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ONLINE COURSEWARE
SUBJECT NAME: BAKERY, CONFECTIONERY AND EXTRUDED FOODS

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Module I 8L

Lecture 1

Bakery Ingredients and Their Functions: Functions of Flour

1.1. Main ingredient used in bakery industries:

- Flour
- Yeast
- Chemical leavening agents
- Milk
- Shortening agents
- Egg
- Sweeteners
- Salt
- Water
- Other ingredients like dough modifies, enzymes etc.

1.1.1. Functions of flour in bakery industries:

In bakery industries the maximum used flour is wheat flour. Flour is used as a thickening agent.Wheat flour also holds wet ingredients such as oils, milk and eggs together. It can do this because of a protein called gluten, which develops as the wheat is worked.

Hard wheat is harvested in spring and is high in gluten. It has a high mineral content and is just the thing for making bread. Soft wheat has a lower amount of gluten and is used for making cakes and pastries. The mix of hard and soft wheat are why all-purpose flour is ideal for most recipes that need flour. You've also seen those packages of self-rising flour when you go shopping. This type of flour has salt and baking powder, but it doesn't store as long as all-purpose flour.

Cake flour is found on the other end of the spectrum. It is soft and silky, has little gluten and is often mixed with cornstarch. Though it's used in pastry, I've actually seen it used to dredge chicken before it's fried. Dipping chicken in egg whites and then dredging it in cake flour gives the crust an unbeatable crispness.

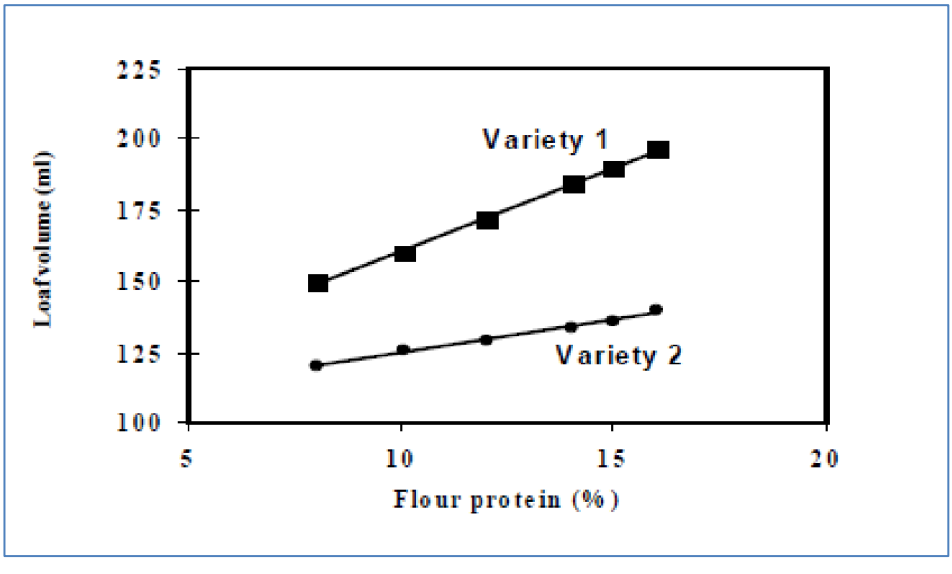
Bakers also tend to prefer bleached all-purpose flour, which is flour that's been treated to not only whiten it but bulk up the gluten. Whole wheat flour has the bran, germ and the endosperm of the wheat berry, while refined flour only has the endosperm. Because it retains the natural oils of the wheat berry, whole wheat flour is perishable and should be used up quickly or stored in the fridge.

Wheat protein functionality in bakery products:

Protein content in wheat flour generally ranges from 8-18 per cent. Fermented bakery products such as bread and buns require higher amount (> 10 percent) of good quality protein for gas retention and dough rise during fermentation or early stages of baking. On the contrary, soft wheat products such as biscuits, cakes and cookies can be produced using low protein flour (8-9 %). Lower amount of proteins confers dough extensibility and spread ability of dough that is considered desirable for texture and quality of soft wheat products.

For example effect of wheat protein in bread making:

It has long been established that the rheological properties and bread making performance of wheat flours are related to the quantity and quality of their proteins. The relationship between protein content and bread making performance (measured as loaf volume) is essentially linear with in a wheat variety over the normal range of protein contents encountered in commercial wheat flours in the following figure.
The differences in the slopes of the regression lines among wheat varieties reflect differences in their protein quality. Higher slopes characterize wheat variety with high bread making performance.



Lecture 2

Functions of Leavening Agents, Milk and Shortening Agents in Bakery Industries

1.1.2. Functions of Leavening Agents:

Leavening Agents:
Substance causing expansion of dough and batters by the release of gases within such mixtures, producing baked products with porous structure. Such agents include air,steam, yeast, baking powder, and baking soda.

Biological leavening agent: Most Common Biological leavening agent used in bakery industries is yeast.
Baker's yeast is the common name for the strains of yeast commonly used as a leavening agent in baking bread and bakery products, where it converts the fermentable sugars present in the dough into carbon dioxideand ethanol. Baker's yeast is of the species *Saccharomyces cerevisiae.*

Common types of Baker's yeast:

- Cream yeast
- Compressed yeast
- Active dry yeast
- Instant yeast
- Rapid-rise yeast
- Deactivated yeast

For most commercial uses, yeast of any form is packaged in bulk (blocks or freezer bags for fresh yeast; vacuum-packed brick bags for dry or instant);

Chemical Leavening Agents:

Chemical leavening can be achieved by producing two types of gases: CO2 and NH3. These may be released by the following methods, combined or alone:

- **Decomposition reaction of ammonium bicarbonate or ammonium carbonate in the presence of heat.** Ammonium bicarbonate, for example, decomposes into ammonia, carbon dioxide and water. The reaction is as follows:

$NH_4HCO_3 \rightarrow NH_3 + CO_2 + H_2O$

- **Reaction of an acid with a base compound**. Combining a leavening acid with baking soda in the presence of moisture undergoes an exothermic reaction to produce neutral salt, water and carbon dioxide. The reaction is as follows:

$HX + NaHCO_3 \rightarrow NaX + H_2O + CO_2$ X: non-metal or hydrocarbon chain

1.1.3. Functions of Milk in Bakery Industries:

The protein in milk softens, contributes moisture, and adds colour and flavour to baked goods. It's a double-whammy in terms of function, as it gives the dough or batter strength and structure, as well as adds tenderness, flavour and moisture.

1.1.4. Functions of Shortening Agents:

Shortening is an edible fat that is solid at room temperature. It shortens the gluten strands in wheat, which provides three textural attributes in baked goods:

1. A short bite
2. A lubricative moist texture
3. The crunchy or crispy auditory sounds

When used in a product, or a medium to be cooked in, these three textural characteristics are heightened. Because shortening provides the breakage in or 'shortens' the gluten-starch network, it reduces starch retrogradation in baked goods. Since it is 100% fat, as opposed to the 80% fat content of butter, it aids in producing a very tender baked product.

Function:

Its main use is to shorten baked goods like pastries and pie crusts to create a tender and flaky final product. This is accomplished by preventing the cohesion of wheat gluten strands during mixing, this action physically shortens the strands of gluten resulting in a less elastic and sticky protein.

Shortening is great for frying. Since it has a low percentage of unsaturated fatty acids, it shows higher resistance to oxidation and rancidity than alternative typical vegetable oils that may be used for frying. It's also a good vehicle for delivering flavor as well as richness to bread and cakes.

Shortening is used for creaming due to its ability to incorporate large volumes of air bubbles. This creates a fine, delicate structure in the end product.

In cake making, it is used to tenderize the product by incorporating air in the finished cake batter as well as lubricating the other ingredients allowing the cake to rise more freely and increase the shelf life of the product.

Application:

Shortening has the biggest range in application for cookie formulas, ranging from 30-85% (sugar to oatmeal cookies). In bread formulas, it can be used anywhere from 3-5% to improve slicebility, moistness, volume and oven spring of the product.[2]In yeasted donuts, the levels can be as high as 12%. In cake donuts, it can range from 5-8%. It can be as high as 50% for yellow layer cake formulas. In pastry products, its use can be as high as 60%.

For cakes and cookie systems that use a high level (>30%), it is better to cream it with the sugar using a paddle in the mixer. This is to ensure proper distribution and aeration of the fat molecules.

Since shortening is non-dairy (dairy is an allergen commonly unacceptable in many bakeries), it is used to replace butter. If there is a need to replace 100g butter, use 80g shortening to obtain similar results.

Types/Variations:

- *Solid* – Recommended for use in pastries, pie crusts and bread.
- *Liquid* – Mainly used in recipes that call for melted shortening, such as cake and bread formulas.
- *All-purpose*– Non-emulsified hydrogenated shortening. Used successfully in hi-ratio cakes with the addition of emulsifiers.
- *Cake or icing shortening* – All-purpose hydrogenated shortening with one or two combinations of emulsifiers added by manufacturer. Emulsifiers blended into a shortening assist in forming an emulsion allowing the baker to add more water to the cakes. In this way, it improves the eating qualities of the finished cake by retaining more moisture.

Lecture 3

Functions of Egg, Sugar, Salt, Water in Bakery Industries

1.1.5. Functions of Egg:

In baking, eggs perform many functions (like acting as emulsifiers) that help bakers eliminate the need to use other additives. Those functions include the ability to add color, coagulate, emulsify and add texture to bakery foods. The use of eggs help simplify the product label. Eggs, particularly egg whites, have high quality proteins that produce superior foams. Through whipping, eggs foam and incorporate air, which gives volume and structure to bakery foods. Foaming holds bakery foods together and promotes a lighter product with smooth mouth feel. Eggs produce a larger foam volume than other foaming agents, making it ideal for baking. This is especially ideal for cakes, such as angel food cake, because the aeration provides necessary structure. In brioche bread, egg provides a good structure for bread that is springy. There are certainly many more

functionalities of egg in baking. However, its usage is limited in the commercial bakery because it is one of the top allergens in North America.

Application:

An egg is a very nutritive food source. Its high protein profile, together with the presence of essential vitamins and minerals like Omega 3, makes it a perfect candidate for healthy baking.

To replace fresh eggs in a formula, use 26% egg powder/74% water ratio. Therefore, every 100g of whole eggs need to be replaced by 26g of whole egg powder and 74g of water.

1.1.6. Functions of Sugar in Baking:

Sugar sweetens baked goods, it actually plays many different roles in baking regarding the structure, texture, and color of baked goods.

The other functions are:

- sweetening and flavoring agent
- encourages browning
- sugar holds onto moisture
- sugar tenderizes
- sugar stabilizes
- etc.

1.1.7. Functions of Salt in Baking:

- Salt acts as a natural antioxidant in the dough and not only adds taste but especially helps bring out the flavors and aromas present in the flour and other ingredients.
- Next to its role in boosting the flavor of your bread, salt plays a role in tightening the gluten structure and adding strength to your dough. It helps the loaf to hold on to the carbon dioxide gas that is formed during fermentation, supporting good volume.
- Salt slows down fermentation and enzyme activity in dough. The salt crystals draw water away form their environment (salt is 'hygroscopic'). When salt and yeast compete for water, salt wins and the yeast is slowed down.
- Because of its moisture maintaining properties, salt can prevent bread from getting stale but it can also (this is especially true in humid environments) absorb moisture from the air and leave you with soft crusts and soggy bread.

1.1.8. Functions of Water in Baking:

Water is responsible for triggering all natural chemical processes in dough, controls dough temperature, and hydrates dough components. Specifically, water is one of the major components

in baking, and thus many bakers use lower tempered water or use water to maintain the temperature of their batter or dough. First upon addition of water, starch particles are hydrated, dough is initially formed, and subsequently water molecules begin hydrating proteins that form gluten. Three distinct factors in the quality of a water sample have a vast impact on dough characteristics as well as final bread attributes. Taste, Chemical Content, and Mineral Content variations in water are the three factors crucial to aspects of baking.

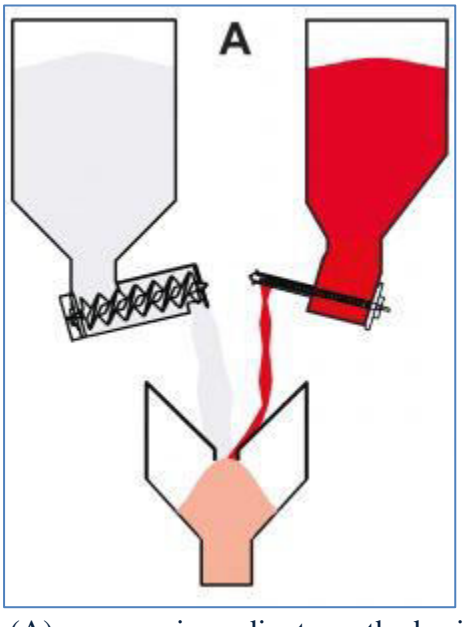
Lecture 4

Machines and Equipment for Batch and Continuous Processing of Bakery Products: Metering and Weighing Equipment

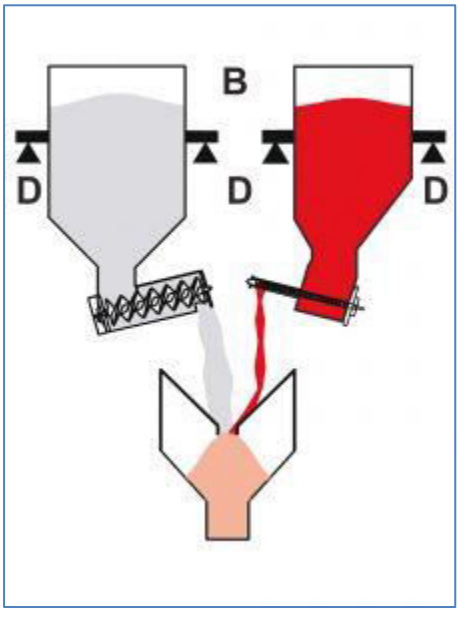
1.2. Metering and Weighing Equipment in Bakery Industries:

In bakery industries both volumetric and gravimetric weighing equipment are used.

As the name suggests, volumetric dosing systems only measure the volume of the ingredients (in cubic centimeters or meters, for example). Because the dosing device does not weigh the components, it must be calibrated to ensure that the correct mass is dosed over a set period. This means it must be recalibrated every time a new material or batch is introduced. Volumetric systems cannot automatically make adjustments for fluctuations in properties such as input material bulk density – and to play it safe, manufacturers tend to deliberately set the system to dispense a larger amount than is actually necessary. It is also important to ensure that the same amount of material is placed in all the "volumetric chambers" within the dosing device, be it a screw, disc or chamber.

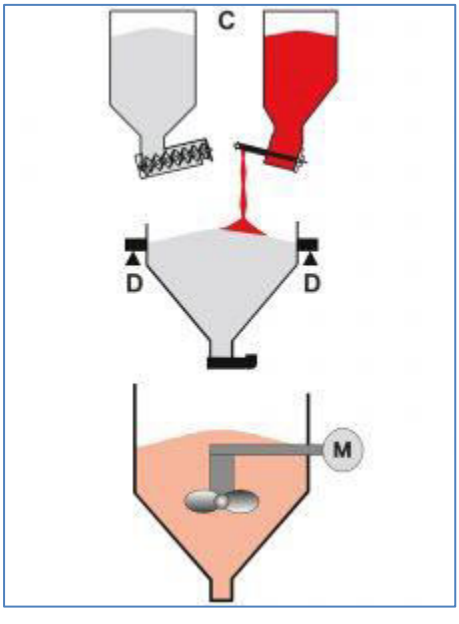


Volumetric dosing systems (A) measure ingredients on the basis of the space they occupy



Gravimetric systems (B) use load cells (D) to measure weight.

Gravimetric dosing systems, on the other hand, use one or more integrated weigh cells to measure input material. This means that mass is the only parameter considered. Because the system continues to dose material until it reaches the required target weight, fluctuations in density do not affect the outcome. A further benefit is that you can say with certainty how much total material – by weight – has been used, this is very important if you need to document the process for quality management purposes.



When in synchronous operation (A and B), materials are simultaneously metered and fed into the process. Asynchronous systems (C), on the other hand, first measure the material before mixing and then feed it to the process in a separate step.
An example from around the home clearly illustrates the difference between volumetric and gravimetric measurements: 250 ml of liquid cream will become around 1000 ml when whipped – but its mass will remain constant at 250 grams.

Whether you use a gravimetric or a volumetric system, you can choose between synchronous or asynchronous operation – in other words, the components can be simultaneously dosed together straight into the process, or they can be first dosed and then mixed together in a second, separate step. If you are deploying an asynchronous system, a mixer must be installed downstream of dosing to mix the ingredients after they have been metered into the reservoir.

Lecture 5

Mixing and Moulding Equipment in Bakery industries

1.3. Mixing Equipment in Bakery industries:

Many professional bakers will attest that the mixing process is the most important step when it comes to producing quality dough to use in their bakery. Each type of food found in a bakery more than likely requires a different type of mixing equipment. For the most part deciding on a bakery mixer depends on the level of business you would like to produce.

Vertical or Planetary Bakery Mixers: Planetary bakery mixers also known as vertical mixers get their name from the orbital motion the dough agitator makes, which are circular orbits along the inside wall. The mixing bowl that is used stays in place while this happens. Planetary mixers are great to have for businesses that need to produce smaller batches at a time. Otherwise planetary mixers are very versatile.

Advantages:

- Planetary bakery mixers use a broad range of attachments, which make them very versatile.
- The attachments turn on an offset shaft while the shaft rotates around the bowl.
- Planetary bakery mixers are capable of mixing, whipping, blending, and stirring various types of dough mixtures.
- These mixers will normally come with a wire whisk, stainless steel bowl, dough hook, and beater blade.

Disadvantages:

- Planetary bakery mixers are not able to mix as much dough at one time as other mixers.
- They tend to be slower than other bakery mixers.
- Since they mix smaller batches of dough, planetary mixers must use downsized bowls and agitators.

Horizontal Bakery Mixers:

Horizontal mixers typically contain a bowl that tilts to remove dough when mixed. The beaters are driven horizontally within the bowl on one or two shafts. How the dough is cut or stretched depends on the shape and speed of the blades.

The three types of Horizontal Mixers:

- **Three roller bar mixer -** used to roll and stretch dough which allows it to develop proper gluten structure.
- **Single sigma mixers** - suitable for cookies, crackers, corn tortillas and biscuits.
- **Double sigma mixers -** used for soft dough cookies mixes, cake, pretzels, granola, muffins, energy type bars, and scones.

Advantages:

- Very powerful mixers, therefore, able to produce tough dough more rapidly.
- Good and accurate control of the temperature of the mixing bowl from a jacket with constantly circulating water or refrigerant.
- Ingredients can be added through the roof of the horizontal bakery mixer while the beaters are moving.

Disadvantages:

- The beaters tend to throw materials up to the roof of the mixer.
- The horizontal mixer's lid totally encloses it; so the progress of the mix can not be completely observed.
- The beater shape allows for blending, dispersion, and kneading, and this could lead to each action being less than ideal.
- As the size of horizontal bakery mixers increases, kneading efficiency tends to decline relative to heat build up due to friction.

Spiral Bakery Mixers:

The spiral-shaped dough agitator gives spiral mixers their name. Unlike the planetary mixing bowl that remains stationary, a spiral mixing bowl moves while the agitator remains in place. Spiral bakery mixers are often the mixer of choice for bakeries. They are often referred to as "one-bagger" or "three-bagger." This represents the amount of 100-pound bags of flour or dough they can hold.

Advantages:

- The sturdy dough agitator found in spiral mixers is typically more effective than traditional beaters and even dough hooks when mixing heavy, stiff dough.
- More dough can be mixed at once in a spiral mixer.
- There is less resistance on the spirals, and this helps to control the temperature of the dough and will ensure proper rising and easier kneading.
- There is no need to use downsized bowls and agitators to mix small batches.

Disadvantages:

• Spiral mixers are only suitable for mixing dough and not mixing or whipping.

1.4.Dough Sheeting Equipment in Bakery industries:

Dough is compressed between two or more rotating rollers.[1] When done the right way, a smooth and consistent dough sheet is produced. The dough then passes one or several gauging rollers (mostly on conveyors) that reduce the dough to the required thickness. After this the dough sheet is shaped into a desired dough product. This technology is mainly used in industrial production

machines for (semi) industrial bakeries and the food industry. Most dough sheeters can handle a wide variety of dough depending on the machine manufacturer. Most commonly dough sheeting technology is used for the production of laminated dough products like croissants and pastries, but it is also suitable for the production of bread, flatbread and pizza.
Functions:

- Shape the dough from individual dough batch to continuous dough sheet
- Less damaging of the gluten network
- Laminate layers of dough together (no pocket proofers and dividers are necessary as the dough sheet is the base of every product).

Lecture 6

Laminating Equipment

1.5. Use of Laminating Equipment in bakery Industries:

Laminating in biscuits making process:

Laminating is the biscuit or cooking making process by which a layered structure is built up through the rolling of the dough, folding it, and then turning it through 90 degrees at least once before the final cutting thickness is gauged. During this stage of biscuit and cookie production, gluten is developed which gives the baked product a delicate flaky structure. Often, another material such as fat will be introduced between the layers for purposes of encouraging further separation of these layers during the baking process.

Process:

Any developed hard dough can be laminated with benefit during the process of biscuit or cookie production. Lamination allows for the creation of clearer dough, as well as the introduction of fat and flour mixtures designed to keep the layers of dough separated during the baking process. Most important to the overall structure of the cookie or biscuit is the dough sheet/ stress relief that the laminator provides.

For puff biscuits and cookies, a lot of fat is introduced between the layers of dough, thereby producing a structure that is very flaky. This fat may be introduced into the dough in the form of knobs before sheeting takes place, or even as a continuous layer following the formation of a good dough sheet. Both cases require gauging and laminating for the subsequent buildup of the number of dough layers that may appear in the form of very thin flakes in the baked cookie or biscuit.

An important feature of the production of this dough is the plasticity of the fat or fat/ flour mixture that is utilized. It is important that the consistency of the dough and fat be very similar such that the fat does not break through the dough layer or on the other hand end up being squeezed out. The baker will need to ensure that the fat utilized does not end up with a large high melting point tail above body temperature. To achieve dough that is sufficiently plastic and firm in consistency, you will need to arrange for the dough to be cold, typically not more than 18 degrees.

Types of Machines Used In the Process:

Laminators use precision motor control for the accurate cutting, stacking and delivery of laminated dough to the downstream forming and reduction equipment. Sheets of dough are moved to the discharge conveyor through the layering carriage, which then deposits the sheets by extending these to the far edge of the laminator take-away conveyor. While conveying, the carriage will retract ad thereby gently lay the sheets on top of the lamination stack which is moving.

As the lapper in the laminator builds up the dough layers, it is crucial to make adjustments to the speed such that the exact same number of laps is present all the time. It is important to avoid the occurrence of a variable thickness which can cause the feeding to the next gauge roll to be uneven, with irregular stresses being set up in the dough on gauging to a final thickness.

Vertical Laminator:

This laminator is typically comprised of a three roll sheeter incorporated with cutter scrap, 2-3 gauge rolls, dust spreader on part of the sheet, as well as a lapper with a capacity of building up approximately 10-12 layers. Such a laminator is advantageous in that it allows for the continuous smooth action of most of the parts.

Another advantage of vertical laminators is that they allow for the continuous spread of filling over the full width of the sheet. Vertical laminators are ideal for plants that wish to save floor space through the elimination of canvas webs between gauge rolls, thereby saving a lot of machinery. Different types of vertical laminators are available with designs that feature resting webs between the gauging stations.

Horizontal Laminator:

Similar in performance to their vertical counterparts, horizontal laminators have units spread out horizontally before the lapper on which the sheeting, gauging and dust filling will take place. This may be supplied by a cut sheet lapper in which case the dough sheet is laid down only with the retraction of the lapper. In such a case, only the top of the dough sheet will appear on the laminated dough pile. The key advantage to this is that little or no stress will occur at the edges as no folding takes place. In addition, an in-line laminating arrangement may also be an option.

One advantage to this type of laminator is the fact that multiple lappers may be used where required, which allows for the introduction of a second turn to the dough. It is common to use 2 three roll sheeters in horizontal laminators, with more fatty fillings being added onto the lower dough sheet, between the two sheets. In this laminator, the width of the laminated dough pile may be controlled by paying attention to the laminating section. In addition, the number of formed layers may be altered through the adjustment of the relative speed of the conveyer that takes the laminated dough away. The faster the running of this conveyor, the fewer the number of layers that will result.

Potential problems and solutions:

- **Bands of Stretched or Crushed Dough** – Where the dough emerges in stretched or crushed bands from the next gauge roll, this may be a problem with lamination. In such an instance, you may open or close the space between each lap by simply altering the speed of the laminator.
- **Uneven Weights/ Lifts** – Where the biscuit or cookie emerges with an uneven lift or weight that affects its eating and coloration qualities, this may be a lamination problem. To fix this, ensure that the amount of filling introduced between laminations is uniform such that it doesn't negatively impact the shape and quality control of the baked cookie or biscuit.
- **Ragged Flaky Structured Cookie or Biscuit** – A cookie or biscuit that splits open along the lamination lines might be as a result of too few laminations. On the other hand, too many laminations will cause excessive crushing and a product with poorly developed thickness. This can be countered by laminating a thinner dough sheet.
- **Poor Quality Edge-Lanes** – If the biscuits or cookies emerge with poor quality edge lanes, carefully observe the gauging after the laminator. In the event that the width of the laminated dough is too great, crushing will have occurred at the edges. On the other hand, if the width of the laminated dough is too narrow, then you will be able to notice some pulling quite clearly. To correct this problem, simply adjust the length of the stroke of the laminator carriage.

Images of Laminating and Moulding Equipment

Lecture 7

Different types of ovens used in bakery Industries

1.6. Different types of ovens used in bakery Industries:

Baking ovens are major equipment for any bakery process. Major function of bakingoven is to heat the wet dough, batter to a temperature where it becomes baked withdesired texture and taste. Baking removes the moisture which helps in improving shelflife of the baked products plus it kills any microbes in the dough at a highertemperature .Accessories to baking oven are circulating fan, steam extraction ,chimneys , safety explosion doors , fire tube , burners , drive ,temperature controller andindicators , fuel system with baking moulds and wire bands. Bakery ovens selection alsotakes dimensions into consideration such as height, width, weight, chimney dimensions,foundation method, electrical wiring and automation.

Baking Ovens are of various types used for baking breads,cookies , biscuits ,cakes ,pizza and cream rolls.

Oven classifications are done as per:

i. Physical Characteristics:

- Rack Oven / Deck Oven
- Rotary Rack oven
- Traveling Oven
- Tunnel Ovens
- Swing Tray Ovens
- Con Tray Ovens
- Manual Loading
- Automatic Loading

ii. Heating:

- Direct Heating ovens
- Indirect Heating Ovens
- Hybrid Ovens
- Convection
- Radiation

iii. Loading:

- Top Loading Ovens
- Front Loading

iv. Fuel Used:

- Diesel Ovens
- Gas Ovens
- Electric Ovens
- Infra red

v. Wire Bands:

- Articulated Wire bands
- Flat Steel bands
- Modular bands

vi. Length or Width:

- 1.5 mtr Band width Oven
- 1.2mtr Band width Oven
- 1.0 mtr Band width Oven
- 0.8 mtr Band width Oven
- 4/5/6/7/8 Zone Ovens

vii.As Per Design:

- Mark III Oven
- TRP Ovens
- Mark II Ovens

viii. Tension Arrangement:

- Pneumatic
- Mechanical

Tunnel Oven

Batch Oven

Lecture 8

Use of Depanner in Bakery Industries

1.7. Use of Depanner in Bakery Industries:

Image of Vacuum depanner used in bakery industry

The Suction De-panner is designed to take baked products from the baking pan or tray with very gentle product handling.

By means of a pick-and-place principle (the Multi-Place unit), a vacuum head is positioned above the bread pans. The (exchangeable) suction head picks up the product and then transfers it to the cooling conveyor and releases it.

The machine's dimensions and the number of vacuum heads are determined by the line capacity, pan sizes, layout, etc. Each machine is custom-made and equipped with a vacuum system.

Different types of vacuum cup

Module II 8L

Lecture 1

Testing of Flour

2.1. Testing of Flour:

Physical Tests:

Weight, kernel hardness, gluten washing, density, internal infestation evaluation, thousand kernel weight, pearling index, granulation and particle size

Chemical Analysis:

- **Determination of Ash in Wheat Flour:**

Materials:

Bunsen burner, porcelain cruse, desiccator, flour, oven, balance.

Procedure:
First of all 2gr of flour was weighed into well-dried porcelain, and then was heated onto a Bunsen burner until 350-400 ^{o}C then it was transferred into oven. After two hours ash was transferred to desiccator. After cooling it was weighed. Finally total ash was calculated as a percentage of samples.

Importance:
The ash content in wheat and flour has significance for milling. Millers need to know the overall mineral content of the wheat to achieve desired or specified ash levels in flour.

- **Determination of Crude Gluten in Flour:**

Materials:
Beaker, flour, KI, balance.

Procedure:
Firstly 25gr of flour was placed in beaker, added about 25ml water, and mixed into dough with a spatula. Then was kneaded the dough gently under water for 10-15min, so that soluble matter and starch were washed away. KI was used to control presence of starch. Then rolled dough into a ball was weighed the moist gluten and expressed as percentage of flour. Also was noted its color. Then it was dried at 100^{o}C to constant weigh and expressed repeat as a percentage of flour.

Importance:
Protein content is a key specification for wheat and flour purchasers since it is related to many processing properties, such as water absorption and gluten strength. Protein content can also be related to finished product attributes, such as texture and appearance. Low protein content is desired for crisp or tender products, such as snacks or cakes. High protein content is desired for products with chewy texture, such as pan bread and hearth bread.

- **Acidity of Wheat Flour:**

Material:
Conical flask, water bath, clear filtrate, phenolphthalein

Procedure:
18gr of flour was shaken with 200 ml of CO_2-free water in a conical flask. Then it was placed in a water bath at 40 degree for 1hour with flask. And filtered then titrated with 0.05 M NaOH solution by using phenolphthalein as an indicator. Finally the acidity of the water extract was calculated as KH_2PO_4 or lactic acid.

- **Moisture Content of Wheat Flour:**

Materials:

Pre-dried dish, desiccator, oven, balance

Procedure:

5 g of sample was weighed and placed into dish. But it was noticed that we should spread the sample as thinly as possible over the base of the dish. Then was put dish in oven maintained at 105^{o}C, and dried for 2hour.And was removed to cool in desiccator and weighed. We must not forget to continue until a constant weight has been reached. Finally; the moisture content from the weight loss of the sample was calculated.

Importance:

Determining moisture content is an essential first step in analyzing wheat or flour quality since this data is used for other tests. Flour millers adjust the moisture in wheat to a standard level before milling. Moisture content of 14% is commonly used as a conversion factor for other tests in which the results are affected by moisture content. Moisture is also an indicator of grain storability. Wheat or flour with high moisture content (over 14.5%) attracts mold, bacteria, and insects, all of which cause deterioration during storage. Wheat or flour with low moisture content is more stable during storage. Moisture content can be an indicator of profitability in milling. Flour is sold by weight, grain is bought by weight, and water is added to reach the standard moisture level before milling. The more water added, the more weight and profitability gained from the wheat. Wheat with too low moisture, however, may require special equipment or processes before milling to reach the standard moisture level.

Lecture 2

Analysis of Other Bakery ingredients

2.2. Analysis of Other Bakery ingredients:

Analysis procedure of Some Ingredients used in baking:

- **Dough Raising Capacity (DRC) of yeast:**

Ingredients:

1) Flour = 100gms
2) Yeast = 4gms
3) Sugar dust =1.5gms
4) Distilled water (hot) = 55ml

Method:

- Mixing of yeast and water with 25ml of distilled water
- Flour is added to the mixture
- The left over water is added to the mixture
- The dough is kept in the measuring cylinder
- Pressure is applied to the dough to make it uniform
- Kept the measuring cylinder inside the water at 27°C
- Initial reading is taken
- Three readings are taken at the interval of 1hrs

Calculation:

DRC = [(F-I)/F]*100%
Here,
F = Final reading (Final height of the dough in measuring cylinder)
I = Initial reading (Initial height of the dough in measuring cylinder)

- **Testing of Fats and Oils: Acid value, peroxide value, iodine value**
- **Determination of acid value and FFA:**

The acid value is determined by directly titrating the material in an alcoholic medium with an aqueous NaOH or KOH solution. FFA is calculated as oleic, lauric or palmitic acids.

Reagent:

1) Ethyl alcohol
2) Phenolphthalein indicator solution
3) Standard aqueous NaOH or KOH solution

Method:

- The oil or melted fat is mixed thoroughly
- A suitable quantity of oil or fat is weighed in a 200 ml conical flask
- Addition of 50-100ml of freshly neutralized hot ethyl alcohol and 1ml of phenolphthalein indicator solution
- The mixture is boiled for 5mins
- The mixture is titrated with standard alkali solution

Calculation:

Acid value = (56.1*V*N)/W
Here,
V = Volume in ml of standard NaOH solution or KOH solution used
N = Normality of standard NaOH solution
W = Weight in gms of the material taken for the test

Free Fatty Acid (FFA): The acidity is frequently expressed as the percentage of FFAs present in the sample. The percentage of FFA in most of the fats can be calculated on the basis of different acids.

Calculation in terms of different fatty acids:

1) FFA in terms of oleic acid (percentage by weight) = (28.2*V*N)/W
2) FFA in terms of lauric acid (percentage by weight) = (20.0*V*N)/W
3) FFA in terms of palmitic acid (percentage by weight) = (25.6*V*N)/W

- **Determination of peroxide value:**

The peroxide value is a measure of the peroxides contained in a sample of peroxide per 1000gms of the material.

Reagents:

1) Acetic acid-Chloroform solution
2) Potassium iodide solution
3) Sodium thiosulphate solution
4) Starch solution

Method:

- About 5gms of fat is weighed in a 250 ml glass Stoppard conical flask
- Addition of 30 ml acetic acid-Chloroform solution
- Swirl the flask until the sample is dissolved
- Addition of 0.5 ml of saturated KI solution
- The solution is allowed to stand exactly 1min in dark
- Addition of 30 ml distilled water
- Titration with 0.1 (N) sodium thiosulphate solutions with constant and vigorous shaking
- The titration is continued until the yellow colour is almost disappears
- Addition of 0.5(N) starch solution
- Titration with 0.1 (N) sodium thiosulphate solutions until the blue colour is just disappears

Calculation:

Peroxide value as mili-equivalent/1000gms of sample = [(S-B)*N*1000]/G
Here,
S = Volume of sodium thiosulphate solution used up by the sample
B = Volume of sodium thiosulphate solution used up in the blank determination
N = Normality of the sodium thiosulphate solution
G = Weight of the sample

- **Determination of SO2 in sugar:**
  - 10 gms of sugar is taken
  - The sugar is dissolved in distilled water in 100 ml volumetric flask
  - Addition of 0.1mol/l NaOH solution (4ml)
  - Up to the mark of the flask
  - 10ml aliquot in dry test tube
  - Addition of 2ml decolorized rosanilineand 2ml of formaldehyde solution
  - Allow the tube to stand for 30mins
  - Absorbance is measured in spectrophotometer

Lecture 3

Preparation Techniques of Different Bread

2.3. Preparation Techniques of Different Bread:

1. Straight Dough method:

- All the ingredients are mixed together, and the dough is fermented for a predetermined time.
- The fermentation time of the straight dough depends on the strength of the flour. Strong flour requires more fermentation time to mature adequately.
- Flours which require 2 to 3 hours for maturing should be used for making bread by straight method. Flours that take very long period for maturing should not be used because during prolonged fermentation periods it is very difficult to control the temperature of the dough and rise in temperature will cause acid taste and flavour in bread.

2. No time dough method:

- Dough is fermented in the usual manner. It is just allowed a brief period (about 30 mins) for it to recover from the strains of mixing.
- Since dough is not fermented the two functions of fermentation (i. e production of gas and conditioning of gluten) are achieved to some extent by increasing the quantity of yeast (2 to 3 times of original quantity)and by making the dough little slacker and warmer.
- Although it is possible to make fairly acceptable bread (during emergency) by using this method the product has poor keeping quality. Due to the absence of fermentation the gluten and starch are not conditioned sufficiently to retain the moisture.

3. Salt delayed method:

- This a slight variation of straight method, where all the ingredients are mixed except salt and fat.
- As a salt has a controlling effect on enzymatic action on yeast, the speed of fermentation of a salt less dough will be faster, and a reduction in total fermentation time will be faster.
- The salt is added at a knock back stage. The method of adding salt at the later stage may be according to the convenience of individual baker. It may be sifted on the dough and mixed or it may be creamed with fat and salt.
- Whatever way is chosen for mixing the salt, only three forth (of actual mixing time) mixing should be given initially and one fourth mixing at the time of adding salt.
- Due to absence of salt, the fermentation speed is enhanced and gluten is matured in a reasonably shorter time.

4. Sponge and dough method:

- Strong flour take too long for conditioning and should not be used for making bread by straight dough method. For such flours sponge and dough method is more suitable where the problem of controlling the dough temperature time is not so acute.
- Flour, proportionate amount of water, yeast and sugar are mixed together. Longer fermenting sponges may also contain some amount of as well. Mix all the ingredients evenly.
- This sponge is fermented for a pre-determined time. The ferment is carried out longest for almost 16 to 17 hours and minimum for an hour. Advantages
- Scheduling flexibility. Sponges can usually be held longer than finished dough.
- Increased flavor, developed by the long fermentation of the sponge
- Less yeast is needed, because it multiplies during the sponge fermentation.

5. Ferment and dough method:

- This is a variation of sponge and dough method.
- Very often a bread formula may contain milk, eggs, substantial quantity of fat and sugar.
- All these formula ingredients will have a retarding effect on yeast activity.

- If all the formula yeast, part of flour, yeast food and sufficient water are mixed together, the yeast gets initially an environment which is conducive to vigorous activity and at the end of fermentation time it is in a fit condition to take on extra load of fermentation in presence of milk, eggs, excessive fat etc.
- Fermentation time of ferment depends on the formulation of the desired product but very often it becomes a matter of individual preference.
- A ferment containing milk should be guarded against over fermentation as it will develop more than desired quantity of lactic acid which in turn will affect the flavor, taste and texture of the product.

Lecture 4

Preparation Techniques of Cake; Cake Icing Techniques

2.4.1. Preparation Techniques of Cake:

Cake is obtained from a chemically leavened batter that results in a spongy and airy texture. There are thousands of cake recipes and variations, but there are some consistencies in defining cake. Cakes are typically circle in shape, however many cakes are also rectangular, or cut into specific shapes in order to be decorated. Cake is almost always sweet, which differentiates cake products from bread, which is typically not sweet. Additionally, cake is often made from a batter, which is much more liquid than dough. Cakes are often named based on their primary ingredients, such as butter cakes, or their shapes, such as Bundt cakes and layer cakes.

Cakes are typically made with some combination of flour, eggs, butter or oil, leavening, salt, and sugar. There are literally thousands of variations on this including additions of ingredients such as fruit, nuts, and spices. Cake is commonly used as a celebration for birthdays and weddings in the United States. These sorts of cakes are often decorated with icing and fresh fruits, as well as sprinkles and candies.

The following methods can be used for cake making

1. Sugar batter method: In this method all the fat and equal amount of sugar is creamed together. Shortening or fat used for cake making should be plastic in nature. Shortening used for cake making should not melt by the heat produced due to friction during the process of creaming. All the fat should be first creamed together in order to blend them thoroughly. Then sugar is added gradually continuing the creaming process.

2. Flour- batter method: In this method fat and equal quantity of flour is creamed together. Fat should be smooth and in plastic state and the flour should be added gradually. The whole mixture is whipped till it becomes light and fluffy. Eggs and an equal quantity of sugar is whipped to a tiff froth. The mixture of eggs and sugar will whip better if the mixture is slightly warmed on a double boiler. Direct heat should be avoided in this case on even slight rise in temperature will cause cooperation of egg protein will lose its air entrapping capacity. Unless the egg-sugar mixture comes down to the room temperature, it should not be added to creamed mixture.

3. Blending method: This method is suitable for making high ratio cakes in which quantity of sugar is more than the quantity of flour. In this method, shortening or fat, flour, baking powder and salt are whipped together to a very light and fluffy consistency. Sugar, milk, colour and flavour are mixed together and added to the previous mixture. Eggs are added next and the whole mass is mixed together to smooth batter.

4. Boiled method: This method is used for making good quality machine cakes and geno--- sponge. Butter or bat is placed in boiler and heated till it melts. Remove the bowl from heat and add all the flour at a time and mix thoroughly. Egg and sugar is beaten to a stiff sponge. Colour and flavour may be added while whisking the sponge. This sponge is added in the fat flour mixture in about 4-5 equal parts. After each addition of sponge, it is thoroughly mixed with a wooden spoon, when the mixture is smooth, it is scaled off into the proper lined tin.

5. Sugar water method: In this method, all the formula sugar and approximately half the quantity of water is agitated in a bowl till all the sugar is dissolved. Then the remaining ingredients except eggs are added and the mixture is well agitated to acquire aeration. Finally eggs are added and the mixture is cleaned. Due to more aeration and better emulsification obtained in this method the cakes so produced have better texture and longer shelf life.

6. All in process method: In this process all the ingredients are put into mixing bowl together. Aeration of the mixture is achieved by controlling the speed of the mixer as well as the mixing time. Beater with wire (wire whip) is used for this operation which ensures a faster breakdown of ingredients and help to achieve good aeration.

2.4.2. Cake Icing Techniques:

Icing, often called frosting in the United States,is a sweet, often creamy glaze made of sugar with a liquid, such as water or milk, that is often enriched with ingredients like butter, egg whites, cream cheese, or flavorings. It is used to cover or decorate baked goods, such as cakes or cookies. When it is used between layers of cake, it is called filling.

Decorating a cake usually involves covering it with some form of icing and then using decorative sugar, candy, chocolate or icing decorations to embellish the cake. But it can also be as simple as sprinkling a fine coat of icing sugar or drizzling a glossy blanket of glaze over the top of a cake. Icing decorations can be made by either piping icing flowers and decorative borders or by molding sugar paste, fondant, or marzipan flowers and figures. An embossing mat is a tool for cake decorationthat creates embossed effects on the top of cakes, cupcakes, or similar items. The user presses the mat down into cake dough or icing and the pattern embossed in the mat is transferred to the item.Embossing mats are often made of silicone rubber or similar flexible polymers.

Lecture 5

Preparation Techniques of Biscuits

2.5. Preparation Techniques of Biscuits:

Definition: These products are cereal based and baked to moisture content of less that 5%.

Ingredients:
There are three major ingredients wheat flour, fat and sugar.

Each recipe has been adjusted to be relative to hundred units of flour including other cereal products such as cornstarch, vital wheat gluten, malt flour.
The sugar level is on a dry bases and it is assumed that liquid sugar has 67% solids, invert syrups 80% solids, malt extract 80% solids, glucose syrups 80% solids.
The fat values on pure fat, so margarines and butter are only 85%.
The water level is the total added water. This is principally as liquid water but may be as fresh milk (87.6% water), butter and margarine (15% water), fresh eggs (75%), syrups (20%), liquid sugar (33%) etc.,
Cereals and some other ingredients have natural moisture content, so the water values do not represent the total dough moisture level even though these important for calculating the losses during baking.

Types of biscuits:

i. Cream crackers
ii. Soda crackers
iii. Savoury or snack crackers
iv. Water biscuits and matzos
v. Puff biscuits

vi. Hard Sweet , Semi Sweet & Garibaldi Fruit Sandwich Biscuit
vii. Short dough biscuits
viii. Deposited soft and sponge drop biscuits
ix. Wafers
x. Miscellaneous biscuits-like products

Steps of biscuit preparation:

For fermented and hard dough:

- Dough is taken in a small trolley
- The trolley is lifted up and the dough is poured in a large container
- Dough is passed through the laminating machine
- A sheet of dough is formed
- The dough is then shaped in its desired shapes using moulders (different for different type of biscuit)
- The excess dough remained from dough sheet after moulding, is recycled
- and mixed with the newly prepared dough
- The shaped dough are passed through the oven for baking at a particular temperature and time
- The baked biscuits are carried to the packaging section through conveyor belt (while passing through conveyor belt the biscuits are cooled)

For short dough:

1) In case of biscuit preparation using short dough the process is, same as the preparation of fermented and hard dough. However here sheet is not formed. The shape of the biscuit is directly formed from the moulder.

2) During moulding there are three types of rollers :
   a) **Moulder roller:** It forms the shape, according to the type of the biscuits.
   b) **Force roller:** It forces the roller to form the shape.
   c) **Rubber roller:** It pulls out the shaped dough from the moulder using suction pressure by creating vacuum.

3) After the shape formation the dough is passed through the oven for baking.

4) The baked biscuits are then carried to the packaging section through conveyor belt (while passing through the conveyor belt the biscuits are cooled)

A simple comparison of how different parameters or properties change as the recipe becomes enriched with fat and sugar

	Crackers	Semi sweet	Short high fat	Short high sugar	soft
Moisture in dough	30%	22%	9%	15%	11%
Moisture in biscuits	1-2%	1-2%	2-3%	2-3%	3+%
Temperature of dough	30-38 ^{0}C	40-42 ^{0}C	20^{0}C	21^{0}C	21^{0}C
Critical ingredients	Flour	Flour	Fat	Fat & sugar	Fat & sugar
Baking time	3 min	5.5 min	15-25 min	7 min	12+ min
Oven ban type	Wire	Wire	Steel	Steel	Steel

Lecture 6

Preparation Techniques of Wafer, Cookies and Crackers

2.6. Preparation Technique of Wafer:

Wafers are baked in different fancy shapes like cones, sheets, sticks etc.

The main features of wafers with respect to other bakery products are:

- Wafers are very thin biscuits: the thickness lies between 1 and 5 mm.
- Wafers often have a typical "wafer pattern" on one or both surface of the product. The surfaces are smooth and precisely formed with the dimensions, engravings, logos etc.
- Wafers are cereal based low fat products. They are made of wheat flour, sometimes with combination of other flours or starches.
- The product density of wafer ranges from 0.10 to 0.25 g/cm^3. The cross-section of product reveals that wafer matrix is highly aerated and primarily composed of gelatinized starch.
- Wafers by their delicate crisp texture combine well with different types of coatings and fillings like cream, ice cream, foam etc.

Classification of wafer Wafers may be classified in two basic types:

i. No-or low-sugar wafers: After baking, these contain from zero to a very low percentage of sucrose or other sugars. The products are of flat and hollow wafer sheets, molded cones, cups, and fancy shapes.

ii. High-sugar wafers: This type of product contains over 10% of sucrose or other sugars, which are responsible for the plasticity of the hot, freshly baked sheets. These are formed into different shapes before sugar recrystallization occurs. The products are obtained in rolled sugar cones, rolled wafer sticks or tubes, and deep-formed fancy shapes.

Wafer may be following three types:

i. Plain: Plain wafers may be hollow or flat or in any shape desired by the purchaser.

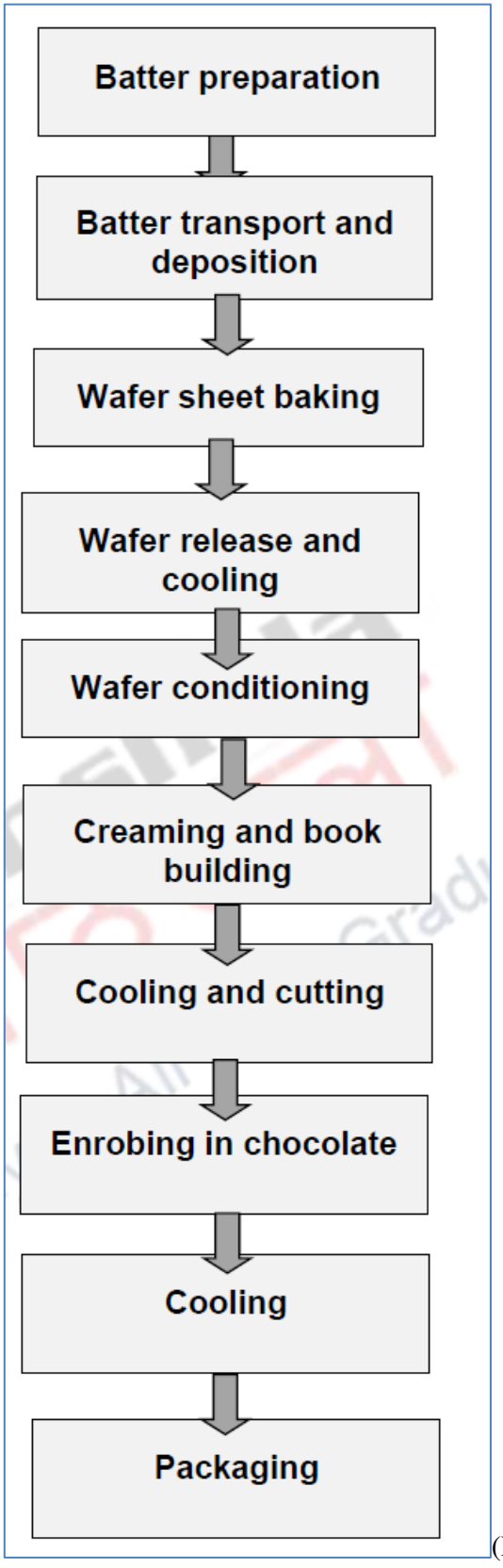
ii. Sandwiched: These types of wafers shall have two or more plain wafers, sandwiched with filling in between. The filling may be cream, jam, jelly, marshmallow, caramel, figs, raisins etc. The fillings shall be not less than 50% by mass of the filled wafer.

iii. Coated: These types of wafers include both half-coated and full-coated wafers. The coating may be of chocolate, substitute fats butter scotch etc. and the fillings shall be not less than 60% by mass of the coated wafers.

Ingredients	Low-sugar wafer	Higher-sugar wafer
Wheat flour	100	100
Water	120-160	100-140
Starch	0-12	0-5
Sucrose	0-4	25-75
Oil/ fat	0.5-2.0	1-6
Milk powder	0-2	0-2
Soy lecithin	0.2-1.0	0.2-1.5
Salt	0-0.6	0-0.6
Sodium bicarbonate	0.1-0.5	0-0.3

Wafer Batter Ingredients (Ref: http://epgp.inflibnet.ac.in)

Flow Diagram of Wafer-Biscuit Production:

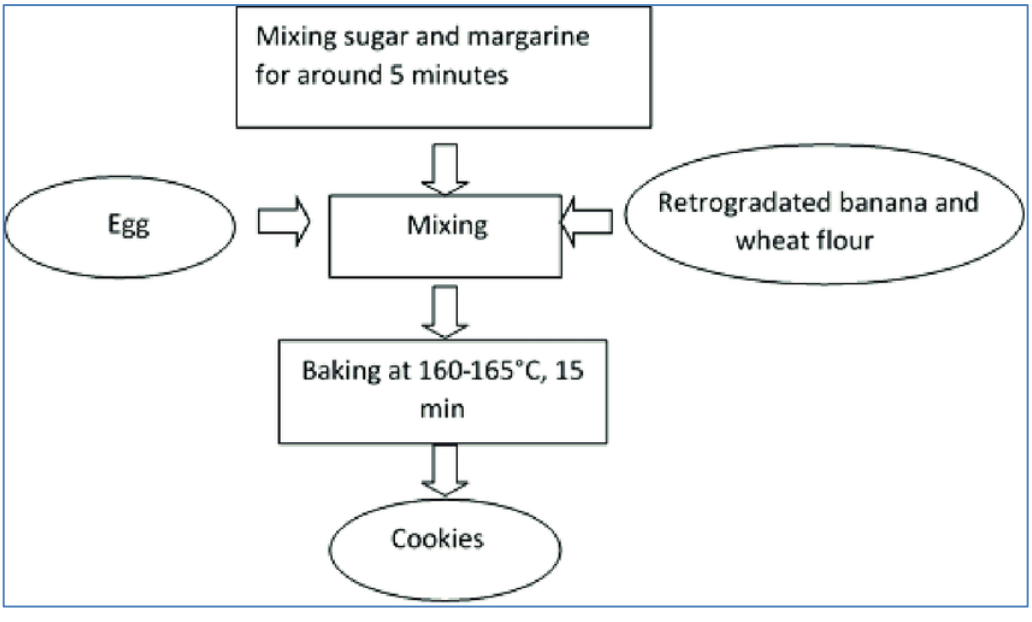


(Ref: http://epgp.inflibnet.ac.in)

2.7. Preparation Technique of Cookies:

Originally called “little cakes,” cookies are made with sweet dough or batter, baked in singlesized servings and eaten out-of-hand. A cookie is a baked or cooked food that is small, flat and sweet. It usually contains flour, sugar and some type of oil or fat. It may include other ingredients such as raisins, oats, chocolate chips, nuts, etc.
Cookies are most often classified by method of preparation—drop, molded, pressed, refrigerated, bar and rolled. Their dominant ingredient, such as nut cookies, fruit cookies or chocolate cookies, can also classify them.

General Flow-chart of CookieMaking:



2.8. Preparation Technique of Crackers:

‘Cracker’ is a generic term used throughout the world and refers to products with very low sugar and fat content. The term cracker can be used when the baked product has a cereal base, e.g. wheat, oat or barley, of at least 60% and a low moisture content of 1–5%, which is the distinguishing factor. Crackers usually have a higher fat content than other baked products and a longer shelf. Crackers are used as a base for savory toppings, most commonly cheese and tomato, but they may also have enough flavour from tasty coatings to be eaten alone. The holes in crackers are called “docking” holes. The holes are placed in the dough to stop overly large air pockets from forming in the cracker while baking.

TYPES OF CRACKERS:

Foods containing moisture content of 50% or more may instantaneously boil or cook when exposed to microwaves as microwaves work best with a moisture content under 25%. Due to internal pressure microwave heating may cause delicate products to puff. Results in lack of crust in microwave-baked bread. Crust is required for flavour and texture, to prevent collapse of the freshly baked bread loaf, and prevent premature microbial spoilage. This problem could be solved by combination cooking, where microwave baking is followed by conventional oven crust formation, although this adds another complicated step to processing. Toughening of protein foods, including bread, following microwave processing. Loaf skin tends to be rubbery, tough and difficult to tear, while the crumb can be firm and difficult to chew. These problems may be solved by reformulating the product to suit microwave cooking.

1. Fermented – For example: soda crackers, saltines and cream crackers.

- Soda crackers have been popular in the US for over 150 years. They are typically about 4 mm thick and 50 x 50 mm square and contain 8–10% shortening (based on flour). A variation on soda crackers are saltines that are a smaller, dainty type of soda cracker with increased shortening. Traditional processing includes a long fermentation using a sponge starter. Then 1% sodium bicarbonate is added to the dough, which increases the alkalinity and gives soda crackers its name. Once the dough is mature it is sheeted to about 4 mm and then laminated 6–8 times. The cracker is cut by making lines of perforations across the dough sheet, although it is baked as a whole sheet, to minimise waste dough. A feature of soda crackers is the nine hole docking pattern on each cracker set out in a 3 x 3 grid pattern. After baking, the sheet of crackers is split along the perforation lines to make a block of four crackers for packaging. The final product texture is flaky but crisp. The spring between docking holes on top of the crackers should be even and bottom surfaces should be flat with numerous small blisters. Soda crackers are dry and bland so they are not usually eaten alone, but are eaten with soup.
- Cream crackers fill the niche of soda crackers in UK. These crackers have a slightly higher fat content than soda crackers (12–18%) but despite what their name suggests they contain no cream. The rectangular shaped cracker is usually 65 x 75 mm, they are slightly thicker than soda crackers and are produced as individual units. Cream crackers are traditionally made using long sponge and dough fermentation, but modern methods include single stage mixing and a 4–16 hour fermentation process. The product is sheeted and laminated as described above. In addition to this processing, laminating dust – containing flour, shortening and salt – is applied in between layers of dough. This causes laminations to lift apart during baking, giving an extra flaky structure. Cream crackers have an uneven surface finish with blisters on the bottom and top surfaces. The final moisture content of 3–4% is high for crackers and with a

higher fat content as well, cream crackers are relatively soft, will not crumble and should 'melt-in-the-mouth'. Without chemical leavening, cream crackers are bland, with a slight nutty flavour so savoury toppings including butter are common.

2. Chemically leavened – For example: snack cracker. These products are newer than fermented crackers and have two distinguishing characteristics: that they are sprayed with hot oil as they leave the oven and that a topping is added to the cracker for flavour. They usually contain some sugar (4–10%) to aid flavour and texture. As snack crackers do not have a long fermentation to mature the dough, proteolytic enzymes or sulphites are used to relax dough so that the crackers are not deformed during sheeting and cutting. There are a wide range of shapes and sizes for the snack crackers but usually they are round and have two docking holes to allow an even lift during baking. Toppings are generally applied before baking and these can include flavourings, e.g. herb, cheese or chicken, or small seeds, such as poppy and sesame. The finished product has a dense texture but is soft to bite, while the hot oil spray improves mouth feel and gives an attractive appearance to the finished product. Occasionally, snack crackers may be produced from fermented dough and these are the only snack crackers produced by lamination.

3. CHEESE CRACKERS:

When making cheese crackers the most important decision is the type of cheese to be used. Essentially it is a matter of taste, especially the taste of the cheese after being baked. Some cheeses show a surprising lack of flavour even after baking. Well matured cheeses are most appropriate, while mild cheeses won't improve with baking. Cheese can be incorporated directly into the dough; the best time to add the cheese should be determined through trial and error as it may vary dependent on processing methods or equipment. In fermented cheese crackers there are no aerating chemicals, although soda may be added to bring pH – and with it, flavour – to an acceptable level. Cheese has an acid flavour and cheese crackers in general have a pH of about 6.0. The pH of the cracker is important as it impacts the shelf life, flavour and baked colour.

(Ref:www.bakeinfo.co.nz)

Lecture 7

Dusting and Breading Procedure

2.9. Dusting and Breading Procedure:

The standard method for breading foods is a three-step procedure, creating a crispy coating before frying them. It's a basic process that's used all the time in the culinary arts, for making everything from fried chicken to onion rings.

Breading helps to seal in moisture when deep-frying or pan-frying. It also provides a crunchy and delicious exterior, and the golden-brown color makes the food more attractive. While this method is typically used for foods that will be fried, breaded items can be baked as well.

The standard breading technique includes three steps: dredging in flour, moistening in egg wash(beaten egg plus a tablespoon or two of water or milk), then coating in crispy breadcrumbs like Panko. The flour helps the egg wash adhere, and the egg helps the breadcrumbs adhere, ensuring the breading actually sticks to the food instead of falling off in the hot oil.

To begin with, make sure the food you're going to bread is dry. You don't want any extra moisture trapped under the coating which will cause the food to be soggy and not fry properly. Then you need to season each of the three coating ingredients with a little salt and pepper. This will assure that the food won't come out bland and every layer will be flavorful. Also lightly season the food you will be frying before you begin the coating process.

If you want to add more flavor to the dish, you can season the breadcrumbs with herbs and spices that will complement what you're making. Including some grated Parmesan cheese in the breadcrumbs also adds a nice flavor if you are preparing chicken cutlets, for example.

Step 1: Dredge the Food in Flour:
Step one is to coat in the flour. Assuming you're working left-to-right, using your left hand, dredge the item in flour and shake off any excess. You want to be sure the food is coated evenly with the flour and there aren't any bare spots or areas where the flour is thick.

Step 2: Transfer to the Egg Wash:
Your left hand is going to be your "dry hand," while your right hand is going to be your "wet hand." So when you transfer the food to the egg wash dish, use your right hand and try not to get your left hand wet. Otherwise, when you go to dredge the next piece in the flour, you'll make a big mess.

Step 3: Toss in Seasoned Breadcrumbs:
Use your wet hand (your right hand) to take the item out of the egg wash, let any excess egg drip off, and then transfer it to the dish with the breadcrumbs. Toss it in the breadcrumbs until it is thoroughly coated; it is okay if you need to press them on a little to assure they adhere. Now repeat the steps for all the pieces to be breaded.

When you're done, make sure you discard any leftover breading ingredients, especially the breadcrumbs that have had raw egg in them.

Once you have all of the food coated, you will want to place in the refrigerator for about 15 minutes. Chilling the breaded food helps the breading really take hold, making the flour stick to the food and the egg wash stick to the flour, and, finally, the breadcrumbs stick to the egg wash. This will offer a better chance of the breading staying on during frying versus falling off when moving the pieces in the hot oil.

Lecture 8

Analysis of Bakery Products

2.10. Analysis of Bakery Products:

- **Moisture content**
- **Ash content**
- **Proximate analysis**
- **Texture Analysis**
- **Physical Analysis**
- **Sensory Analysis**

Module III 8L

Lecture 1

Preparation Techniques of Confectionary like Pies

3.1. Preparation Techniques of Pies:

A pie is a baked dish which is usually made of a pastry dough casing that covers or completely contains a filling of various sweet or savory ingredients.

Pies are defined by their crusts. A *filled* pie (also *single-crust* or *bottom-crust*), has pastry lining the baking dish, and the filling is placed on top of the pastry but left open. A *top-crust* pie has the filling in the bottom of the dish and is covered with a pastry or other covering before baking. A *two-crust* pie has the filling completely enclosed in the pastry shell. Shortcrust pastry is a typical kind of pastry used for pie crusts, but many things can be used, including baking powder biscuits, mashed potatoes, and crumbs.

Pies can be a variety of sizes, ranging from bite-size to ones designed for multiple servings.

Pies are generally classified in 3 groups:

i. Fruit filled pie
ii. Mince or meat filled pie
iii. Fried Pie

Ingredients of Pie Dough:

- Flour: Unbleached pastry flour with 9 to 9.5% protein content.
- Shortening
- Water
- Salt
- Pie fillings

Method:

Shifting of flour, salt and sugar.Rubbing of shortening lightly into flour mix with figure tips. The dough is gently mixed by addition of cold water. Then it is allowed to rest for 1 hr.

Dough is sheeted as desire thickness. Dough is rolled and placed on the pie plates and the edges are trimmed. This trimming can be used for decoration. Onpie top after depositing the filings. The pie shell is always docked before depositing the filling to raise the pie crust uniformly. Docking is generally done by fork.

After filling the pie is baked at 450^{o}F for 12 to 15 minutes until the filling becomes firm and the pie becomes golden yellow.

Lecture 2

Preparation Techniques of Pastries

3.2. Preparation Techniques of Pastries:

Pastry is dough of flour, water and shortening that may be savory or sweetened. Sweetened pastries are often described as *bakers' confectionery*. The word "pastries" suggests many kinds of baked products made from ingredients such as flour, sugar, milk, butter, shortening, baking powder, and eggs. Small tarts and other sweet baked products are called pastries.

Pastry is differentiated from bread by having a higher fat content, which contributes to a flaky or crumbly texture. A good pastry is light and airy and fatty, but firm enough to support the weight of the filling. When making a short crust pastry, care must be taken to blend the fat and flour thoroughly before adding any liquid. This ensures that the flour granules are adequately coated with fat and less likely to develop gluten. On the other hand, over mixing results in long gluten strands that toughens the pastry. In other types of pastry such as Danish pastry and croissants, the characteristic flaky texture is achieved by repeatedly rolling out dough similar to that for yeast bread, spreading it with butter, and folding it to produce many thin layers.

Different kinds of pastries are made by utilizing the natural characteristics of wheat flour and certain fats. When wheat flour is mixed with water and kneaded into plain dough, it develops strands of gluten, which are what make bread tough and elastic. In a typical pastry, however, this toughness is unwanted, so fat or oil is added to slow down the development of gluten. Lard or suet work well because they have a coarse, crystalline structure that is very

effective. Using unclarified butter does not work well because of its water content; clarified butter, which is virtually water-free, is better, but short crust pastry using only butter may develop an inferior texture. If the fat is melted with hot water or if liquid oil is used, the thin oily layer between the grains offers less of an obstacle to gluten formation and the resulting pastry is tougher.

Pastry production in industries:

The sifted flour is poured into an industrial mixer. Temperature-controlled water is piped into the mixer. A pre-measured amount of yeast is added. The growth of the yeast produces gas bubbles, which leaven the bread. Depending on the type of pastry to be made, other ingredients are also poured into the mixer. The resulted dough is than fermented.

After the dough has fermented, it is loaded into a divider that cut the dough into pre-determined weights. A conveyer belt then moves the pieces of dough to a molding machine. The molding machine shapes the dough into balls and drops them onto a layered conveyer belt that is enclosed in a warm, humid cabinet called a "prover." The dough moves slowly through the prover so that it may "rest," and so that the gas reproduction may progress.

When the dough emerges from the prover, it is conveyed to a second molding machine which re-shapes the dough into loaves and drops them into pans. The pans travel to another prover that is set at a high temperature and with a high level of humidity. Here the dough regains the elasticity lost during fermentation and the resting period.

From the prover, the pans enter a tunnel oven. The temperature and speed are carefully calculated so that when the loaves emerge from the tunnel, they are completely baked and partially cooled.

Types of Pastries:

1. Shortcrust pastry :

Shortcrust pastry is the simplest and most common pastry. It is made with flour, fat, butter, salt, and water to bind the dough. This is used mainly in tarts. It is also the pastry that is used most often in making a quiche. The process of making pastry includes mixing of the fat and flour, adding water, and rolling out the paste. The fat is mixed with the flour first, generally by rubbing with fingers or a pastry blender, which inhibits gluten formation by coating the gluten strands in fat and results in a short (as in crumbly; hence the term shortcrust), tender pastry.

2. Flaky pastry:

Flaky pastry is a simple pastry that expands when cooked due to the number of layers. It bakes into a crisp, buttery pastry. The "puff" is obtained by the shard-like layers of fat, most often butter or shortening, creating layers which expand in the heat of the oven when baked.

3. Puff pastry :

Puff pastry has many layers that cause it to expand or "puff" when baked. Puff pastry is made using flour, butter, salt, and water. The pastry rises up due to the water and fats expanding as they turn into steam upon heating. Puff pastries come out of the oven light, flaky, and tender.

4. Choux pastry :

Choux pastry is a very light pastry that is often filled with cream. Unlike other types of pastry, choux is in fact closer to dough before being cooked which gives it the ability to be piped into various shapes such as the eclair and profiterole. Its name originates from the French *choux*, meaning cabbage, owing to its rough cabbage-like shape after cooking.

5. Phyllo (Filo):

Phyllo is a paper-thin pastry dough that is used in many layers. The phyllo is generally wrapped around a filling and brushed with butter before baking. These pastries are very delicate and flaky.

6. Hot water crust pastry:

Hot water crust pastry is used for savoury pies, such as pork pies, game pies and, more rarely, steak and kidney pies. Hot water crust is traditionally used for making hand-raised pies. The usual ingredients are hot water, lard and flour, the pastry is made by heating water, melting the fat in this, bringing to the boil, and finally mixing with the flour. This can be done by beating the flour into the mixture in the pan, or by kneading on a pastry board. Either way, the result is a hot and rather sticky paste that can be used for hand-raising: shaping by hand, sometimes using a dish or bowl as an inner mould. As the crust cools, its shape is largely retained, and it is filled and covered with a crust, ready for baking. Hand-raised hot water crust pastry does not produce a neat and uniform finish, as there will be sagging during the cooking of the filled pie, which is generally accepted as the mark of a hand-made pie.

What is a Puff Pastry?

Puff pastry is traditional French pastry dough that has distinct flaky layers. It is commonly used in making croissants, turnovers and classic French cuisine. This pastry dough is the base of both sweet and savory dishes, though the number of layers is usually less for savory, and more for sweet items. The dough owes its layers to steam making the dough expand, or puff, during the baking process. This happens because there are distinct layers of fat, usually butter, and dough that separate in the oven. It is similar to phyllo dough, but phyllo dough is traditionally stretched in the production, while puff pastry is rolled out.

Method of preparation of puff pastry:

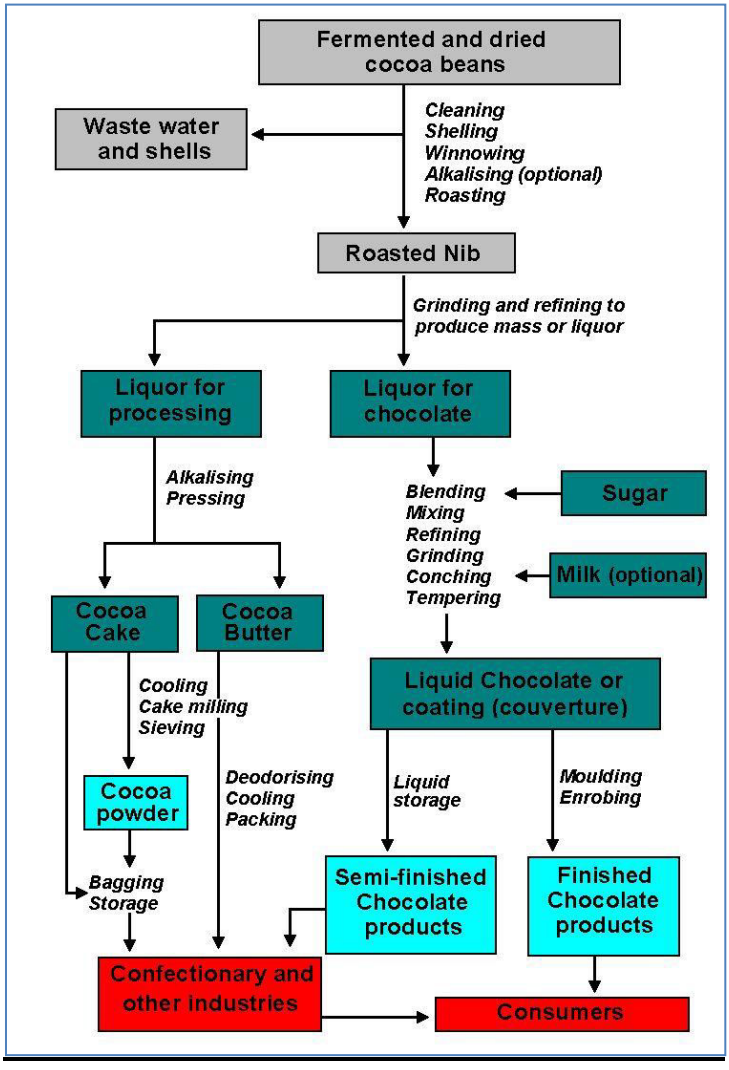
Making puff pastry can take days depending on the number of layers desired. The basic ingredients are flour, salt, water, and butter. Puff pastry is sensitive to over mixing, because if the butter is fully incorporated, distinct layers will not form. During the production of puff pastry, temperature is critical. The dough should never exceed 16 °C (60 °F). To do this, all ingredients and utensils must be chilled before and between each addition of butter. To start a puff pastry dough, firstly a short crust pastry dough is prepared and it is rolled into a rectangle. A flattened sheet of butter (that is about one fourth to one third the size of the dough) is placed over the dough. Then the dough is fold into thirds on its self and roll the dough back out. After this, the dough is chilled for at least thirty minutes, and then the process is repeated. The more times the chef folds and rolls the dough out, the more layers that will form. The formula for the number of layers is I= (f+1) n. In this formula I is the total number of final layers. F is the number of times folded, usually two, and n is the number of times this process is repeated. So if the dough is folded into thirds, f=2, and that is repeated 3 times, n is 3, thus the number of layers is 256. The number of layers desired depends on the use, but generally meats and foods with juices require fewer layers, and sweets and cookies require more layers. Some recipes call for as few as sixty layers, while others want over seven hundred. A common variation on this pastry dough involves the addition of yeast, giving an even more air and risen pastry. This is common in Spanish empanadas. This is also common for croissants, and Danish pastry dough. The type of fat used is important in making puff pastry as well. Butter gives the richest flavor, though lard gives a better texture. Some chefs mix butter and lard to obtain a product that is both flavorful, and texturally perfect. Rough puff pastry is an easier, but less flaky adaptation of puff pastry.

Lecture 3

Preparation Techniques of Chocolates

3.3. Preparation Techniques of Chocolate:

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



Lecture 4

Preparation Techniques of Candies

3.4. Preparation Techniques of Candies:

Candy making is the preparation of candies and sugar confections. Candy making includes the preparation of many various candies, such as hard candies, jelly beans, gumdrops, taffy, liquorice, cotton candy, chocolates and chocolate truffles, dragées, fudge, caramel candy and toffee.

Candy is made by dissolving sugar in water or milk to form a syrup, which is boiled until it reaches the desired concentration or starts to caramelize. The type of candy depends on the ingredients and how long the mixture is boiled. Candy comes in a wide variety of textures, from soft and chewy to hard and brittle. A chocolatier is a person who prepares confectionery from chocolate, and is distinct from a chocolate maker, who creates chocolate from cacao beans and other ingredients. Cotton candy is a form of spun sugar often prepared using a cotton candy machine.

Examples and Classifications of Candy:

1. Sugar based:

i. Crystalline sugar:

- Large crystals: Rock Candy
- Small Crystals: Fondant, fudge

ii. Non crystalline sugar:

- Hard candies: sour ball, butterscotch
- Brittle: peanut brittle
- Chewy candies: caramel, toffee
- Gummy candy: jelly, caramel, toffee

2. Chocolate based:

Chocolate covered confectionary, chocolate panned confectionary, chocolate bars, chocolate covered fruits and nuts etc.

Differences between crystalline and non-crystalline candies:

Crystalline Candies	Non-Crystalline candies
Lower sugar concentration than non-crystalline	Higher sugar concentration than crystalline
Sucrose solution boiled at lower temperature	Sucrose solution boiled at higher temperature
Contain many small, fine crystals of sucrose	From very saturated solution - no crystals
Generally smooth & creamy. crystalline candies contain crystals of sucrose in their finished form; the sucrose molecules are able to align and form large lattices. they are best formed by slow cooling of a sugar solution, without stirring, which can disrupt crystal formation.	Generally hard & brittle. non-crystalline, or amorphous candies, form when crystallisation is prevented. this can be accomplished by the addition of sugars such as glucose and fructose that interfere with the development of crystals. often, their mixtures are too viscous for crystals to form.

Crystallization at Candy Making:

Crystallization is a process of formation of solid crystals precipitating from a solution through a natural or an artificial method. It is also a chemical solid–liquid separation technique, through mass transfer of a solute from the liquid solution to crystalline phase in the form of a solid matter. Crystallization is therefore is a precipitation process, obtained through a change of the solubility of the solute in the solvent. The crystallization process proceeds into two major steps, Nuclei formation and Crystal growth.

Factors Affecting Crystallization of Sugars:

In making icings, frostings, or candy like fondant and fudge, it is necessary to crystallize the sugar solution. For crystallization to occur, nuclei must form in the solution. To these nuclei the material of the solution is added to form crystals. Both the rate of formation of nuclei and the rate of crystallization are affected by the nature of the crystallizing substance, the concentration, the temperature, agitation, and the impurities present in the solution.

- Nature of the crystallizing substance
- Formation of nuclei
- Seeding
- Rate of crystallization
- Concentration of the solution
- Temperature at which crystallization occurs

- Agitation
- Impurities
- Interfering substances
- Degree of inversion
- Added ingredients

Lecture 5

Coating or Enrobing of Chocolate (Including Pan-Coating)

3.5. Coating or Enrobing of Chocolate (Including Pan-Coating):

Enrobing is a process that involves covering a confection or snack with chocolate or chocolate coatings. Traditionally, this process was slow and involved manually dipping the pieces into melted chocolate by hand. As demand for chocolate-coated sweets increased, it became impractical or impossible to employ enough people to dip sweets into melted chocolate to keep up with production demand. Enrobing can be carried out with chocolate or compound coatings (compound coating is a replacement product made from a combination of cocoa, vegetable fat, and sweeteners). An advantage of compound coatings is that they may set faster and no tempering (the process in which chocolate masses are thermally treated to produce a small fraction of homogeneously dispersed, highly stable fat crystals of the correct type and size) is needed.
They include wafer bars, fondant centres, jellies, nuts, biscuits and ice cream.
Through covering the centre with chocolate or compound coatings, the shelf-life of the product may be extended. This is primarily applicable to centres that, if not covered, could be prone to moisture uptake/loss, oxidation, or microbial spoilage. Enrobing has some advantages over moulding (which is another method of getting a chocolate covered centre) such as greater production rates, lower capital costs. Enrobing often allow for greater production rates with lower capital costs than moulding.

Enrobing process

Enrobers are available in different sizes, suitable for large and small scale production and there is a wide variety of different designs to meet all requirements. Belt widths from 125 millimeters to 2600 millimetres are available. Although the basic elements of an enrober have largely remained unchanged over the years, the methods of operation and degree of precision possible have changed significantly. This has been accompanied by a modest increase in throughput. The biggest change in the manufacturing of chocolate enrobed sweets can be credited to the efficiency of the coolers.
Processing a real chocolate always requires a tempering unit. It is important that the centres entering the enrober are maintained at 21-24°C, and that the enrobing chocolate has the desired

viscosity and rheological properties. Warmer centres may lead to possible bloom problems due to the residual heat increasing the chocolate temperature of the enrobed sweets. Cold centres can lead to blooming and cracking of the coating shell due to expansion of the centre mass as it warms. Fat bloom develops in different ways. Automatic crystal conversion on the one hand caused by incorrect and/or insufficient tempering; on the other, it may be caused by fat migration from the filling where this fat penetrates the chocolate coat and causes the cocoa butter crystals to rise through the surface. Loss of temper can also be due to heat damage.
The centres are fed on to a feed band and transferred to a wire belt, which passes through the enrober. The coating medium is maintained at a constant temperature and in a controlled condition in an agitated tank; it is then pumped to a flow pan. The flow pan aids the process by creating a continuous curtain of coating and feeding a bottoming device. This leads to the formation of a bed of coating, which floods the mesh band. The centres are passed through this curtain and bed and are covered on all surfaces. After the curtain, excess chocolate is forced off the product by an air blower and a licking roller is used to control the amount of mass left on underside of the sweet. There is normally a vibrator after the blower to remove excess chocolate and to improve the appearance of the sweet. Finally, there should be a detailing rod between and end of the wire belt and the start of the cooler belt. Following the curtain, using an air blower, the excess chocolate is removed and a licking roller controls the amount of mass left on the underside of the sweets.

The excess mass from the curtain falls through the wire mesh belt into a sump, and is recirculated. Part of the mass is diverted through a de-temperer and is then re-tempered; blending of the freshly tempered and recirculated streams controls the overall level of chocolate in the enrober. Vibrating the centres removes ripples left by the fan, smoothens the coating and removes any surplus chocolate returning it to the tank. The centres are discharged from the enrober on to a cooling conveyor passing over a de-tailer which is a rapidly spinning rod across the end of the wire band. This results in the removal of the tail that forms as the centre leaves the wire band.

Cooling

After enrobing, the product enters a cooling tunnel to allow the coating to harden. To avoid blooming problems, temperature changes in the tunnel should be gradual, and the relative humidity properly controlled. If the dew point is lower than room temperature, moisture could condense on the product and cause sugar bloom during storage. The chocolate coating and the filling are cooled down to approximately 18°C to ensure trouble-free packaging. A good cooling tunnel should be divided into three zones.

Convection chocolate cooling is a time-dependent but not energy-dependent process. A higher temperature and longer cooling time are more favourable than a lower temperature and shorter cooling time. The recommended cooling times for pure dark chocolate, milk chocolate and milk chocolate with CBE portions are approximately six, eight and 12 minutes respectively. Milk chocolate requires a longer cooling time than dark chocolate due to the higher milk fat content and consequent lower solidification temperatures. Compound coatings may require different cooling

profiles i.e. adjusted to suit the setting properties of the vegetable fat used. After cooling, a product which is shiny and resistant to handling should be available for packaging.

Product attributes

Physico-chemical properties of enrobed products are important for two reasons. Firstly, if the crystallisation or flow properties are incorrect this results in a poor quality product being made, which may have to be sold cheaply as a misshapen product or perhaps has to be reworked. Secondly, sensory attributes are critical to the consumer's appreciation.

An enrobed product is unlikely to be purchased of if it does not look glossy or worse still, if the fat has bloomed. One important visual characteristic of enrobed products is gloss. This is determined by the reflected light. If the surface is flat with a lot of small crystals, which happens with correct tempering and cooling, the product appears shiny. Cocoa butter can solidify in different forms of crystals, where only the high melting forms b_v and b_{vi} are stable. A temperingmachine can only effect formation of the crystal formb_v. This crystal form provides good gloss, long shelf life and good mouldability. The b_{vi}form is a super stable crystal, which forms only after a longer period of storage.
Chocolate or compound flow properties are decisive factors in terms of processing possibilities. The flow properties of a coating are very complicated because the viscosity is not a single value but is dependent on the speed of flow (technically as non-Newtonian fluid). Yield value (YV) is the shear stress required to initiate the flow of a coating. YV is recorded in Pascal (or dynes/cm^2). Plastic viscosity is then the force needed to maintain this flow once it is moving, which is recorded in Pascal seconds.
Enrobing of high-quality confectionery items nearly always requires a low-viscosity coating with some reasonable yield value present. The viscosity depends on the level of fat, emulsifier content, temper profile, particle size distribution and temperature. Low viscosity is required for quality lines, giving precise control of coverage to the enrober operators. Without some yield value present, the chocolate would continue to flow down the side of an enrobed piece before setting in the tunnel, resulting in 'skirts' or 'feet' on the bottom edge of pieces, and decorative markings would be lost .

Generally, bubbles are not a major problem on enrobed items as the coating is fluid enough for them to be displaced or burst by the blower. However, with thicker masses or some more difficult products, bubbles can be problem and action may be needed to minimise them. Each feed pipe to the curtain trough should have its outlet under the chocolate surface to avoid incorporating air.

Chocolate Panning:

All types of chocolates (Dark, white and milk chocolate) can be used for panning purpose. The total fat content of chocolate should be 28 to 35%. Here, decisive role is played by milk solids and

fat content. The quantity of milk constituents influences the viscosity and the proportion of cocoa butter to milk fat which consequently influences the hardness of the final product. The chocolate is mostly delivered in liquid form or is molten before use at around 38–42°C and then applied or sprayed on. The advantage of using non-tempered chocolate is that the viscosity of the chocolate is low, thus the danger of stickiness is reduced. Another advantage could be a more homogeneous surface and consequently reduces smoothing time. Since tempering machine is not necessary, it eliminates high investment. On the other hand, the application of tempered chocolate has the advantage of reducing the cooling time between the separate layers and reduction in the quantity of chocolate sticking to the coating pan's walls.

Chocolate panned confectionery products:

Any confectionery inclusion can be chocolate coated through panning process. The coating material used can be milk chocolate, dark chocolate, white chocolate, sugar free dark or milk chocolate, compound coating or combination thereof. Chocolate panned confectionery products include dried fruits (raisins, blueberries, cherries, apricots, and cranberries), nuts (almonds, peanuts, cashews, and macadamias), espresso beans, soft pieces (fondant, caramel, and jellies) and crunchy pieces (maltballs, cookie pieces, flavoured bits). The most popular among them are nutmeats (peanuts, almonds and cashews), fruits (raisins, cherries) and malted milk balls.

Lecture 6

Preparation Techniques of Doughnuts

3.6. Preparation Techniques of Doughnuts:

Raw Materials:

Ingredients vary depending on whether they are yeast or chemically leavened. Furthermore, homemade doughnuts generally include far few ingredients than mass- produced or those made from mixes. Chemically-raised doughnuts are made with ingredients such as flour, baking powder, salt, liquid, and varying amounts of eggs, milk, sugar, shortening and other flavorings. This type of doughnut uses baking powder in the batter to leaven the dough. Yeast-leavened doughnuts are made with ingredients that include flour, shortening, milk, sugar, salt, water, yeast, eggs or egg whites, and flavorings.

Doughnuts produced in sanitary baking conditions in grocery stores, bakeries, or franchises often come from pre-packaged mixes. These vary but can include: flour (wheat and soy flour), shortening, sugar, egg yolks, milk solids, yeast dough conditioners, gum, and artificial flavors. One franchise adds a yeast brew. Mixes require the bakeries to add fresh wet ingredients such as water, milk, and eggs in the mixing process. Doughnuts also require oil (usually vegetable oil) for

frying. Glazes or frostings are often added after the product is fried and are made with flour, sugar, flavoring, and sometimes shortening.

The Manufacturing Process:

This process will describe the manufacture of doughnuts in a mechanized doughnut bakery that makes only yeast-raised doughnuts. Because yeast requires time for kneading, time to rest and additional time to rise or proof, it takes at least an hour to take dry pre-packaged mix to completed product.

Acquiring the ingredients:

- 1 Bakeries or franchises that do a brisk business (making hundreds of dozens in a day) acquire mixes in bags, often as large as 50 lb (22.7 kg). Chains have the ingredients shipped to them from company warehouses within the region and the mixes are stored on the premises and used as needed. The bakery must shop for large quantities of perishable fresh ingredients such as eggs and milk and keep them refrigerated.

Measuring the ingredients:

- 2 A batch is referred to by weight of dry ingredients put into the mixture. The weight of the batch varies with doughnut type and amount to be made. The pre-packaged mix is poured from a bag onto a scale and the precise amount measured.

Mixing and kneading:

- 3 The flour mixture is then poured into a large mixing bowl put onto an industrial mixer and the appropriate amount of wet ingredients are added depending on weight of the batch and type of doughnut in production. The wet yeast slurry (for leavening) is mixed separately and carefully added to the flour-water mixture at this time. The dough mixer then begins its work; a large dough hook first mixes and then simulates the human kneading process, pulling and stretching, as it homogenizes the ingredients and develops the dough by forming the gluten into elongated and interlace fibers that form the basic structure of the doughnut. The mix runs on an automatic timer and the entire mixture, including the softened yeast, is kneaded together for approximately 13 minutes.

Resting the yeast:

- 4 It is essential that yeast dough "rests" or simply sits for about 10 minutes after it is mechanically kneaded. As the yeast grows, it converts its food into carbon dioxide (this is called fermentation) and causes the yeast dough to rise. As the dough sits, it allows the gas to develop and the dough starts to rise, indicating the fermentation process of the yeast reacting to sugar in the mix is beginning. If this does not happen, the dough yields flat,

tough doughnuts and the mix should be discarded. At the end of this period, a good-quality dough is spongy and soft.

Shaping the doughnuts:

5 The dough is then hoisted by hand and loaded into the hopper of a machine called an extruder—a machine that forms the individual doughnuts using a pressure-cutter system. The batch of yeast dough is put into the top of the open machine. A cover is then placed on the machine and the machine is pressurized, forcing the dough into tubes that extrude a pre-determined amount of dough into the desired shape—rings for conventional doughnuts and circles for doughnuts that are to be filled with jam or cream. It takes about 15 minutes for the extruder to push out about 30 dozen doughnuts.

An automated doughnut stamper can also be used in conjunction with an extruder. In this case, the dough is extruded in a continuous, unshaped flow through a series of rollers that flatten the dough. Once flattened to 0.5 in (1.27 cm) thickness, the sheet of dough is stamped into doughnut shapes.

Proofing:

- 6 The extruder is attached directly to the proofing box (a warm, oven-like machine), which is a hot-air, temperature-controlled warm box set to approximately 125° F (51.6° C). Here, the thin doughnuts are slowly allowed to rise or proof as the yeast ferments under controlled conditions. Proofing renders the doughnuts light and airy. (Yeast doughs must be allowed to rise slowly and at just the right temperature. If the proofing box is too hot, the yeast bacteria will be killed and the doughnuts will not rise. If too cold, the yeast remains inactive and cannot ferment thus preventing leavening. A machine attached to the extruder pushes the rings or circles onto small shelves that move through the proof box for about 30 minutes. The shelves are chain-driven and move down, up, and over during this 30 minute period. After 30 minutes, they are quite puffy.

Frying:

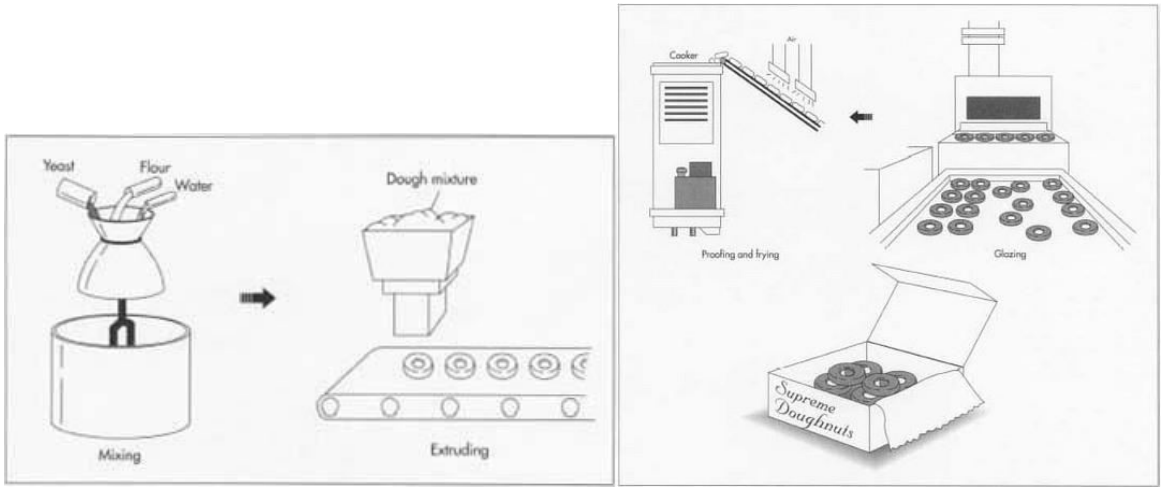
- 7 Next, the raw doughnuts fall automatically, one row at a time, into the attached open fryer. It is important to drop just a certain amount of raw doughnuts into the grease at a time. If too many are placed in the fryer at one time, the oil temperature is drastically lowered, fry time is longer, and the doughnuts absorb too much oil. The frying oil is the most expensive ingredient in the production process, and if the doughnuts absorb too much oil, it reduces the profit margin on the batch. As the doughnuts move through the fryer, they are flipped over by a mechanism. After two minutes, the doughnuts have moved completely through the fryer and are forced into the mechanism that applies glaze.

Glazing and drying:

- 8 As the doughnuts leave the fryer, they move under a shower of glaze. Here, glaze is forced through holes from a bridge running several inches above the hot doughnuts. The glaze coats the top, sides, and part of the bottom of the doughnuts. The doughnuts are conveyored out of the production area to dry and cool.

Further finishing and sale:

- 9 Once conveyored to a finishing station, the doughnuts may be sprinkled with candies or nuts or are given a thicker frosting. The disk-like doughnuts (those with no hole) are forced onto a machine that injects two doughnuts at a time with the desired, pre-measured filling. The completed doughnuts are placed on trays for movement to the counter or packed into boxes for custom orders.



Doughnut manufacturing procedure

(Ref: http://www.madehow.com/Volume-5/Doughnut.html)

Lecture 7

Maintenance, Safety and Hygiene of Bakery Plants

3.7. Maintenance, Safety and Hygiene of Bakery Plants:

Important Food safety considerationfor any bakery manufacturers:

- Laws and regulations
- Vendors selection for raw materials

- Food safety plans / Traceabilit
- Recall plan
- Documentation
- Audits and inspection

Food safety in bakeries can be achieved through:

- GMPS : GOOD MANUFACTURING PRINCIPLES
- GHP : GOOD HYGIENE PRACTICES

Key areas and equipment's for food safety and hygiene's for bakery plants are:

Pest control

Factory or ware house or retail shops are prone to pest different types of pest grow in unhygienic environment or where food material are available .Most prevalent pest are flies , cockroaches , rodents, birds, spiders and reptiles . The pest control management system one should adopt is to prevent , control and eliminate such pest because if they are allowed to grow they could easily infect the raw material and finished goods .Various chemicals and technologies have come to capture and kill these pest . Few mentioned are insecticutors , air curtainsetc.

Employee's hygiene

Employee hygiene also contributes to food safety .Employees have to wear protective clothes where ever they come in direct contact of food .It covers heads , clothes and shoes , gloves. Visitors to any food factory has to be asked to follow the food safety procedures . Includes washing hands by potassiumpermagnate .Wearing protective covers to the shoes etc .Food handlers should not be allowed to wear accessories like rings, any ornaments or accessories.

Medical checkup and medical records of food handlers

Food manufacturing industry normally follows practice of getting their food handlers checked and examined by doctors for any contagious disease .Medical records are kept and in case any food handlers is found to be infected by disease then that worker is shifted to other department.

Cleanliness of factory

Sanitation of factory premises includes cleaning and washing of factory, washrooms and canteens floor sweepings of larger areas can be achieved through automated floor sweeping machines like scrubbers and washer various industrial floor cleaning equipment are available now days . Manual push and pull type and driver mounted floor washers are available. Chemicals are also available to kill bacteria and worms and remove bad odour.

Storage of raw materials and finished goods

Storage of raw material and finished good requires regularmonitoring. Raw materials have to keep in dry and cool place certain material has to be kept in cold room as required. Humidity can damage certain bakery products. Raw material should be always kept on plastic pallets and never on floors.

A gap has to kept from the wall and between the pallets .Silos for bulk storage is highly recommended.

Drainage system

Good drainage system has to be designed for smooth flow of domesticwaste water and trade waste water to the collection pit. Effluent and sewerage treatment plant to be installed as per regulatory requirement.

Metal Detection

- Magnets- Magnets to be installed at all the places where ever required to detect any metal particles in the raw material
- Sieves- Materials to passed through sieves wherever possible to check for any foreign particles and contamination
- Metal detectors- Metal detectors can be placed in the process to check for any metal and non-metal contamination.
- Filters -- Liquid ingredients to passed through these filters to prevent any contamination .

Glass policies

All glasses under production areas need to be safe break type and windows to be safe break; ie in case of any glass breakage the glass shouldn't break and fall into the products .Tube lights and other lighting fixtures to be safe break even clocks placed need to be safe break.

Jewelry policies

Most of the bakeries employs women workers who as per traditions wear jewelry duringwork. Thesejewelry are of various types and could be hazardfor any food processing unit. A clear cut jewelry policy should be defined for women folks to adhere. Jewelrieslike bangles, hair clips, chains,rings etc. can be dangerous if worn while working .

Plastic policies

Various plastic items are used in bakeries during process and storage eg.,bottles , buckets , funnels , scoops , spoon and lab items (beaker ,jars and test tubes etc.). A clear cut plastic policy could be drawn to avoid any contaminationof food products from these plastic items.

Visitor's policies

Bakery units have frequent visitors for various functions in its production hall from service personnel , out sourced maintenance personnel , consultants , educational tours etc . To prevent any contaminations from these visitors food manufacturing companies draws a visitor policies giving instructions to visitors as to what are basic requirement during visit to production hall . eg wearing coats , caps and gloves as they enter these premises with instruction not to touch or feel the products etc.

Lecture 8

Water

Water is used in all bakery operations .the purity has to be checked for the presence of microbes and certain minerals and contaminations if any .Filters to be provided at various places in process. Water storage tanks to be cleaned in regular intervals .

Solid Waste Management

All soiledwaste to be stored in garbage bags and to shifted to outside garbage yard .Garbage should always be covered and should not be open in any case . Bins with cover should be used where ever possible . Plastic crates can be used to store defectives and unpacked products

Cleaning of utensils and equipment

All utensils need to be cleaned in regular intervals for any contamination due to material decay. Bands and crates to be cleaned in regular intervals to maintain the hygiene of the equipment. Hot water is most suitable for such cleaning process.

Lubrication

Lubrication or greasing of machines drive ,chains and sprockets could be done by food lubricants .Various food lubricants are available in markets . Even certain guides requires lubrication these guides can be lubricated by food lubricants

Material of construction

Material of construction of all bakery equipment and machinery should be stainless steel 316 grades which is food grade and does not got rust on its surface .Other material get to affected by rust.All utensils and other holding should also be food grade stainless steel or plastic.

Building design and maintenance

Ensure that walls of building are crack proof and floors are tiled no openings are found in the floor .Design of building has to be such that it is rodent , pest and bird proof .Daily inspection for

baits, sanitation and cleanliness are followed . Windows has to be covered by mesh so as to prevent flies. Doors have to be such that it gets closed automatically. Lighting outside the plant should be such that It does not attract insects inside the factory ie., It should be at some distance.

Food Safety Management Systems (FSMS) and food safety Audits

Food Factories world over have implemented one or the other FSMS to standardize operations with respect to food safety.Major FSMS are HACCP , BRC, ISO22000, SQF , these certification helps food manufacturing units to achieve food safety standards . Regular food safety audits which are mandatory in these certified units help manufacturers for compliance. Corrective and preventive measures are taken in case of any lapses/deviation/non-compliances from manufacturer side .It is therefore highly recommended to have FSMS certification done for bakeries.

Module IV 8L

Lecture 1

Importance and Applications of Extrusion in Food Processing

4.1. Importance and applications of extrusion in food processing:

Extrusion cooking is a multi-functional thermal/mechanical process, which has drawn wide attention in agro-food processing industries. This process has various beneficial effects like destruction of anti-nutritional factors, gelatinization of starch, increased soluble dietary fiber and reduced lipid oxidation. On the other hand, Maillard reaction also influence in the nutritional value of the food by the interaction between protein and sugars. The raw material and their composition along with the process condition also influence the nutritional value of the food. The extrusion cooking is widely applied for cereal and protein processing such that the mild extrusion condition (low temperature, low residence time and high moisture) improves the nutritional quality of food largely. In case of high extrusion condition such as high temperature <200ºC, low moisture content (<15%) with the presence of high reactive sugars adversely affects the nutritional quality of food. In order to obtain a nutritionally balanced food control of process parameters along with the physico-chemical changes should be monitored properly at timely basis. This review also suggests the recent development in food industries regarding the extrusion technology.

Extrusion enables mass production of food via a continuous, efficient system that ensures uniformity of the final product. Food products manufactured using extrusion usually has high starch content. These include some pasta, breads (croutons,bread sticks, and flat breads),

many breakfast cereals and ready-to-eat snacks,confectionery, pre-made cookie dough, some baby foods, full-fat soy, textured vegetable protein, some beverages, and dry and semi-moist pet foods.

Effects of Extrusion:

Extrusion enables mass production of food via a continuous, efficient system that ensures uniformity of the final product.

Extrusion has the following effects:

- Destruction of certain naturally occurring toxins
- Reduction of microorganisms in the final product
- Slight increase of iron-bioavailability
- Creation of insulin-desensitizing starches (a potential risk-factor for developing diabetes)[7][8]
- Loss of lysine, an essential amino acid necessary for developmental growth and nitrogen management
- Simplification of complex starches, increasing rates of tooth decay
- Increase of glycemic index of the processed food, as the "extrusion process significantly increased the availability of carbohydrates for digestion"
- Destruction of Vitamin A (beta-carotene)
- Denaturation of proteins.

Lecture 2

Different Types of Extruders Used in Food Industries

4.2. Different Types of Extruders:

Extruders come in several designs, dependent upon their application. Some extruders are designed simply to convey the raw materials, while others are designed to mix and knead them; most, however, are designed to impart mechanical and thermal energy to the raw materials to bring about desired physico-chemical changes. Extruders can be broadly categorized on the basis of the number of screws. The most commonly used extruders are single- and twin-screw. Extruders with more than two screws have been used in the plastics industry but not in food processing.

Depending upon the processing conditions, moisture, functional or thermodynamic characteristics, extruders are classified into three categories:

i) Autogenous: Here heat is generated from viscous dissipation of mechanical energy. Example; Cooking and Snack extruders.

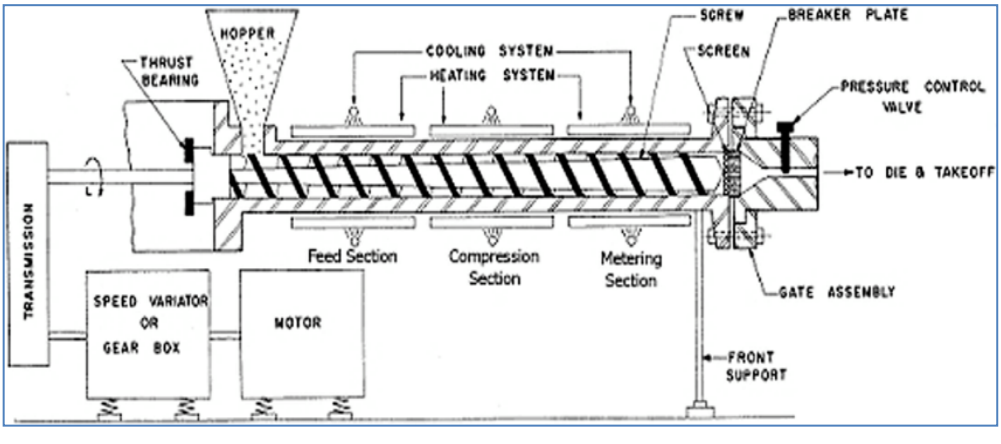
ii) Isothermal: Heat is controlled from auxiliary sources through heating or cooling jackets on the barrel eg., Farming extruders.
iii) Polytrophic: Heat input comes from the combination of viscous dissipation of mechanical energy and auxiliary sources such as heat transfers. Example; cooking extruders.

Food Extruders can also be classified by their method of pressure development, positive displacement or viscous drag. Extruders can be classified as single or twin screw based on the design pattern.

4.2.1. Single-Screw Extruders:

Single-screw extruders contain a single rotating screw in a metal barrel, and come in varying patterns. The main design features are shown in Figure 5. The most commonly used single-screws have a constant pitch. Single-screws usually consist of three sections: (1) feed, (2) transition or compression, and (3) metering, as shown in Figure 5. The raw materials are fed in a granular form at the hopper located in the feed section. The rotating action of the screw conveys the material to the transition section. In the transition section, the screw channel becomes shallower and the material is compacted. A major portion of mechanical energy is dissipated in this section, which results in a rise in temperature of the material. Starch becomes gelatinized, and the material becomes more cohesive. It is transported further by the metering section and pushed through the die opening. The barrels of single-screw extruders usually have helical or axial grooves on the inner surfaces. This helps to convey and mix the material more effectively.

Single-screw extruders are usually characterized by their length to diameter (L/D) ratio and their compression ratio, which is the ratio of the maximum channel depth to the minimum channel depth. The most commonly used compression ratio is 3 to 1. The throughput (mass flow rate) capacity of a single-screw extruder is linked to screw speed, screw geometries, and material characteristics.



Schematic diagram of single screw extruder

Lecture 3

Twin Screw Extruder

4.2.2. Twin Screw Extruder:

Twin screw extrusion is used extensively for mixing, compounding, or reacting polymeric materials. The flexibility of twin screw extrusion equipment allows this operation to be designed specifically for the formulation being processed. For example, the two screws may be corotating or counter-rotating, intermeshing or non-intermeshing. In addition, the configurations of the screws themselves may be varied using forward conveying elements, reverse conveying elements, kneading blocks, and other designs in order to achieve particular mixing characteristics.

The term 'twin-screw' applies to extruder s with two screws of equal length placed inside the same barrel. It consists of two parallel screws in a barrel. It is more complicated than single screw extruders, but at the same time provides much more flexibility and better control. Twin screws produce a more uniform flow of the product through the barrel due to the positive pumping action of the screw flights. Twin-screw extruders aremainly of twotypesas follows:

i. Counter-rotating twin-screw extruder
   - Non-intermeshed, counter rotating
   - Intermeshed, counter rotating

ii. Co-rotating twin-screw extruders
   - Non-intermeshed, co-rotating
   - Intermeshed, co-rotating

From these four types of twin-screw extruders, co-rotating, intermeshed screw typehas found the widest acceptance in food industry.

Differencebetween Single Screw and Twin Screw Extruders:

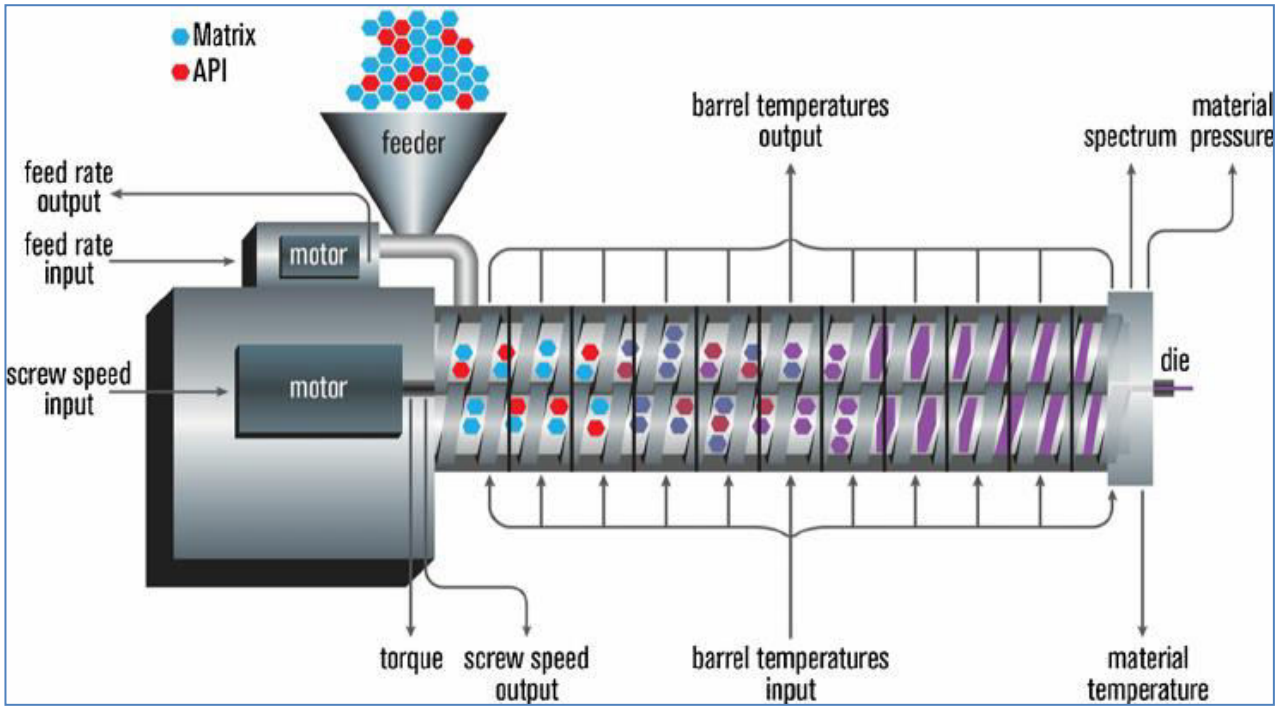
Single screw extrudeis simple, using rotating belt way with a constant un-adjustable spindle speed. It can get good blending through high speed operation in short time.Solid conveying, melting, pumping and mixing occur simultaneously and are interdependent. The conveying capacity of single extruder is poor under high pressure. Compared to the same power twin-screw extruder production of single-screw extruder is lower. This is because the transfer method is pressure sensitive, pressure will produce reflux, and therebythe transmission efficiency is reduced. Thepurchase cost of single screw extruder is lower than twin screw extruder.

Advantages of Twin Screw Extruders:

- Handle viscous, oily, sticky or very wet material and some other products which will slip in single screw extruder, (it is possible to add up to 25% fat in a twin screw extruder)
- Less wear in smaller part of the machine than in single screw extruder.
- Wide range of particle size (from fine powder to grains) may be used, where as single screw is limited to a specific range of particle size

Advantages of twin-screw extruders over Single screw:

- The throughput of these systems can be independent of feed rate and screw speed.
- Process variables include degree of fill, temperature-shear history, and heat transfer, all of which may influence the properties of the extruded product.
- Twin-screw systems provide increased flexibility in terms of higher moisture content extrudates, as well as higher concentrations of ingredients (lipids, carbohydrates, etc.).
- These systems usually have less wear due to shorter sections of the barrel being exposed to the high pressures required for product extrusion.
- Twin-screw extruders will accommodate a wider range of particle sizes in the ingredients.



Schematic diagram of twin screw extruder

Lecture 4

General Process of Food Extrusion

4.3. General Process of Food Extrusion:

Principle of Extrusion Cooking:

The raw materials are allowed intothe extruder barrel and the screw(s)then convey the food along it. Further down the barrel, smaller flights restrict the volume and increase the resistance to movement of the food. As a result, it fills the barrel and the spaces between the screw flights and becomes compressed. As it moves further along the barrel, the screw kneads the material into a semi-solid, plasticized mass. If the food is heated above 100ºC the process is known as extrusion cooking (or hot extrusion). Here, frictional heat and any additional heating that is usedcause the temperature to rise rapidly.High temperature of operation in presence of water promotes gelatinisation of starch components and stretching of expandable components. The food is then passed to the section of the barrel having the smallest flights, where pressure and shearing is further increased. Finally, it is forced through one or more restricted openings (dies) at the discharge end of the barrel as the food emerges under pressure from the die, it expands to the final shape and cools rapidly asmoisture is flashed off as steam.

The basic elements of proper extrusion cooking are the following:

- Feeding of granular or milled material in the extruder should be continuous at desired feed rates.
- The material should be pre-conditioned with steam at controlled temperature of 82^{o}C to 99^{o}C at atmospheric pressure.
- The moisture should be uniformly applied to the product.
- The equipment must transform the granular or processed floury material into dough at 82^{o}C to 110^{o}C.
- The temperature of the dough should be elevated to 115^{o}C to 200^{o}C during last 10 to 30 seconds in their extruder to cook and expand the product.
- Formation of desired shape and size of the product by a nozzle or die at the end of the process. The extrudate is cut into desired lengths.
- Drying and cooling of the extrudate.

Lecture 5

Factors Affecting the Extrusion Process

4.4. Factors Affecting the Extrusion Process:

The two factors that most influence the nature of the extruded product are the rheological properties of the food and the operating conditions of the extruder.
Rheological properties of the food.The properties of the feed material have an important influence on the texture and colour of the product;

The most important factors are:

i. The type of feed material
ii. Their moisture content
iii. The physical state of the materials
iv. Their chemical composition, particularly the amounts and types of starches, proteins, fats and sugars
v. The pH of the moistened material.
vi. Feed rate
vii. Screw speed
viii. Barrel temperature
ix. Die characteristics
x. Screw design

Operating characteristics:

The most important operating parameters in an extruder are

i. TemperatureIncrease in extrusion temperature results in higher degree of gelatinisation.
ii. Pressure
iii. Diameter of the die apertures(Increase in diameter reduces gelatinisation of starch)
iv. Shear rate
v. Moisture

If moisture increases viscosity decreasetorque decreaseproduct temperature decreasebulk density increase (expansions diepressure decreases)

Lecture 6

Manufacturing Process of Extruded Products: Pasta Production

4.5.Manufacturing Process of Extruded Products: Pasta Production:

Although pasta products were first introduced in Italy in the 13th century, efficient manufacturing equipment and high-quality ingredients have been available only since the 20th century.Prior to the industrial revolution, most pasta products were made by hand in small shops. Today, mostpasta is manufactured by continuous, high capacity extruders, which operate on the auger extrusionprinciple in which kneading and extrusion are performed in a single operation.
The manufacture ofpasta includes dry macaroni, noodle, and spaghetti production.

Process Description:

Pasta products are produced by mixing milled wheat, water, eggs (for egg noodles or egg spaghetti), and sometimes optional ingredients. These ingredients are typically added to a continuous,high capacity auger extruder, which can be equipped with a variety of dies that determine the shape ofthe pasta. The pasta is then dried and packaged for market.

Raw Materials:

Pasta products contain milled wheat, water, and occasionally eggs and/or optional ingredients.
Pasta manufacturers typically use milled durum wheat (semolina, durum granulars, and durum flour) inpasta production, although farina and flour from common wheat are occasionally used. Most pastamanufacturers prefer semolina, which consists of fine particles of uniform size and produces thehighest quality pasta product. The water used in pasta production should be pure, free from off-flavors, and suitable for drinking. Also, since pasta is produced below pasteurization temperatures,water should be used of low bacterial count. Eggs (fresh eggs, frozen eggs, dry eggs, egg yolks, ordried egg solids) are added to pasta to make egg noodles or egg spaghetti and to improve thenutritional quality and richness of the pasta. Small amounts of optional ingredients, such as salt,celery, garlic, and bay leafs, may also be added to pasta to enhance flavor. Disodium phosphate maybe used to shorten cooking time. Other ingredients, such as gum gluten, glycerylmonostearate, andegg whites, may also be added. All optional ingredients must be clearly labeled on the package.

Wheat Milling:

Durum wheat is milled into semolina, durum granular, or durum flour using roll mills.
Semolina milling is unique in that the objective is to prepare granular middlings with a minimum offlour production. After the wheat is milled, it is mixed with water, eggs, and any other optional ingredients.

Mixing :

In the mixing operation, water is added to the milled wheat in a mixing trough to produce

dough with a moisture content of approximately 31 percent. Eggs and any optional ingredients mayalso be added. Most modern pasta presses are equipped with a vacuum chamber to remove airbubbles from the pasta before extruding. If the air is not removed prior to extruding, small bubbles will form in the pasta which diminish the mechanical strength and give the finished product a white,chalky appearance.

Extruding:

After the dough is mixed, it is transferred to the extruder. The extrusion auger not only forces the dough through the die, but it also kneads the dough into a homogeneous mass, controls the rate ofproduction, and influences the overall quality of the finished product. Although construction anddimension of extrusion augers vary by equipment manufacturers, most modern presses have sharp-edged augers that have a uniform pitch over their entire length. The auger fits into a groovedextrusion barrel, which helps the dough move forward and reduces friction between the auger and theinside of the barrel. Extrusion barrels are equipped with a water cooling jacket to dissipate the heatgenerated during the extrusion process. The cooling jacket also helps to maintain a constant extrusiontemperature, which should be approximately 51°C (124°F). If the dough is too hot (above 74°C[165°F]), the pasta will be damaged.Uniform flow rate of the dough through the extruder is also important. Variances in the flowrate of the dough through the die cause the pasta to be extruded at different rates. Products ofnonuniform size must be discarded or reprocessed, which adds to the unit cost of the product. Theinside surface of the die also influences the product appearance. Until recently, most dies were madeof bronze, which was relatively soft and required repair or periodic replacement. Recently, dies havebeen improved by fitting the extruding surface of the die with Teflon inserts to extend the life of thedies and improve the quality of the pasta.

Drying :

Drying is the most difficult and critical step to control in the pasta production process. The objective of drying is to lower the moisture content of the pasta from approximately 31 percent to 12to 13 percent so that the finished product will be hard, retain its shape, and store without spoiling.Most pasta drying operations use a preliminary drier immediately after extrusion to prevent the pastafrom sticking together. Pre-drying hardens the outside surface of the pasta while keeping the insidesoft and plastic. A final drier is then used to remove most of the moisture from the product.Drying temperature and relative humidity increments are important factors in drying. Sincethe outside surface of the pasta dries more rapidly than the inside, moisture gradients develop acrossthe surface to the interior of the pasta. If dried too quickly, the pasta will crack, giving the product apoor appearance and very low mechanical strength. Cracking can occur during the drying process oras long as several weeks after the product has left the drier. If the pasta is dried too slowly, it tends tospoil or become moldy during the drying process. Therefore, it is essential that the drying cycle betailored to meet the requirements of each type of product. If the drying cycle has been successful, thepasta will be firm but also flexible enough so that it can bend to a considerable degree beforebreaking.

Packaging:

Packaging keeps the product free from contamination, protects the pasta from damage during shipment and storage, and displays the product favorably. The principal packaging material for noodles is the cellophane bag, which provides moisture-proof protection for the product and is usedeasily on automatic packaging machines, but is difficult to stack on grocery shelves. Manymanufacturers utilize boxes instead of bags to package pasta because boxes are easy to stack, providegood protection for fragile pasta products, and offer the opportunity to print advertising that is easier to read than on bags.

Emissions and Controls:

Air emissions may arise from a variety of sources in pasta manufacturing. Particulate matter (PM) emissions result mainly from solids handling and mixing. For pasta manufacturing, PM emissions occur during the wheat milling process, as the raw ingredients are mixed, and possibly during packaging. Emission sources associated with wheat milling include grain receiving, precleaning/handling, cleaning house, milling, and bulk loading. There are no data for PM emissions from mixing of ingredients or packaging for pasta production.

Volatile organic compound (VOC) emissions may potentially occur at almost any stage in the production of pasta, but most usually are associated with thermal processing steps, such as pasta extruding or drying. No information is available on any VOC emissions due to the heat generated during pasta extrusion or drying.Because of the operational similarities, emission control methods used in grain milling and processing plants are similar to those in grain elevators. Cyclones or fabric filters are often used to control emissions from the grain handling operations (e. g.,unloading, legs, cleaners, etc.) and also from other processing operations. Fabric filters are used extensively in flour mills. However, certain operations within milling operations are not amenable to the use of these devices and alternatives are needed. Wet scrubbers, for example, may be applied where the effluent gas stream has a high moisture content.

Lecture 7

Textured Vegetable Protein

4.6. Textured Vegetable Protein:

Textured or texturized vegetable protein (TVP), also known as textured soy protein (TSP), soy meat, or soya chunks is a defattedsoy flour product, a by-product of extracting soybean oil. It is often used as a meat analogue or meat extender. It is quick to cook, with a protein content comparable to certain meats.

Texturized vegetable can be defined as “fabricated palatable food ingredients

processed from edible protein source, including among others soy grits, soy protein isolates, and soy protein concentrates with or without suitable option ingredients added for nutritional or technological purposes. They are made up as fibers, shreds, chunks, bits, granules, slices or other forms. When prepared for consumption by hydration, cooking, retorting or other procedures, they retain their structural integrity and characteristic 'chewy' texture".

Meat Extender:

Meat extenders produced from the extrusion processing of defatted soy flour or flakes and soy concentrates, and they represent the largest portion of textured protein. Meat extenders are rehydrated to 60-65% moisture, blended with the meats or meat emulsions, to food product to a level of 20-30% protein.

Meat Analog:

An extrusion process utilizing one or two extruders in a series can be employed to convert vegetable protein source directly into simplified varieties of meat analogs. These meat analogs have remarkable similarity in appearance, texture and mouth feel to meat. Extrusion technology can form a fibrous matrix (analog) almost indistinguishable from meat, and consumed as it is.

Uses of Texturized Soy Protein:

Texturized soy protein has been a commercial success for many years because of the development of machinery that is capable of continuously producing textured vegetable product. The texturization of plant proteins has been a major development in the food industry. Processes, like extrusion, have been developed to impart a fibrous structure to amorphous plant proteins. Once texturized, these plant proteins can be dehydrated for use as an extender of fresh or processed meat. Consumers are becoming increasingly interested in healthy foods and open to soy protein ingredients. Texturization of soy flours into usable meat extenders and replacers is economically feasible for some time. Texturized soy products serve a variety of purposes, including alternative protein sources for the manufacture of convenience foods and for centralized feeding of large numbers of people within defined budgets. Today, due to increasing consumer demand for healthy diets and concerns about rising meat prices, some industry leaders are betting that consumers will increase their appetites for soy-based burgers. As a result, various types of soy based meat products are now seen in the market. There are basically three major market groups for meat analogs. Each may restrict the ingredient choices during product formulation. They range from those who limit certain animal products because of religious dietary restrictions. The second group consists of those looking for a healthier alternative to meat. The final group consists of people who are looking for cheaper protein sources

Texturized vegetable protein is being used increasingly in North America as an extender of red meat products. Among the low cost vegetable protein products developed for use in foods as meat extenders or replacement, the most rapid growth has been in the area of textured products manufactured by thermoplastics extrusion.

Technology is becoming quite accomplished at creating realistic analogs that equal their meat counterparts in term of flavor, texture and most importantly, satiety. There are analogs of hamburger, both in patties and ground form; sliced lunch meat; sausages; hot dogs; Canadian bacon; pepperoni; bacon bits; and stuffed turkey. Texture and flavor are the two biggest challenges in developing a meat analog. Vitamins and mineral fortification can be done for the school and military luncheon programs.

Some popular prepared vegetable protein foods are pareve (without meat, milk, eggs and their derivatives) and are of interest to people following Jewish (Kosher) dietary laws. Islam is one of the world's fastest growing religions, and Muslim are today demanding Halal foods. Texturized vegetable foods provide an alternative to animal meat and falls under the Halal foods.

Texturized vegetable protein from soy concentrate have the advantages of blander flavor and major reduction of non-digestable natural sugars (stachyose and raffinose) which can cause considerable flatulence, abdominal discomfort, and venting in some individuals. Modern texturized soy flours have milder flavors than in earlier years, which are easily masked in highly seasoned foods, like tomato sauces, pizza toppings, and canned chilli. A user of texturized vegetable protein includes the growing numbers of vegetarians, and people concerned with lowering cholesterol and total fat intake.

Vegetarians have modified many recipes to replace meat with soy proteins.
Recipes are available to use textured soy protein in breakfast foods, appetizers, soups, sandwiches, gravies, desserts, ethnic food and main dishes. Several food items are available with textured soy protein, which are designed to grill or cook in microwave ovens. Some times these food items are co-extruded with soy concentrates and wheat gluten. Ingredients, including flavors, and colors and edible adhesives (like soy protein isolates, hydrocolloids, or starch, calcium caseinate and egg whites) are added to hydrates textured soy protein before forming into patties, freezing and packaging.

The demand for meat extenders and meat analogs will continue to rise. Meat extenders are still the largest segment of the textured vegetable protein market, however, the use of meat analogs are increasing. We are becoming more aware nutritionally of the foods we eat. Along with the beneficial high protein content of actual meats, there are some negative health benefits, namely cholesterol. However, most people still like their meat. Meat analogs have become a viable alternative in offering a nutritionally acceptable meat substitute that in some cases come close to matching actual meat products. Food scientists have made major headway in improving flavor, texture, mouthfeel, appearance and color of meat analog products. In the market place, you can see more and more meat analog and meat extender products such as, bacon bits, soy burgers, meat free hot dogs, chicken nuggets, breakfast sausage patties/links and bacon to name a few. Many of these products are even packaged in the same fashion as their meat counterparts.

Lecture 8

Change of Functional Properties of Food Components during Extrusion

4.7. Change of Functional Properties of Food Components during Extrusion:

i. Degree of Expansion on Exit from the Extruder:

- For many products, the sudden release of pressure when exiting the die of the extruder causes water to flash off and the product to expand.
- The extent of expansion depends on the composition of the product, its internal microstructure as it exits the die, and the conditions (pressure and temperature) in the extruder.
- Degree of expansion may be calculated as either the ratio of the diameters or areas of the extruded product to the die

ii. Bulk Density:

- The density of the final product depends on the nature of the solid material as well as on the amount of air space within the product. A highly expanded product, with plenty of air spaces, has significantly lower bulk density than a product with little air inclusion.

iii. Mechanical Properties:

- Physical and rheological properties determine the characteristics of the extruded product.
- These may be expressed as fundamental parameters, like elastic modulus, or may be characterized by Empirical measures, such as hardness or crispness.
- Instruments that measure fundamental properties (rheometers) or empirical techniques (Instron or penetrometer) may be used to quantify characteristics of extruded products.

iv. Internal Microstructure:

- The arrangement of the components of the extruded product leads to the physical properties described above.
- The state of starch, whether partially or completely gelatinized, in the final product strongly influences physical characteristics.
- Typically, internal microstructure is evaluated using microscopy (scanning electron microscopy).

v. Protein Quality:

- The nature of extruded proteins depends on the Extruder operating conditions, especially temperature profile as the extruded product is formed.
- High-heat treatment causes denaturation of many proteins,which influences physical characteristics such as viscosity.

vi. Starch Characteristics:

- Properties of starch in an extruded product that influence quality characteristics include such measures as water absorption index, water solubility index, and enzyme susceptibility.

These depend on the operating parametersθ within the extruder as well as the type of raw materials used for extrusion.

Question Bank

1. MULTIPLE CHOICE QUESTIONS (MCQ)(1 mark each)

(i) Which one is an emulsifier?
(a) CMC (b) monoglycerides (c) pectin (d) all of these

(ii) Which of the following parameters is an important characteristics of corn syrup?
(a) BE (b) CE (c) DE (c) LE

(iii) Marshmallow is
(a) Confectionary product (c) Bakery product (c) Fruit concentrate (d) Dairy product

(iv)Leavening agent Yeast used in baked goods is
(a) Chemical agent (b) Biological agent (c) Physical agent (d) Both (b) and (c)

(v) The brown colour of crust of bread during baking is due to the maillard reaction between
(a) Protein and sugar(b) sugar and vitamin (c) sugar and salt (d) Damaged starch and amino acid.

(vi) The cake which do not contain any added fat or shortening is
(a) Pound cake (b) Sponge cake (c) Angel cake (d) Both (b) and (c)

(vii) The white portion which is seen after slicing of bread is called
(a) Crumb (b) Crust (c) Cells (d) Comb

(viii) Egg has the following properties
(a) Foaming power (b) coagulation (c) emulsification (d) all of these

(ix) Monomers of Lactose are
(a) Glucose and Fructose (b) Galactose and Fructose (c) Galactose and Glucose (d) None of these

(x) The action responsible for gluten formation in hydrated dough is
(a) Sheeting (b) Kneading (c) Moulding (d) Turning

(xi) Which of the following is aerated hard candies?
(a) Crunchies(b) Marshmallows (c) Toffee (c) Caramel

(xii) Which of the process in chocolate making is critical in avoiding fat bloom?
(a) Conching (b) Refining (c) Tempering (d) Moulding

(xiii) Potassium bromate is an example of
(a) Emulsifier (b) Dough modifier (c) Shortening agent (d) Leavening agent

(xiv) Which of the following is/are commercially used as glazing agents in panned confectionary?
(a) Mineral oil (b) Cocoa butter (c) Carnauba wax (d) All of the above

(xv)Farinograph, Extensograph are example of
(a) Water testing (b) Milk testing (c) Flour testing (d) Food color testing equipment

(xvi) Cause of staling in case of bread is due to
(a) Retrogradation of starch (b) Gelatinization of starch (c) Coagulation of protein (d) none of the above.

(xvii) Baking powder contains
(a) Sodium bi carbonate (b) Leavening acid (c) Starch (d) all of these.

(xviii) In case of Baking powder it can be
(a) Only fast acting (b) Fast or slow acting (c) Fast and slow acting (d) Both (b) and (c)

(xix) Which one is a biological leavening agent?
(a) Baking soda (b) ammonium bicarbonate (c) baker's yeast (d) none of these.

(xx) An example of leavening agent is
(a) Butter (b) sugar (c) salt (d) yeast

(xxi) Angel and sponge cakes are
(a) Yeast raised products (b) Chemically leavened products (c) Air leavened products (d) Partially leavened products

(xxii) Which of the following is widely used during manufactured of hard boiled candy?
(a) Corn syrup (b) Wheat syrup (c) Rice syrup (d) All of the above

(xxiii) All purpose flour flour is typically made of
(a) Soft wheat (b) Hard wheat (c) hard and soft wheat blend (d) None of the above

(xxiv)Silver coating in confectionary is also called
(a) Panning (b) Gilding (c) Polishing (d) None of the above

SHORT ANSWER TYPE QUESTIONS (5 marks each)

1. Write down the advantages and disadvantages of reciprocating and band slicers.
2. Write a short note on different types of rounder.
3. Write down the merits of extruder technology.
4. Write a short note on high speed mixer.
5. Classify candies with examples.
6. What are the effects of crust and crumb during baking?
7. Classify and write about the weighing and metering equipment in bakery industries.
8. Discuss about principle of baking. What is the difference between Baking soda and Baking powder?
9. Write a short note on biscuit forming equipment.
10. Compare between the tunnel oven and traveling tray oven.

LONG ANSWER TYPE QUESTIONS (15 marks each)

1. What is the role of ingredients in making bread? Discuss in details. Discuss about straight dough and sponge dough making process. What are the advantage and disadvantage of these methods?

2. Mention name of three oxidizing agent used in making of bread. Discuss about mechanical dough development process in case of bread making. What is the advantage of this method than other traditional methods? What do you mean by staling of bakery product? What are the advantages of high gluten fortified flour?

3. What is the basic rule of formula balance? Discuss with an example. Discuss about microbial spoilage of bread and bakery product. What are the possible defects in bread?

4. What are the differences between shortened and unshortened cake? Discuss the role of ingredients in making cake. Discuss about possible causes of loss of quality in cakes.

5. How do you classify extruders? Discuss about the production of any one extruded product. What are the uses of extruded foods?

6. Discuss about quality of good bread. Discuss any two methods for production of cake. What are the difference between high ratio cake and low ratio cake?

7. Write in details about the manufacturing of chocolate. Write about the panning and enrobing processes by chocolate.

8. What are the factors that affect the performance of extrusion process? What changes of macromolecules (starch, protein and lipid) occur during the process of extrusion?

9. Classify the pies. Which types of ingredients are used in pie manufacturing? Write the method of pie making. Write about the faults of pie making.

10. Write short notes on (**any three**):
    (a) Sweet yeast dough
    (b) Leavening agent
    (c) Candy
    (d) Pastry manufacture
    (e) Bread roll manufacture
    (f) Doughnuts