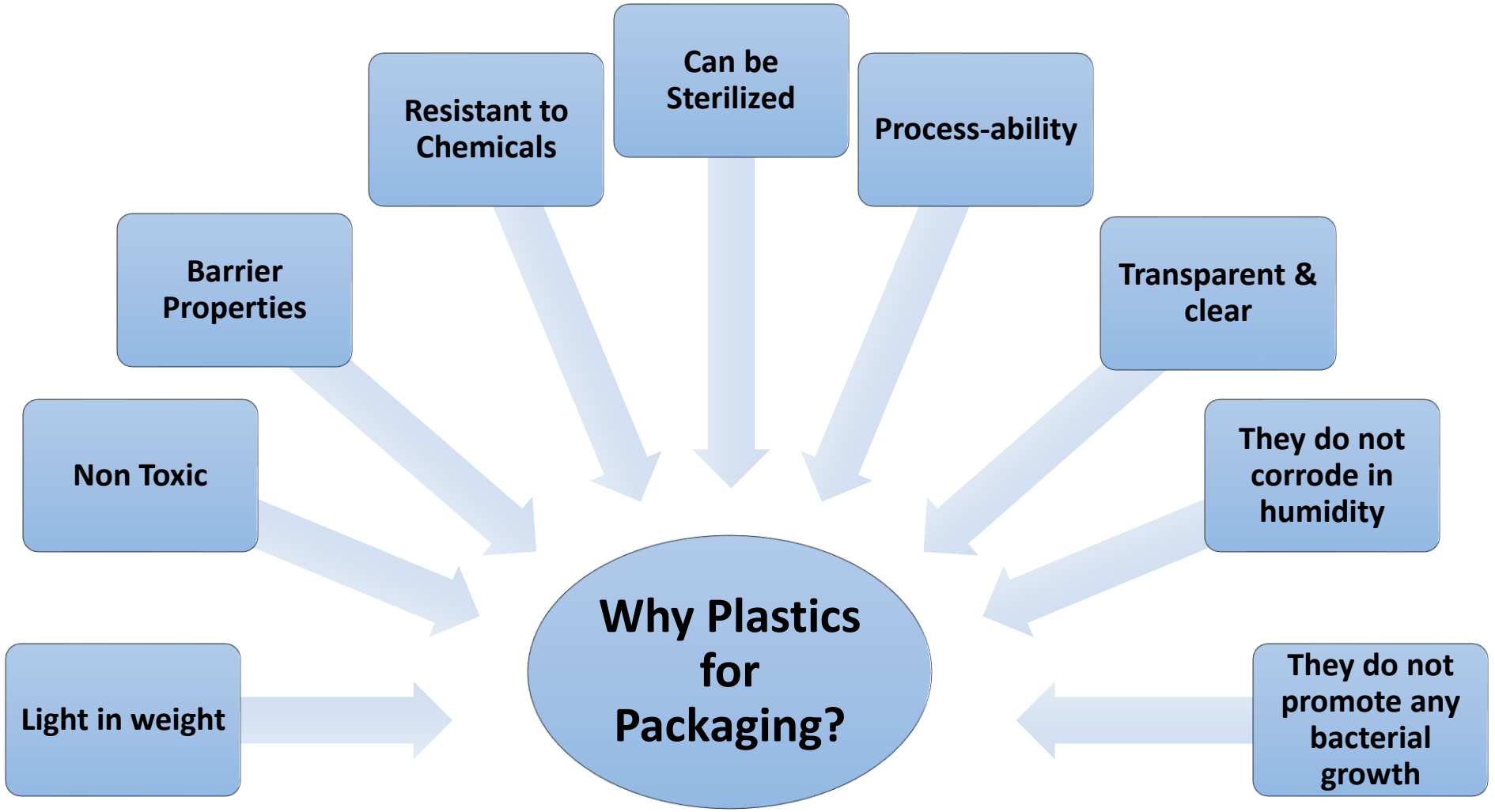
Material

Packaging can be created using various materials these includes:

- Paper
- Board
- Plastic
- Lamination
- Metal
- Glass
- Other



Why Plastics for Packaging?

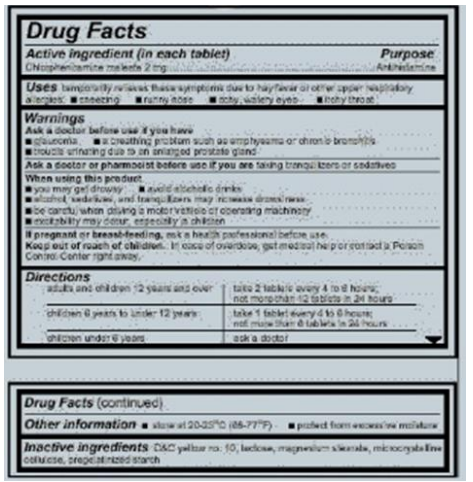


Labelling

- Label is a part of product, which carries verbal information about the product. It may be a small slip or printed statement.
- The seller must label the products
- The label might carry only the brand name or a great deal information.

Type of labelling

Brand label

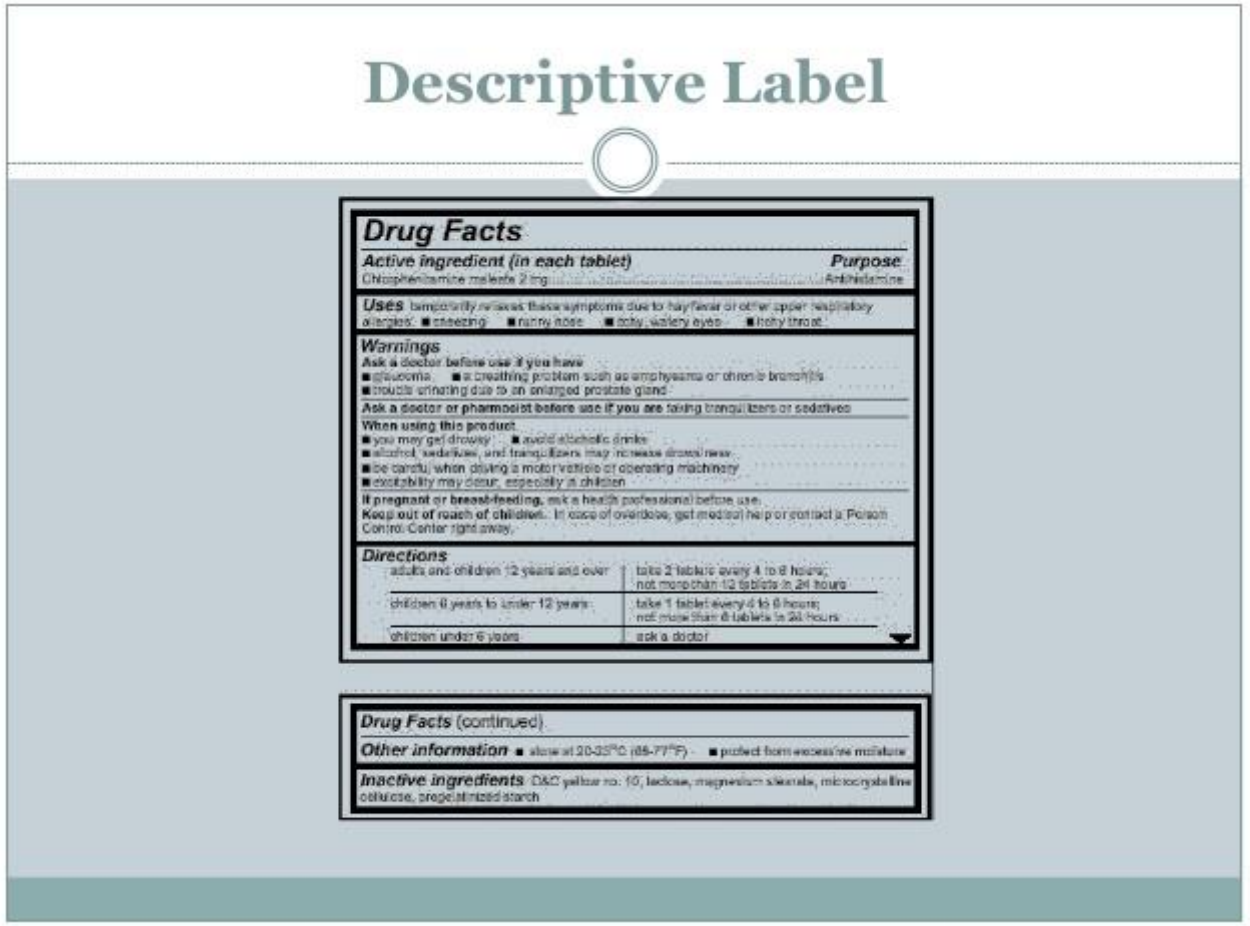


Descriptive label

Grade label

Role of Packaging.

Role of Packaging.



Role of Packaging.

Branding.

- Branding is a practice of giving a specified name to a product or group of product of one seller.
- Branding is the process of finding and fixing the means of Identification
- **Definition of Branding: A brand is defined as a "Name, Term, Sign Symbol or a combination of these that identifies the maker or seller of the product"**
- Example: Rado watch

Why Brand ?

- A brand name helps an organization differentiate itself from its competitors.
- In today's competitive world customers expect products to have brand.
- Some people will only purchases a particular brand even through there are acceptable alternatives on the marker.

Example: Apple Inc.

Brand Equity

- Brand equity referrers to the value of a brand. Brand equity does not develop instantaneously.
- A brand needs to be carefully nurtured and marketed so consumers feel real value and trust towards that brand.
- Nike, Adidas have high brand equity. These brands command high awareness and consumer loyalty

Branding Strategies

Line extension:

This is where an organization adds to its current product line by introducing versions of its products with new features, and example could be a crisp/chips manufacturer extending its line by adding more exotic flavours.

Brand extension

- If your current brand name is successful, you may use the brand name to extend into new business areas.
- For example Virgin Group extending its brand from records, airlines, mobiles and banking

Multi Branding

- The company decides to introduce more brands into an exiting category.
- Procter & Gamble (P&G) – Is an American consumer goods company, that sells 23 difference brands, examples are Tide, Pampers, Gillette, Ace, Head & Shoulders, etc.,

Branding Decisions

Strategies adopted by the marketer while branding a product:

- Individual names
- Blanket family names
- Separate family names for all products
- Company trade name combined with individual product names

भारतीय पैकेजिंग संस्थान
Indian Institute of Packaging
An autonomous body under the Ministry of Commerce & Industry, Govt. of India

Thank you

Packaging of Food Products and Self life Studies

Dr. DONAL BHATTACHARJEE
Research Associate, R&D Division
Indian Institute of Packaging, Mumbai

Plan of Presentation

- Introduction
- Food packaging
- Types of packaging
- Selection criteria for packaging material
- Shelf life studies
- Conclusion

INTRODUCTION

- **Food security** exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs, whereas **Nutrition Security** demands the intake of a wide range of foods which provides the essential needed nutrients
- Large losses from farm to plate are attributed to poor handling, distribution, storage and consumption behaviour
- Losses at almost every stage of the food chain may be reduced by using appropriate packaging
- **Food packaging** protect food from environmental contamination and other influences (such as odors, temperature, humidity, physical damage, light, microorganisms etc.)
- Key to ensure quality and safety of food
- Extend shelf-life, minimize food losses and wastage

FOOD PACKAGING

- Packaging is an essential part of processing and distributing foods
- Preservation is the major role of packaging
- Different groups within the food chain, i.e. consumers, retailers, distributors, manufacturers and growers, offer different perspectives of shelf life, reflecting the aspect of greatest importance and significance to them.
- Consumers actively seek the product on the shelf with longest remaining shelf life as this is considered to be indicative of freshness

FUNCTIONS OF PACKAGING

Packaging: A mean or system by which a fresh produce or processed product will reach from the production center to ultimate consumer in safe & sound condition at an affordable price

TO PRESERVE

- Foods are packaged to prevent them from going rotten.
- It also keeps them hygienic and allows them to be bought conveniently.

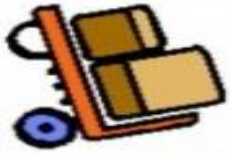
TO PROTECT

- The packaging protects the contents, allowing the contents to arrive at the shop or at home undamaged.

TO INFORM

- Labels provide information about the product to the customer or shop.
- They can be used as a marketing tool.
- They can make claims to a customer.
- They can carry information for shops in barcodes.

TO TRANSPORT



- Items are packed into boxes or trays called 'Outers' so that they can be moved, and stacked easily.
- Packaging usually tessellates to allow more to be transported in a smaller lorry, reducing costs.

REQUIREMENTS FOR EFFECTIVE PACKAGING

- Be non-toxic
- Protect against contamination from microorganisms
- Act as a barrier to moisture loss or gain and oxygen ingress
- Protect against ingress of odors or environmental toxicants
- Filter out harmful UV light
- Provide resistance to physical damage
- Transparent
- Tamper – resistant
- Easy to open
- Have dispensing and resealing features
- Be disposed of easily,
- Meet size, shape and weight requirements
- Have appearance, printability features
- Low cost
- Compatible with food

TYPES OF PACKAGING

Packaging Materials	Examples
Paper/paperboard	Paper bags, Multiwall paper sacks, Corrugated and solid fiberboard boxes, Composite containers, Moulded pulp container, Paper- coated or impregnated with waxes, resins, lacquers, plastics and laminations of aluminum to improve its strength, especially in high humidity environments
Glass	Bottles, Jars, Containers, Jugs
Metal	Beer and soft drink cans, Food cans, Open trays, Caps and closures (e.g. lids on glass jars and bottle tops), Lids (e.g. for yoghurt and butter containers)
Plastic	Bags, Pouches, Bottles, Jars, Containers (lids and without lids)

PACKAGING CATEGORIES

- **Primary packaging-** surrounds the product
- **Secondary packaging-** ease of manual movement of products
- **Transit packaging-** packaged products are placed in shipping containers for long-distance transportation and distribution

Selection Criteria of Packaging Materials

Agro Products/ Raw Food

Processed Food

FOOD CLASSIFICATION

- **(1) Highly perishable foods** (milk, fresh meat, fresh fruits and vegetables)–These are very short shelf life products that are subject to microbiological and/or enzymatic deterioration. Measurements are taken every day in order to determine shelf life.

- **(2) Semi perishable foods** (pasteurized milk, smoked meats, cheeses, and some bakery products) – These are short-to-medium shelf life products and may contain natural inhibitors or have received minimal preservative treatment. Measurements are made every week in order to determine shelf life.

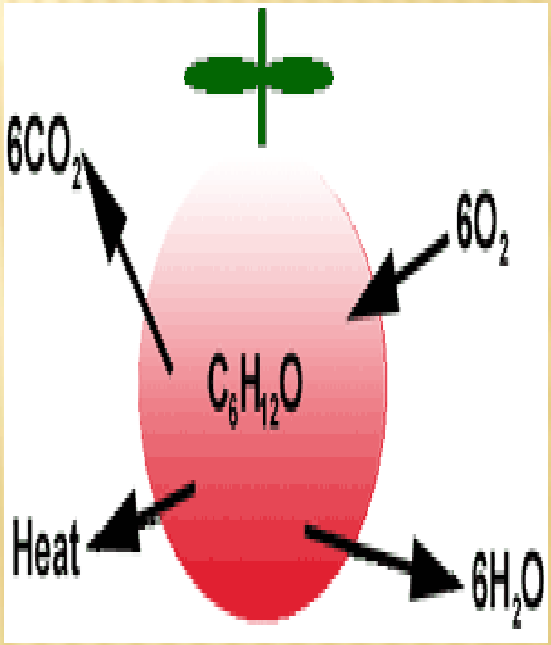
- **(3) Highly stable foods** (dried food, canned food, and frozen food) – These are medium-to-long shelf life products that have received a thermal process or are maintained in specific conditions. Measurements are made every week or monthly in order to determine shelf life.

CEREALS AND LEGUMES

- Cereals and legumes are produced as staple foods
- Maize, millets, rice, wheat, types of pea and beans.
- Usually dried on farms before sale and producers may also mill grains to produce flours
- Packaging options depend on type of selling: wholesale and retail
- Wholesale- sacks (jute, cotton), multi-walled paper sacks, woven polypropylene sacks
- Retail- polythene bags, sacks that can be heat sealed, brown kraft paper sacks etc.

FRUITS AND VEGETABLES

- Horticultural commodities are living biological entities, having a respiratory system
- Continue their living processes after harvest
- Respiration is the process by which plants take in oxygen and give out carbon dioxide (biochemical oxidation)
- Respiration rate is proportional to temperature (doubling every 10°C)



POSTHARVEST PHYSIOLOGY

- On the basis of the respiration rate and ethylene production patterns during maturation and ripening, fruits can be classified in two groups:

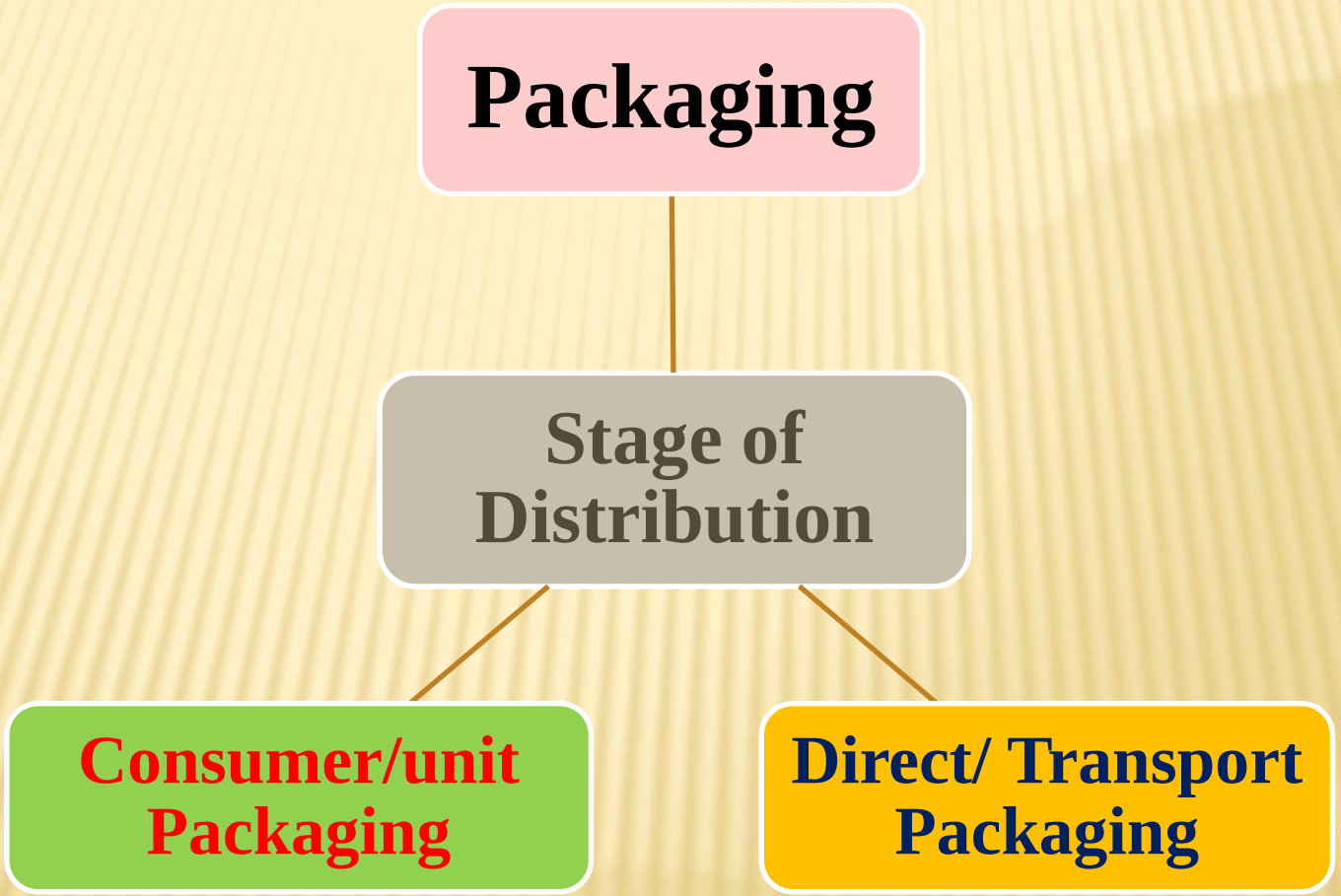
- **Climacteric fruits-** exhibit a large increase in carbon dioxide and ethylene production rates coincident with their ripening
- **Non-climacteric fruits-** exhibit no changes (low carbon dioxide and ethylene production rates during ripening).

- **Ethylene-** natural product of plant metabolism and is produced by all tissues of higher plants.
- Natural aging and ripening hormone and is active even at small traces

FACTORS AFFECTING SHELF LIFE

- Due to high respiration, heat build up will be more, which in turn increases temperature and respiration of the produce, reduces shelf life.
- Very high moisture content (75-95%).
- Under any normal atmospheric condition, they will dry rapidly and this causes wilting and shrivelling due to loss of rigidity and shrinkage of the cells.
- All these processes are highly sensitive to temperature.
- Shock and vibration leads to damage to produce cells which causes an increase in respiration and may lead to enzymes being released that will cause browning reactions.
- Spoilage caused by microorganisms like yeasts, molds and bacteria. Grows on exterior or invade interior through bruise/cuts internal decay

TYPES OF PACKAGING



PACKAGING OF FRUITS AND VEGETABLES

Packaging methods	Description	Materials used
Flexible Plastic Films	Mostly used as pouches with holes- air to circulate. Film bags are clear, allowing for easy inspection of the contents, and readily accept high quality graphics	LDPE or PP
Net Bags	Stretches and accommodates all size and shapes. Provide desired ventilation and allow free air	HPDE and polyamide
EPS Tray	Tray are overwrapped with heat shrinkable or stretch films. A tight wrap immobilizes fruits and keep them apart. Avoids abrasion and bruising, provides cushioning effect	Expanded polystyrene (EPS)/PVC/PP
Plastic Punnets with Lids	Punnets are light weight, offers excellent clarity, stackable and recyclable. Small holes positioned throughout (produce can breathe)	Food grade PET PVC, PP
Stretch Film/Cling Film	Transparent film with property of clinging to the packed product when stretch wrapped. It can be used without application of heat. Film is semi-permiable and allows exchange of gases for respiration of the produce	LDPE, LLDPE, PVC film

Flexible Plastic Pouch

Net Bag

EPS Tray

Plastic Punnet

Stretch Film/Cling Film

DIRECT BULK PACKS

CUSTARD APPLE- RSC STYLE (0201)

MANGOES-TELESCOPIC STYLE (0300)

APPLES AND ORANGES- TELESCOPIC STYLE (0320) WITH PULP TRAYS

DIRECT BULK PACKS

Custard Apple in Telescopic Box with Slotted Partitions

Oranges in Telescopic Box with Slotted Partitions

Grapes in Moulded EPS Box

Kiwifruits in Moulded EPS Box

PALLETIZATION

- Process of storing and transporting goods and cargo on a pallet
- **Pallets are how fruits make their way from farms to supermarkets**
- **Pallet** is a portable platform on which goods are stored or moved
- Provides standard way to handle and transport palletized goods with mechanical equipment like **Pallet Jack or fork lifts**
- Pallets have been standardized keeping in view of the standard package sizes and sea containers
- Sizes of pallets are of strategic importance since they correspond directly to the sizes of various containers, ship cargo compartments, trucks, fork trucks etc.
- Better utilization of storage space

DIMENSIONS OF PALLETS

Type of Pallet	Base Dimension
IATA-A	2130 x 3070 mm
IATA-B	2340 x 3070 mm
EURO-A	1200 x 1000 mm
EURO-B	1200 x 800 mm

(IATA: International Air Transport Association)

- Standard internal dimensions of a 20 ft refrigerated containers are:

5364 x 2255 x 2255 mm

TRANSPORT PACKS FOR CONSUMER PACKS

Grapes in Punnets

Kiwifruits in EPS Trays

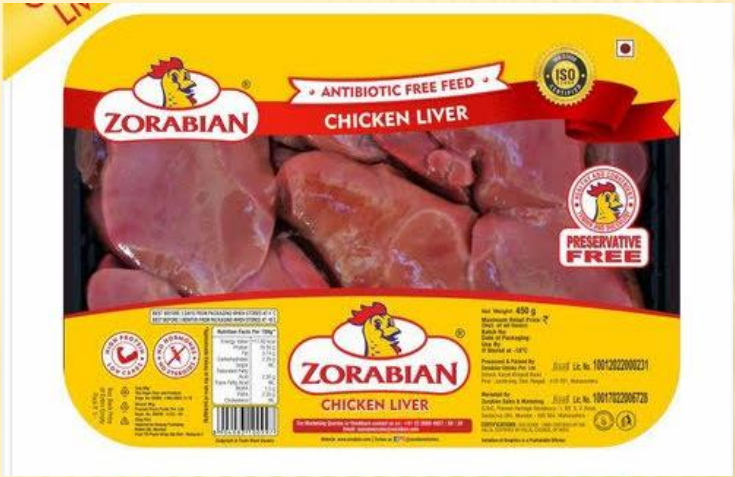
Kiwifruits in Net Bags

RAW MEAT

- Most meat is offered to consumers in a freshly or recently cut form
- Little processing- to reduce carcass meat to edible cuts
- Fresh meat is vulnerable to microbiological deterioration
- Microorganisms can be as benign as slime formers to stink producers to pathogens such as *E. coli* O157:H7
- Major mechanisms to retard fresh meat spoilage are temperature reduction, often coupled with reduced oxygen during distribution, to retard normal spoilage microbial growth.
- Reduced oxygen also leads to fresh meat color being the purple of myoglobin, a condition changed upon exposure to air which converts the natural meat pigment to bright cherry red oxymyoglobin characteristic of most fresh meat offered to and accepted by consumers

Packaging methods	Description	Materials used
Shrink packed	Meat cut has been individually wrapped in an approved material	Polyvinyl chloride (PVC), polypropylene (PP), irradiated polyethylene (PE) and polyvinylidene chloride (PVdC)
Tray packed	Meat is packed into an open container or tray, and covered with a film	EPS and PE
Modified atmosphere packed (MAP)	Packs are wrapped and are flushed with a mixture of gases to remove or lower the oxygen	PVC/PE, PET/PE, (PS/EVOH/PE), (PET/EVOH/PE)
Vacuum Packed	Air and oxygen are removed from the packaging. Vacuum packing is adapted to all methods of packaging listed above except MAP	PA, EVOH and PET-PVdC
Metal cans	Meat is hermetically sealed and cooked to make commercially sterile for long term storage	Tinplate cans with sulphur resistant lacquer

Shrink wrap



Tray pack

Vacuum Packed

Metal Cans

FISH AND SEAFOOD

- Fish-most difficult of all foods to preserve in their fresh state because of their inherent microbiological populations
- Many of which are psychrophilic, i.e., capable of growth at refrigerated temperatures.
- Seafood may harbor *Clostridium botulinum* type E, capable of toxin production without signaling spoilage
- Both salt water and fresh water fish contain comparatively high levels of proteins (about 18%)
- Internal flesh of healthy, live fish is sterile, microorganisms that exist on fresh fish are found in the gills, the outer slime, and the intestines.
- Immediately after post mortem, a whole series of tissue enzyme reactions begin the process of autolysis which leads eventually to spoilage

PACKAGING OF SEAFOOD

Packaging methods	Description	Materials used
Tray packed	Fish is packed into an open container or tray, and covered with a film	EPS and PE
MAP	Gas compositions vary according to fish species Non-fatty fish would be 30% O_2, 40% CO_2 and 30% N_2 Fatty fish 40% CO_2 and 60% N_2	PVC/PE, PET/PE, (PS/EVOH/PE), (PET/EVOH/PE)
Vacuum Packaging	Air and oxygen are removed from the packaging	PA, EVOH and PET-PVdC
CFB Box	Used for shipper for fresh and frozen seafood. Laminated box can retain product moisture but also protect the structural case against internal moisture	CFB, PE
Metal cans	Hermetically sealed and cooked to make commercially sterile for long term storage	Tinplate cans with sulphur resistant lacquer

Tray packed

Frozen Tray packed

Vacuum packed

Metal Cans

MILK AND DAIRY PRODUCTS

- Milk and its derivatives are generally excellent microbiological growth substrates and therefore potential sources for pathogens.
- Almost all milk is thermally pasteurized or heated short of sterility as an integral element of processing.
- Refrigerated distribution is generally dictated for all products that are pasteurized, to minimize the probability of spoilage

PACKAGING OF MILK AND DAIRY PRODUCTS

- **Milk-** (i) Bulk Distribution: Aluminium cans with lids (ii) Distribution in Bottles: Glass bottles

(iii) Distribution in Non-Returnable Containers: Plastic pouches (LDPE, LLDPE, HDPE or EVOH)

(iv) Paperboard Cartons: Tetrapak, Tetrabrik

- **Cheese-** polystyrene or polypropylene tubs or polyethylene pouches for refrigerated distribution
- **Fermented Milks-** same as cheese, flexible barrier materials such as nylon + polyvinylidene chloride or polyester/polyvinylidene chloride
- **Ice cream and frozen desserts-** distribution under frozen conditions. Water-resistant paperboard, polyethylene-coated paperboard, and polyethylene structures


Nestlé
Nestlé
Nourish
अमूल
ताज़ा
DANONE
World's No. 1 Fresh Dairy Co.
Milk
Quality You Can Trust
Toned milk


b
MILK
leche fresca
de vaca
b
MILK
leche fresca
de vaca
semidesnatada
b
MILK
leche fresca
de vaca
desnatada

NEW TRENDS AND TECHNOLOGICAL INNOVATIONS

- Several new technologies offer the packer opportunities to modify the atmosphere inside the shipping package during distribution.

- Controlled atmosphere packaging (CAP)
- Modified atmosphere packaging (MAP)
- Edible coatings and films
- Antimicrobial packaging
- Smart/intelligent packaging

PROCESSED FOOD PRODUCTS

- **Tomato Products:** tomato-based sauces, pizza toppings
- Tomato-based products for retail sale are more commonly packaged in glass jars with reclosable metal closures
- **Sauces & ketchup:** PE bottles, Squeeze bottles etc. PET/EVOH, PET/EVOH/PET

FRUIT JUICES

- Juices and analogous fruit beverages may be hot filled or aseptically packaged.
- Traditional packaging has been hot filling into steel cans and glass bottles and jars.
- Much fruit beverage is currently hot filled into heat-set polyester bottles capable of resisting temperatures of up to 80ºC without distortion
- Hot filling generates an internal vacuum within the pouch after cooling so that the contents are generally ambient temperature shelf stable.
- Package materials used are generally laminations of polyester and aluminum foil with LLDPE internal sealant to achieve an hermetic heat seal

DRY FOODS

- Removing water from food products markedly reduces water activity and its subsequent biochemical activity, and thus also significantly reduces the potential for microbiological growth.
- Moisture can change physical and biological properties. Engineered dry products include beverage mixes such as blends of dry sugars, citric acid, color, flavor, etc. and soup mixes, which include dehydrated meat stock plus noodles, vegetables, meats, etc.
- Such products must be packaged in moisture-resistant structures to ensure against water vapor entry which can damage the contents

FATS AND OILS

- Edible liquid oils are packaged in polyester bottles usually under nitrogen.
- Fat-resistant packaging such as polyethylene-coated paperboard, aluminum foil/paper laminations and parchment paper wraps, and polypropylene tubs are used to package butter, margarine, and similar bread spreads.

CEREAL PRODUCTS

- Dry breakfast cereals generally are sufficiently low in water content to be susceptible to water vapor absorption and so require good moisture- as well as fat-barrier packaging.
- Breakfast cereals are usually packaged in coextruded polyolefin films fabricated into pouches or bags inserted into or contained within printed paperboard carton outer shells.
- Sweetened cereals may be packaged in aluminum foil, metalized plastic, or gas barrier plastic films or laminations to retard water vapor and flavor transmission

BAKERY PRODUCTS

- Breads, cakes, and muffins are highly aerated structures subject to dehydration and staling.
- To retard water loss, good moisture barriers such as coextruded polyethylene film bags or polyethylene extrusion coated paperboard cartons are used for packaging.
- Package structures for cookies and crackers include fat- and moisture-resistant coextruded polyolefin film pouches within paperboard carton shells and thermoformed polystyrene trays over-wrapped with polyethylene or oriented polypropylene film.
- Soft chewy cookies are packaged in high moisture-barrier laminations containing metallized film to improve the barrier.

SALTY SNACKS

- Dry cereal or potato products such as potato and corn and tortilla chips and include roasted nuts.
- Snacks are usually packaged in flexible pouches made from oriented polypropylene or metallized oriented polypropylene to provide low moisture and gas transmission.
- Many salty snacks are packaged under nitrogen both in pouches and in rigid containers such as spiral-wound paperboard composite cans to extend shelf life

CHOCOLATE AND CANDIES

- Chocolate, a mixture of fat and non-fat components such as sugar, is subject to slow flavor change.
- Ingredients such as nuts and caramel are susceptible to water content variation.
- Chocolates, which are generally shelf stable at ambient temperatures, are packaged in fat-resistant papers and moisture/fat barrier such as pearlized polypropylene film.

- Hard sugar candies are flavored amorphous sugars which are very hygroscopic because of their extremely low moisture contents.
- Sugar candies are packaged in low-moisture-transmission packaging such as aluminum foil, oriented polypropylene film, or metallized oriented polypropylene film

SHELF LIFE

"The period of time during which the food product will remain safe; be certain to retain desired sensory, chemical, physical, microbiological and functional characteristics; and comply with any label declaration of nutritional data when stored under the recommended conditions"

Factors Affecting Shelf Life	
Compositional/Intrinsic Factors	**Environmental/Extrinsic Factors**
Food composition	Time-temperature profile during processing
Water activity (a_w)	Pressure in the headspace
pH value	Temperature control during storage and distribution
Total acidity	Relative humidity during processing, storage, and distribution
Redox potential (E_h)	Exposure to light (UV and IR) during processing, storage, and distribution
Available oxygen	Environmental microbial counts during processing, storage, and distribution
Nutrients	Atmospheric composition within packaging
Natural micro flora and surviving microbiological counts	Distributor, retailer, and consumer handling
Natural biochemistry of the product formulation (enzymes, chemical reactants)	
Use of preservatives in product formulation (e.g., salt)	

METHODS FOR ASSESSING SHELF LIFE

- **Real Time Shelf Life Testing**

This is the one most commonly used. It involves storing the product under preselected conditions for a period of time longer than the expected shelf life and checking the product at regular intervals to see when it begins to spoil. The exact procedure is unique for each product. **(27°C + 65% RH)**

- **Accelerated Shelf life Testing**

Indirect method attempts to predict the shelf life of a product without running a full length storage trial; hence, they can be useful for products with long shelf lives. The method involves storing the product under accelerated storage conditions like high temperature, agitation and humidity. As a result the end of shelf life is achieved quickly and the product is ready for sale in a relatively short period. It can be two to four times faster than the real shelf life study **(38°C + 90% RH)**

MECHANISMS INVOLVED IN SHELF LIFE PREDICTION

- **Sensory Evaluation**:
- Assesses a food's smell, appearance, flavour, and texture
- Sensory properties are estimated by using 9-point Hedonic scale
- Scores are assigned as 9-Like Extremely, 8-Like Very Much, 7-Like Moderately, 6-Like Slightly, 5-Neither Like nor Dislike, 4-Dislike Slightly, 3-Dislike Moderately, 2-Dislike Very Much, 1-Dislike Extremely

- **Microbiological:**
- Micro flora that colonizes a particular food depends on the characteristics of the product and the way it is processed and stored.
- Consequences of microbial growth in food products are changes in pH, formation of toxic compounds, gas production, slime formation and off-flavor production.
- Microbial tests can be used to evaluate both food quality and safety.
- Tests may be done to estimate changes in the number and type of spoilage organism (yeasts, moulds or bacteria) occurring over time

- **Chemical**:
- Chemical tests can detect changes in the product's quality throughout its shelf life.
- Examples: pH, moisture content, total acidity, total soluble solids, sugar content, headspace gas analysis, free fatty acids etc.
- **Physical:**
- These include tests for measuring product texture, examination of packaging, travel tests and determining the best, worst and average retail conditions.
- A travel test helps to identify any hazards involved in transport and handling

CONCLUSION

- Packaging is one of the most important steps in the long and complicated journey from grower to consumer
- Bags, punnets, EPS Trays, Net bags, CFB Boxes, metal cans etc. are available
- Palletized containers are convenient containers for handling, transporting, and marketing
- Package- Cost effectiveness, microbial contamination, moisture, weight loss and ethylene concentration
- Reliable, accurate, environmentally benign and food contact safe
- Future packaging= conventional material + smart packaging

SERVICES OFFERED BY IIP

- Real time shelf life, accelerated shelf life and refrigerated shelf life testing of food products under simulated controlled climatic conditions.
- Measurement of changes in texture, colour, and nutritional parameters.
- Structural assessment of changes during storage
- Sensory profiling to give a complete description of product quality characteristics and the way in which they change.
- Risk assessment and complete microbial analysis of products during storage.
- Consumer package testing to measure changes in acceptability levels over time.
- Transport Worthiness Testing to determine performance of packaged product during transportation.
- Result interpretation and guidance regarding packaging specifications.

Indian Institute of Packaging

INDIAN INSTITUTE OF PACKAGING

E 2, MIDC Area, Andheri East

Mumbai – 400093

https://www.iip-in.com/

THANK YOU