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MOFPI

NIFTEM

PM Formalisation of Micro Food Processing Enterprises (PM-FME) Scheme

HANDBOOK OF BAKERY AND CONFECTIONARY PROCESSING

Organized By

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Content

1. INTRODUCTION

1.1 Overview of PM FME Scheme and Implementation

In India, unorganized food processing sector comprises nearly 25 lakhs unregistered and informal food processing enterprises. With only 7% of investment in plant & machinery and 3% of outstanding credit, the unorganized enterprises contribute to 74% of employment (a third of which are women), 12% of output and 27% of the value addition in the food processing sector. Nearly 66% of these units are located in rural areas and about 80% of them are family-based enterprises. The unorganized food processing industry in India faces challenges that limit its development and weakens performance. These challenges include: lack of productivity and innovation due to limited skills and access to modern technology and machinery for production and packaging, deficient quality and food safety control systems, including lack of basic awareness on good hygienic and manufacturing practices, lack of branding & marketing skills and inability to integrate with the supply chains, etc., capital deficiency and low bank credit.

PMFME scheme is a centrally sponsored scheme with an outlay of Rs. 10,000 crores over a period of five years that is designed to address the challenges faced by the micro enterprises and to tap the potential of groups and cooperatives in supporting the upgradation and formalization of these enterprises.

Objectives:

i) Increased access to credit by existing micro food processing entrepreneurs, FPOs, Self Help Groups and Co-operatives;

ii) Integration with organized supply chain by strengthening branding &marketing;

iii) Support for transition of existing 2,00,000 enterprises into formal framework;

iv) Increased access to common services like common processing facility,
laboratories, storage, packaging, marketing and incubation services;

v) Strengthening of institutions, research and training in the food processing sector

vi) Increased access for the enterprises, to professional and technical support.

One District One Product:

The Scheme adopts One District One Product (ODOP) approach to reap the benefit of scale in terms of procurement of inputs, availing common services and marketing of products. ODOP for the scheme will provide the framework for value chain development and alignment of support infrastructure. The States would identify the food product for a district, keeping in perspective the focus of the scheme on perishables. A baseline study would be carried out by the State Government. The ODOP product could

be a perishable agri-produce, cereal based product or a food product widely produced in a district and their allied sectors.

The programme has four broad components addressing the needs of the sector:

i) Support to individual and groups of micro enterprises;

ii) Branding and Marketing support;

iii) Support for strengthening of institutions;

iv) Setting up robust project management framework

1. **Support to Individual Micro Enterprises:**

Individual micro food processing units would be provided credit-linked capital subsidy @35% of the eligible project cost with a maximum ceiling of Rs.10.0 lakh per unit. Beneficiary contribution should be minimum of 10% of the project cost with balance being loan from Bank.

2. **Group Category:**

The Scheme would support clusters and groups such as FPOs/SHGs/ producer cooperatives along their entire value chain for sorting, grading, assaying, storage, common processing, packaging, marketing, processing of Agri-produce, and testing laboratories.

Farmer Producer Organizations (FPOs)/Producer Cooperatives:

i) Grant @35% with credit linkage;

ii) Training support

Self Help Groups (SHGs):

- Seed capital @ Rs40,000/- per member of SHG for working capital and purchase of small tools at the federation level of SHGs
- Support to individual SHG member: credit linked grant @35% with maximum amount being Rs 10 lakh.
- Support for capital investment at federation of SHG level, with credit linked grant @35%.
- Training & Handholding Support to SHGs by resource persons.

Support for Common Infrastructure:

Support for common infrastructure for assaying of agriculture produce, sorting, grading, warehouse and cold storage at the farm-gate, Common processing facility for processing of ODOP produce, Incubation

Centre would be provided to FPOs, SHGs, cooperatives, any Government agency or private enterprises. Common infrastructure created under the scheme should also be available for other units and public to utilize on hiring basis for substantial part of the capacity. Credit linked grant would be available @ 35%.

Branding and Marketing Support:

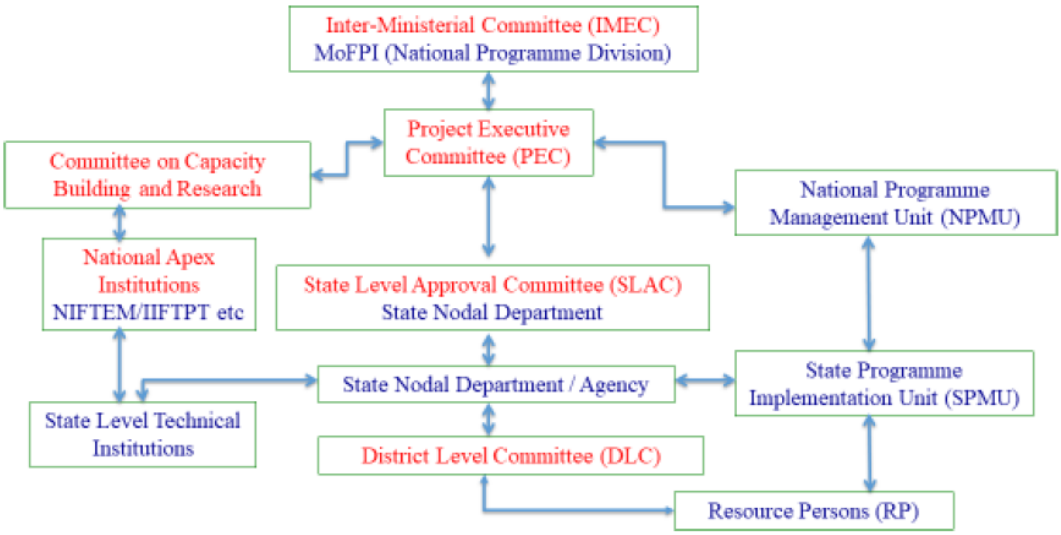
Marketing and branding support would be provided to groups of FPOs/SHGs/ Cooperatives or an SPV of micro food processing enterprises under the Scheme.

Following the ODOP approach, marketing & branding support would only be provided for such product at the State or regional level. Support for Marketing and Branding requires a minimum volume which can be generated through active involvement of FPO/ SHG/ Cooperatives to bring large number of producers together. Support for branding and marketing would be limited to 50% of the total expenditure with maximum limit as prescribed.

Capacity Building & Research:

Capacity building and training is a critical component in technical upgradation and formalization of micro food processing enterprises. At the National level, National Institute for Food Technology Entrepreneurship and Management (NIFTEM) and Indian Institute of Food Processing Technology (IIFPT) would play pivotal role in capacity building & research. They would be eligible for financial assistance towards research and capacity building. NIFTEM and IIFPT in partnership with State Level Technical Institutions would provide training and research support to the selected enterprises/groups/clusters. National level product specific institutions under ICAR, CSIR or premier institutes like DFRL and CFTRI will be partner institutions for providing support at the vertical level across the country for training and research.

Institutional Architecture:



List Document's available on MoFPI website:

S. No	Document's available on MoFPI website (www.mofpi.ni.in/pmfme/)
1	Scheme Brochure in English & Hindi
2	Scheme Guidelines in English & Hindi
3	Structure of State/UT Project Management Unit (SPMU)
4	Structure of State/UT Project Management Unit (SPMU)
5	List of State Nodal Department Incharge, State Nodal Officer and State Nodal Agency
6	Rates for Outsourcing Training Materials/ Technologies etc. under the Capacity Building Component of PMFME Scheme
7	Guidelines for Capacity Building Component under PMFME Scheme in English & Hindi
8	Guidelines for Establishment of Common Incubation Facitlity under PMFME Scheme
9	Guidelines for Implementation of Seed Capital Component under PMFME Scheme

10	List of approved State Level Technical Institutions for 23 States

Frequently Asked Questions (FAQs)

Q 1. **What is PM FME scheme?**

A. PM FME stands for "*Prime Minister Formalisation of Micro Food Processing Enterprises*". PMFME is an all India Centrally Sponsored Scheme with an outlay of Rs. 10,000 crore for coverage of 2, 00,000 enterprises over 5 years from 2020-21 to 2024-25 being implemented by MOFPI.

Q 2. **What are key features of PM FME scheme and which types of support will be provided in this scheme?**

- Increased access to credit.
- Professional/technical support and training.
- Improvement and standardisation of Micro Food Processing Enterprises, FPOs and SHGs.
- Branding for better Marketability

Q 3. What type of businesses/groups can avail benefit under PM FME scheme?

Already existing Micro Food Processing Enterprises, FPOs, SHGs and producers'cooperatives and cooperative society presently involved in food processing. New units whether for individuals or groups would only be supported for ODOP products.

Q 4. How to apply under PMFME scheme?

Applications would be invited at the district level on an ongoing basis for units interested in availing the benefits under the scheme. Existing food processing units desiring to seek assistance under the scheme should apply on the FME portal.

Q 5. Is there any qualification required to avail the benefits of the scheme?

For Micro food processing units, the applicant (must have ownership rights of the enterprise) should possess at least VIII standard pass educational qualification.

Q 6. What is eligibility criteria required for Micro food processing units to avail of the benefits of the scheme?

- The applicant should have ownership right of the enterprise.
- Ownership status of enterprise could be proprietary / partnership firm.
- The applicant should be above 18 years of age and should possess at least VIII standard pass educational qualification.

Q 7. What is eligibility criteria required for FPOs to avail of the benefits of the scheme?

- It should have minimum turnover of Rs.1 crore.
- The cost of the project proposed should not be larger than the present turnover.
- Should have experience in dealing with the product for a minimum period of 3 years.

Q 8. What is eligibility criteria required for SHGs to avail of the benefits of the scheme?

- SHG members that are presently engaged in food processing.

●SHG members should have for a minimum period of 3 years' experience in processing of the ODOP product for Credit Linked Grant for Capital Investment for SHGs

Q 9. What is ODOP?

A ODOP stands for "One District One Product". The products selected under ODOP category are traditionally famous for the production and manufacturing from the particular district.

Q 10. Are all members of SHG eligible for the seed capital?

No, only those members of SHG are eligible for the seed capital who is involved in food processing. For that, seed capital will be provided at the federation level of SHG.

Q 11. Is there any support provided to the individual SHG member as a single unit of the food processing industry?

Yes, Credit linked grant @35% with the maximum amount being Rs 10 lakh.

Q 12. What are the eligibility criteria for seed capital for SHGs?

●Only SHG members that are presently engaged in food processing are eligible.

●The SHG member has to commit to utilize this amount for working capital and purchase of small tools and give a commitment in this regard to the SHG and SHG federation.

●Before providing the seed capital, SHG Federation should collect the following basic details for each of the members:

a) Details of the product being processed;
b) Other activities undertaken;
c) Annual turnover;
d) Source of raw materials and marketing of produce.

Q 13. What is the eligibility for credit linked grant for capital investment for SHGs?

- The SHGs should have sufficient own funds for meeting 10% of the project cost and 20% margin money for working capital or sanction of the same as grant from the State Government;
- The SHG members should have for a minimum period of 3 years' experience in processing of the ODOP product.

Q 14. Is there any provision of financial assistance for preparation of DPR?

A Yes, assistance of Rs. 50,000/- per case would be provided to FPOs/SHGs/Cooperatives for preparation of DPR.

Q 15. What is the eligibility criterion for availing marketing and branding support?

A ●The proposal should relate to ODOP;

●Minimum turnover of product to be eligible for assistance should be Rs 5 crore.

●The final product should be the one to be sold to the consumer in retail pack.

●Applicant should be an FPO/SHG/cooperative/ regional - State levels SPV to bring large number of producers together.

●Product and producers should be scalable to larger levels

Q 16. Is there any provision of special benefits for women applying in the scheme?

A No.

Q 17. Is there any requirement of experience of the applicant in their respective fields of production?

A Yes, minimum of 3 years of experience is required in processing of ODOP produce for the group category (e.g. FPOs and SHGs).

Q 18. What will be the amount of subsidy provided under the scheme?

A ● Grant will be provided as credit-linked capital subsidy @35% of the eligible project cost with a maximum ceiling of Rs.10.0 lakh.

●For SHG members involved in food processing, seed Capital of Rs 40,000/- per member will be distributed as working capital and for the purchase of small tools

Q 19. Is there any initial investment required by the person applying for the scheme?

A Yes, the applicant should be willing to contribute 10% of the project cost as well as obtain bank loan.

Q 20. Is there any infrastructure required to avail of the benefits of the scheme?

A Yes, applicant should have their existing infrastructure/ work shed.

Q 21. Is Cost of land to be included in total project cost?

A ● No, cost of the land should not be included in the Project cost.

● Whereas, Cost of the ready built as well as long lease or rental workshed could be included in the project cost.

● Lease/Rent for Maximum Period of 3 years can be included in total project cost.

Q 22. Will the person who is having no land be eligible for availing of the benefits?

A No, at least the applicant should have to work shelter on lease for 3 years

Q 23. What types of common infrastructure to be funded under the scheme?

A ● Premises for assaying of agriculture produce, sorting, grading, warehouse and cold storage at the farm-gate;

●Common processing facility for processing of ODOP produce;

● Incubation Centre should involve one or more product lines, which could be utilized by smaller units on a hire basis for processing of their produce. The Incubation Centre may partly be used for training purpose. It should be run on commercial basis.

Q 24. Is there any criteria based on the type of Agri-produce/food products being processed in the proposed project for availing benefits for capital investment under PM FME scheme?

A Yes.

●Enterprises producing ODOP and non ODOP products are eligible for availing benefit under capital investment support. However, preference for the capital investment new units will be given to agri produce/food products listed under ODOP category.

● In Group Category (FPOs & SHGs), predominately those involved in processing of ODOP products are supported. However, in case of non ODOP product the support is provided to groups already processing those products and with adequate technical, financial and

entrepreneurial strength.

Q 25. Is there any provision for availing benefits for new units under PM FME scheme?

A. Yes, individuals and groups interested in ODOP products are eligible for benefits of new units under PM FME scheme.

Q 26. Is there any criteria based on the type of agri-produce/food products being processed in the proposed project for availing benefits for common infrastructure and marketing and branding under PM FME scheme?

A. Yes, support for common infrastructure and marketing and branding is for those involved in processing of ODOP products. However, in case of non ODOP product the support for marketing & branding will be provided.

Q 27. Which type of agri-produce/food products are covered under PM FME scheme for availing the benefits of this scheme?

A ● Perishable agri produce &cereal based product: Illustrative list of such products includes mango, potato, litchi, tomato, tapioca, kinnu, bhujia, petha, papad, pickle, millet based products, fisheries, poultry, meat as well as animal feed among others.

● Certain traditional and innovative products including waste to wealth products could be supported under the Scheme: Honey, minor forest products in tribal areas, traditional Indian herbal edible items like turmeric, amla, haldi, etc.

Q 28. What are the benefits under PM FME scheme for Food processing units involved in the processing of products other than ODOP?

A Existing units producing products other than ODOP agri-produce/food products are also eligible under the scheme.

Support to enterprise/FPOs/SHGs processing other products in such districts would only be for those already processing those products and with adequate technical, financial and entrepreneurial strength.

Q 29. What types of agri-produce/ food products involved under the scheme to avail benefits for the same?

A The agri-produce / food product which comes under ODOP approach will be selected on priority basis and other products will also be supported.

Q 30. How will small micro-enterprises, FPOs, SHGs, and producer cooperatives benefit under the scheme?

A This scheme will provide increased access to credit to existing micro food enterprises for technology up-gradation, support to FPOs, SHGs, producer cooperatives & cooperative societies along their entire value chain to enable microenterprises to avail common services, support for the transition of existing enterprises into formal framework for registration under the regulatory framework and compliance, Integration with organized supply chain by strengthening branding & marketing, Capacity building of entrepreneurs through technical knowledge, skill training and handholding support services.

Q 31. Is there any provision for training under the scheme?

A Yes, State level technical institutions will provide training support to selected enterprises/groups/clusters etc.

Q 32. How the training will be provided/mode of training?

A ● Online modules would be used for the general training applicable to all Units.

● Product specific training would be provided for the districts for ODOP using RSETI physical infrastructure to the extent possible;

● Training should be organized in short modules on a weekly basis using audio- visual support within the district so that the disturbance to the existing business operations is least.

Q 33. Who will be the person responsible for hand-holding support?

A Each district will have a resource person allocated for the hand-holding ground support to the applicants.

Q 34. Is there any resource center available at the village level?

A No, it will be available at district level

Q 35. How the technical support will be provided?

A Technical support will be provided in form of trainings, DPR preparation, up-gradation of units, getting necessary regulatory approvals, hygiene etc.

Q 36. Is there any provision for guarantee by the person applying under the scheme as loan security?

A No, but the applicant applying under the scheme should willing to contribute 10% of the total project cost.

Q 37. Will there be any on-site survey of the applicant by the resource person?

A Yes, resource person will verify the site of the applicant and prepare a proposal report for further approval

Q 38. How illiterate applicants involved in the production will avail of the benefits of the scheme?

A Resource person available at district level will assist them to avail the benefits of scheme

Q 39. What types of handholding support will be provided by the resource person?

A Resource person will assist in preparation of DPR, taking bank loan, support for obtaining necessary registration and licenses including food standards of FSSAI, Udyog Aadhar, GST etc.

Q 40. How the subsidy will be transferred to the beneficiary?

A. At the national level, a Nodal bank would be appointed for disbursement of subsidy to the banks and liaison with the banks.

Q-41 Is there any provision for offline/paper application under the scheme?

A No, only online application will be accepted.

1.2 Scope of Baking Industry in India

Bakery is largest of the food industry. India is the 2nd largest *wheat producing* and *biscuit producing* country in the world next only to China and USA, respectively. The present production of wheat in India is about 107.18 million tonnes indicating 3.46% growth rate as per Index mandi reports. The five major wheat producing states in India are U.P., Punjab, Haryana, Bihar and Himachal Pradesh. According to the latest report by IMARC Group, titled "**Indian Bakery Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2020-2025**", the Indian bakery market reached a value of around US$ 8 Billion in 2019.

Bakery industry today has an important place in the industrial map of the country. The Indian bakery market stood at a value of nearly USD 7.60 billion in 2020. The market is further estimated to grow at a CAGR of 8.5% between 2021 and 2026 to reach a value of USD 12.39 billion by 2026. The Indian bakery market is being supported by the thriving biscuits and cookies industry in the region (https://www.expertmarketresearch.com/reports/indian-bakery-market) . The bakery industry comprises mainly of bread, biscuits, cakes and pastries manufacturing units whereas bread and biscuit still covers 80% of total bakery products produced in the country. Bakery Industry comprises of several large and small scale organised as well as unorganised units. So, PM FME scheme will help to formalize the unorganised sector of bakery industry. Bakery Industry is mainly concentrated in the states of Maharashtra, West Bengal, Andhra Pradesh, Karnataka and Uttar Pradesh. The per capita consumption of bakery products is highest in Maharashtra followed by New Delhi and West Bengal.

As per the IMARC Bakery Market analysis report:

- Approximately 45% of bakery industry belongs to Organized segment
- Nutritionally enriched and brown breads segments is in high demand while white bread still remains the largest segment at 75%
- The market value is expected to reach a value of US$ 13.3 billion by 2025

Market Potential and Future trends of Bakery Industry

Bakery products have now become essential food items of vast majority of population in India due to urbanisation which is resulting in increased demand for convenient product at reasonable cost. With increase in the health awareness among the consumers, the demand for greater nutritional quality products is also increasing. The bakery products have become popular among all cross section of

populations irrespective of age group, and economic conditions. Bakery Products can be broadly categorized by its type and ingredients:

- **Segments by TYPE of Products:**

  Sliced bread, pav, burger buns, pizza base, exotic breads, cakes, biscuit etc.

- **Segments by INGREDIENTS of Products:**

  White bread, Brown bread, Fruit bread, Nutritional Bread etc.

Bakery products which include bread, rolls, cookies, pies, pastries, and muffins, are usually prepared from flour or meal derived from some form of grain and cooked by dry heat process , especially in some kind of oven. Under PM FME scheme, bakery products have been opted as ODOP in following four states and their several respective districts:

1. Punjab
2. Uttar Pradesh
3. Tripura
4. Karnataka

With the advanced aspiration for increased socialisation, the demand for more hang-out options is observed. This demand has powered the rise of newer café formats like bakery cafés, which, at the core, is a provider of baked food, with the beverage segment only. A wide range of baked products are available in market, encompassing such exotic variants as wheat, rye, five-grain, multigrain, cracked wheat, flute, baguettes and ciabatta, and other baked goodies like brioches, croissants, cookies, muffins, cakes, scones, strudels, brownies, pies and puffs. The bakery industry would enjoy more innovative ideas and concepts, and is expected to grow with the growing awareness and a flourishing economic environment. The increase in demand of bakery products and surplus wheat produced in the country can complement each other. Promotion of bakery industry under PM FME scheme will not only help country in economic development but will also help in the creation of more employment potential. To sum-up with the strengths, weaknesses and opportunities of Bakery Industry in India:

STRENGTHS:

1. Abundant raw material
2. Part of a bigger pie
3. Low Capital Requirements

WEAKNESS:

1. Large share of un-organized players
2. Dependence on one major raw material
3. Sensitive to commodity price fluctuations
4. Lack of Knowledge product technical specifications
5. Poor understanding of process technology and machinery
6. Fragmented Cold Chain Supply

OPPORTUNITIES:

1. E-Food Retailing in India
2. Growing Consumption of biscuits
3. Bakery potential in Rural India
4. Expanding attractiveness of coffee bars

Bakers also face a few challenges, such as, Government regulations; Demand-supply chain; Rising prices of flour, the major ingredient, and other raw materials such as oil, fat and eggs, and the price-sensitivity of the market.

Bakery Products Regulations as per FSSAI guideline

1. **Biscuits** including wafer biscuits shall be made from maida, vanaspati or refined edible oil or table butter or desi butter or margarine or ghee or their mixture containing any one or more of the following ingredients, namely:— Edible common salt, butter, milk powder, cereals and their products, cheese cocoa, coffee extract, edible desiccated coconut, dextrose, fruit and fruits products, dry fruit and nuts, egg, edible vegetable products, ginger, gluten groundnut flour, milk and milk products, honey, liquid glucose, malt products, edible oilseeds, flour and meals, spices and condiments, edible starches such as potato starch and edible flours, sugar and sugar products, invert sugar, jaggery, protein concentrates, oligofructose (max 15%) vinegar and other nutrients and vitamins: Provided that it may contain food additives specified in these regulations inclulding Appendix A: Provided further that it may contain artificial sweetener as provided in regulation 3.1.3 of these regulations and label declaration as provided in regulation 2.4.5 (24, 25, 26, 28 & 29) of Food Safety and Standards (Packaging and Labeling) Regulations, 2011. Provided also that it shall conform to following standards, namely: - (i) ash insoluble in dilute hydrochloric acid (on dry basis): shall not be more than 0.1 per cent (ii) acidity of extracted fat (as oleic acid):- not exceeding 1.5 per cent. It may contain Oligofructose (dietary fibres) upto 15%

maximum subject to label declaration under Regulation 2.4.5 (43) of Food Safety and Standards (Packaging and Labeling) Regulations, 2011.

2**. BREAD** whether sold as white bread or wheat bread or fancy or fruity bread or bun or masala bread or milk bread or of any other name, shall mean the product prepared from a mixture of wheat atta, maida, water, salt, yeast or other fermentive medium containing one or more of the following ingredients, namely:— Condensed milk, milk powder (whole or skimmed), whey, curd, gluten, sugar, gur or jaggery, khandsari, honey, liquid glucose, malt products, edible starches and flour, edible groundnut flour, edible soya flour, protein concentrates and isolates, vanaspati, margarine or refined edible oil of suitable type or butter or ghee or their mixture, albumin, lime water, lysine, vitamins, spices and condiments or their extracts, fruit and fruit product (Candied and crystallized or glazed), nuts, nut products , oligofructose (max 15%) and vinegar: Provided that it may also contain food additives specified in these regulations including Appendix A: Provided further that it may also contain artificial sweetener as provided in regulation 3.1.3 of this regulation and label declaration in Regulation 2.4.5 (24, 25, 26, 28 & 29) of Food Safety and Standards (Packaging and Labeling) Regulations, 2011. 370 THE GAZETTE OF INDIA: EXTRAORDINARY [PART III—SEC. 4] Provided also that it shall conform to the following standards, namely: — (a) alcoholic acidity (with 90 per cent alcohol) Shall be not more than equivalent of 7.5 ml. N NaOH per 100 g of dried substances. (b) ash insoluble in dilute HCL on dry weight basis — (i) bread except masala bread or fruit bread Not more than 0.1 per cent (ii) masala bread or fruit bread Not more than 0.2 per cent Provided also that it shall be free from dirt, insect and insect fragments, larvae, rodent hairs and added colouring matter except any permitted food colours present as a carry-over colour in accordance with the provision in regulation 3.1.17, in raw material used in the products. It may contain Oligo fructose (dietary fibres) upto 15% maximum subject to label declaration under labelling regulation 2.4.5 (43) of Food Safety and Standards (Packaging and Labelling) Regulations, 2011.

Advertising Standards Council of India (ASCI) has been cracking the whip on ads that use “immunity boosting" proposition for their products. ASCI has been taking proactive action against these companies, asking them to prove their claims with facts or withdraw the ads and tweak packaging. The body is also actively working with food industry regulators such as the Food Safety and Standards Authority of India, flagging misleading claims by food and beverage, dairy and restaurant businesses. Recently, after ASCI flagged a immuno booster claim by a bread brand Modern Foods on its packaging the company had to withdraw the product. It has also tagged FSSAI to verify a claim made by restaurant chain Biryani Blues about the immunity boosting impact of turmeric in its flagship dish in a print ad. FSSAI is also actively

updating the regulatory conditions for the food products with the nutritional claims. Trans-fats are considered to be the worst type of fats one can consume. A diet-laden with trans-fat increases the risk of heart diseases and decreases good cholesterol in the human body. The manufactured form of trans-fat, known as partially-hydrogenated oil, is found in a variety of food products, including baked goods, snacks, fried foods, creamers, and margarine. The apex food regulator-FSSAI has, in regulatory regard, issued an advisory for the FBOs. Stating "Food establishments like bakeries, sweet shops and other food outlets are encouraged to use healthier fat/oil options, thereby reducing the use of trans-fat content in the food. The food establishments which uses trans-fat-free fats/oil, and do not have industrial trans-fat more than 0.2g per 100g of the food, in compliance with the regulations on claims and advertisements can display the trans-fat-free logo in their outlets and on their food products."

1.3 Bakery Ingredients

Wheat and Wheat Flour:

Wheat is a grass and belongs to the family gramminae; genus *Triticum*; species *aestivum*. Rich in nutrients so, form a major part of the base of the food guide pyramid as established by USDA. Wheat is unique among the cereals in that its flour possesses the ability to form dough when mixed with water (Cotton and Ponte 1973). It provides bulk and structure to most of the bakery products, including breads, cakes, cookies, and pastries. The 'gluten' protein is responsible for this. Also has unique ability to retain the gas produced by biological or, chemical leavening. Thus, the wheat flour is responsible for the characteristic structure of bakery goods. Also contribute toughness, texture and test to the product. Wheat can be classified according to time of planting, color, and kernel hardness.

- **Time of planting, or season** classifications include spring wheat and winter wheat.
- **Classification by color** includes red-kernel wheat and white-kernel wheat.
- **Classification by kernel hardness** includes soft-kernel or hard-kernel.

INDIAN CLASSIFICATION

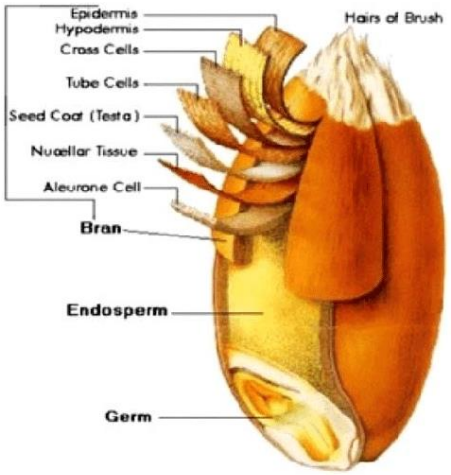
Three species of Wheat namely, (i) T. aestivum, (ii) T. durum and (iii) T. dicoccum are being cultivated in the india.

Soft Wheat: Soft, low protein (8-10%) wheat is used in cakes, pastries, biscuits and crackers because it produces finer textured flour.

Hard Wheat: Hard, high protein (11-12%) wheat is used in breads as it produces the coarse flour used in breads.

Durum wheat: a hard wheat very high in protein (>12%) is used in pasta and egg noodles. Durum wheat is also used for making semolina. Semolina is the granular flour used to make a variety of pasta products.

Structure of Wheat:



Wheat structure is majorly divided into below 3 segments:

1. Endosperm
2. Bran
3. Germ

1. Endosperm: About 83% of the kernel weight.
   Supply energy to the new plant emerging from germ. Consists starch granules embedded in a protein matrix. The protein matrix is made up of gluten forming proteins. The main non-starch polysaccharides are pentosans found in endosperm cell walls. The endosperm contains the greatest share of protein, carbohydrates and iron, as well as the major B-vitamins, such a as riboflavin, niacin, and thiamine. It is also a source of soluble fiber.
2. Bran: About 14.5% of the kernel weight. The BRAN is the hard-outer protective covering of the wheat kernel (pericarp) with aleurone layer form bran. The bran contains a small amount of protein, large quantities of the three major B-vitamins, trace minerals, and dietary fiber - primarily insoluble. It contains relatively large % of ash (inorganic minerals), fibre (cellulose), pentosans and proteins. Bran mostly removed during milling process. Mostly used in breakfast cereals and in fiber-enriched bakery goods, such as high fiber bread and muffins.
3. Germ: About 2.5% of the kernel weight. The germ is the embryo or sprouting section of the seed, i.e. it is the living portion of wheat kernel. Even in dry seed, germ is respiring. Contain high amount of lipid, so if left in flour during milling process, subject to rapid development of rancidity in flour. Hence, it is removed in the milling process when producing refined flour. The germ contains minimal quantities of high-quality protein and a greater share of B-complex vitamins and trace minerals. Part of germ (1%) can be recovered during milling, is stabilized and sold as an ingredient and remainder is found in mill feed and sold as animal feed.

Wheat Milling:

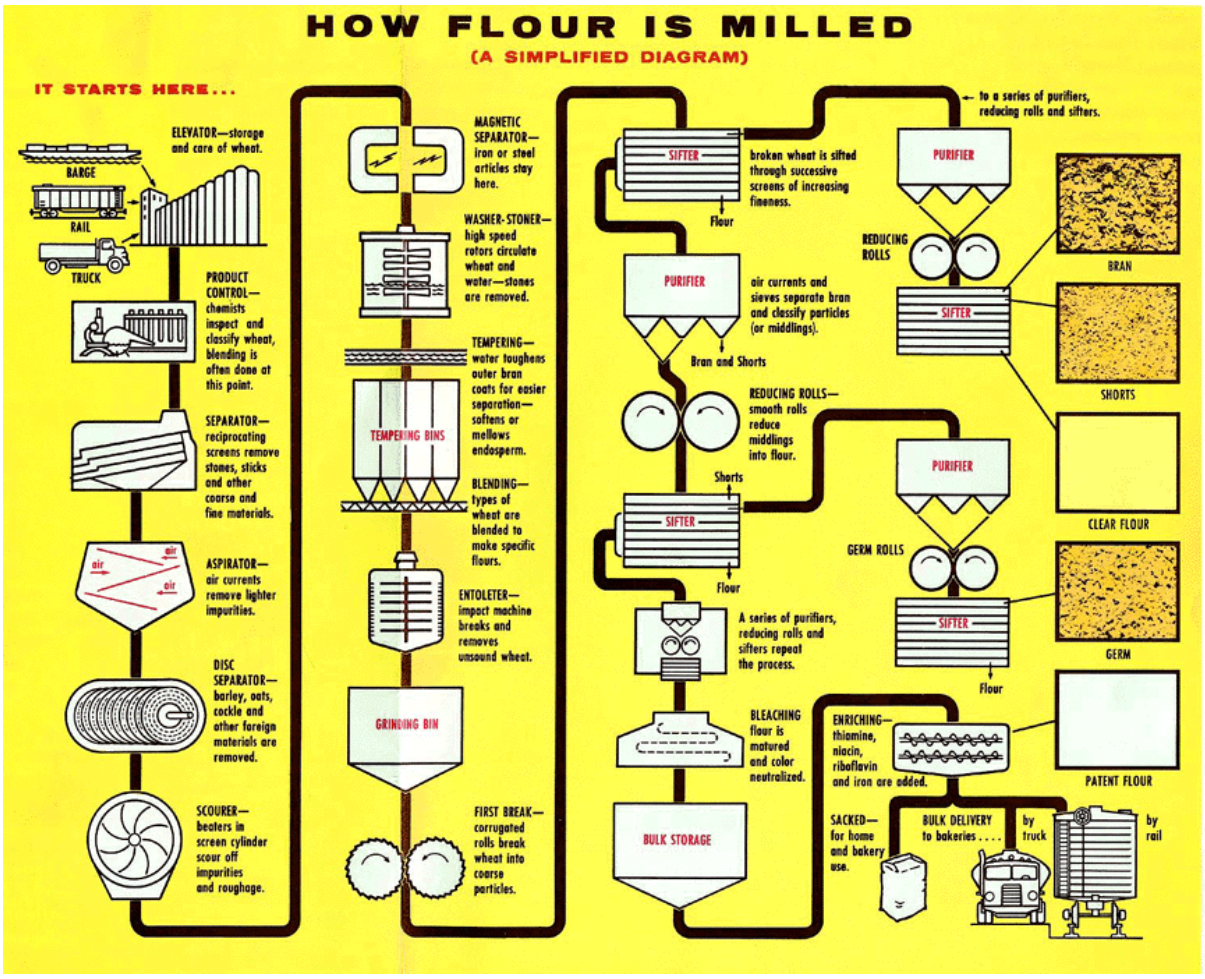


Fig 1: process of wheat milling (Source: North American miller association)

Process of Milling involves cleaning & separation of unwanted impurities, removing the Bran layer from the endosperm and to reduce the endosperm to flour. Bran deteriorates the quality of the flour and increases the colour & ash content of the flour.

Main steps involved are:

1. Product Control: Involve the inspection & classification of wheat as strong/medium/soft wheat based on origin, seasonal growth, color of the grain and protein content
2. Cleaning: Involve processes that eliminates metallic impurities, separates wheat from other seeds and grains and scours each kernel of wheat.
3. Tempering: Involve proper amount of water and allow rest for 8-24 hours to make the endosperm soft and mellowed and bran hard so that the separation of bran from the endosperm become easy. It also increases the milling efficiency.
4. Grinding: Involve the running action of two pair cast iron roller, the first pair is break roll that separate the bran from the endosperm and another pair called reduction rolls just after the break rolls to flatten the germ and bran and to reduce the size of endosperm particles.
5. Purifying: Involves the separation of bran particles by means of controlled air and at the same time separating and grading of coarser fractions by size and quality.

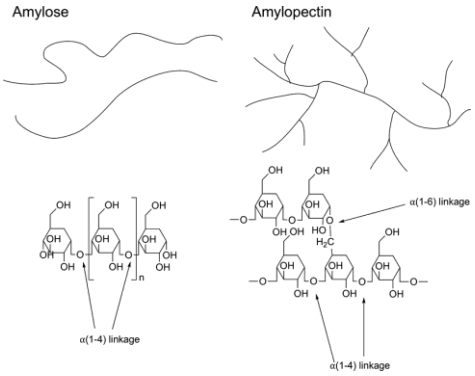
Wheat based Milling Products:

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

Wheat Flour Composition:

Starch: Energy store for grains (60 to 75% of the grain weight). Insoluble and high molecular weight. Influences degree of gelatinisation of foods (setting of cakes, gravy thickening, etc).

Divided into two parts:



A. Amylose: Linear polymer of α-1,4 linked α-D-glucose, (low degree of branching) Molecular weight: varies around 250 000 (1500 anhydroglucose units).

B. Amylopectin: Randomly branched polymer of α-D-glucose Molecular weight: about 100 millions 4-5% of α-1,6 glycosidic branches average unit chain contains only 20-25 glucose units

Protein: Dough Builder. Available around 8-14% in wheat flour depends on wheat quality soft or hard). Wheat protein is made up of 4 amino acids: Glutenin, Gliadin, Albumin and Globulin.

Glutenin and Gliadin make Gluten (85% of wheat protein) and plays major role in dough formation. These are water insoluble. Albumin and Globulin (15% of wheat protein) water soluble and non-dough forming.

Gluten:

Glutenin +	***Gliadin*** =	***Gluten***
-resilient	-gluppy	-has properties
-rubbery	-very cohesive	between gliadin and glutenin
-resistant to extension	-little resistance to extension	
-prone to rupture	-MW: 40-80 kDa	
-MW: millions of kDa		
Chain entanglement		

Non-Starch Polysaccharides:

Non-starch polysaccharides influence the physical properties of dough and the baking performance of flour. It is present as 2-3% of wheat flour and they interact with other flour components. NSP interact with gluten to make doughs more resistant to extension, thus decreasing their extensibility. The term, non-starch polysaccharides, encompasses a variety of polysaccharides that are composed of pentoses (monosaccharides containing five carbon atoms) and Non-starch polysaccharides affect flour quality hexoses (monosaccharides containing six carbon atoms). Some NSPs are water soluble and some are water insoluble.

Flour Quality Analysis:

A. **Moisture Content:** Essential first step for flour analysis. It Indicates quality of flour, eg. Lower moisture content of wheat flour will have lesser chances of spoilage during storage. Moisture content also used as indicator for profitability. Millers add more water before milling so they can get more profit by selling flour on weight basis.

B. **Ash Content:** Indicates mineral content of flour. It also indicates milling performance by calculating amount of bran content present in milled flour. White flour have lower ahs content and whole wheat flour has higher ash content dur to more bran.

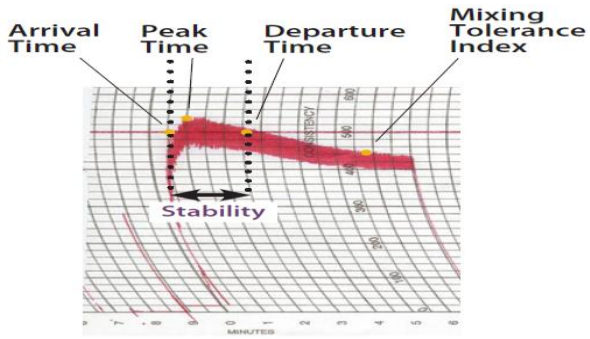
C. **Protein Content:** Most important specification for flour as it defines flour quality for final product. Water absorption and dough strength depends on protein content of flour. Low protein content (8-10%) is preferred for cookies, cakes whereas high protein flour goes for bread, crackers, tortilla products.

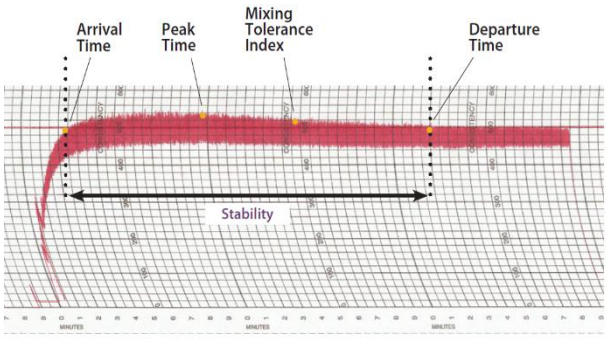
D. **Falling Number:** The FN of a flour is related to the amount and activity of cereal enzyme α-amylase, which is present in the wheat after harvesting. Wheat kernels with high moisture levels usually exhibit high levels of α-amylase. Too much enzyme activity gives lesser falling number which gives sticky dough and tough crumb structure whereas, too less enzymes activity gives higher falling number, tighter dough which leads to less volume and dry crumb structure. In India, acceptable falling number range is 250-280secs.

E. **Sedimentation:** The sedimentation test provides information on the protein quantity and the quality of ground wheat and flour samples. Positive correlations were observed between sedimentation volume and gluten strength or loaf volume attributes. The sedimentation test is used as a screening tool in wheat breeding as well as in milling applications.

F. **Gluten Analysis:** Gluten quality and quality is major indicator of flour characteristic. It is majored by instruments like Glutomatic or by washing dough ball in water which wash out starch and water-soluble protein. Remaining wet gluten gives gluten quantity and further wet gluten pass through centrifugal machine and strong gluten remains on sieve gives gluten quality. At the end gluten is dried and weighed to find our dry gluten % of flour.

G. **Farinograph:** Farinograph instrument is used to mix the dough which is attached with graph machine where the curve indicates absorption, arrival time, stability time, peak time, departure time, and mixing

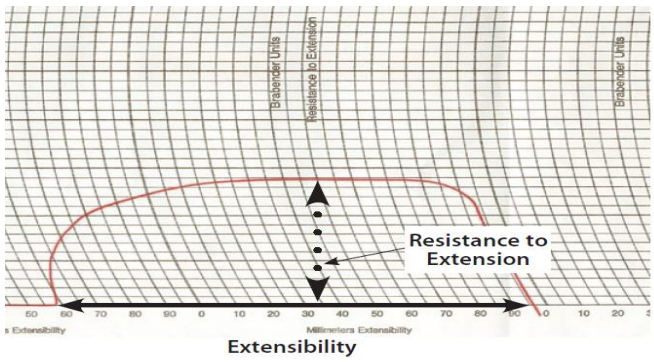


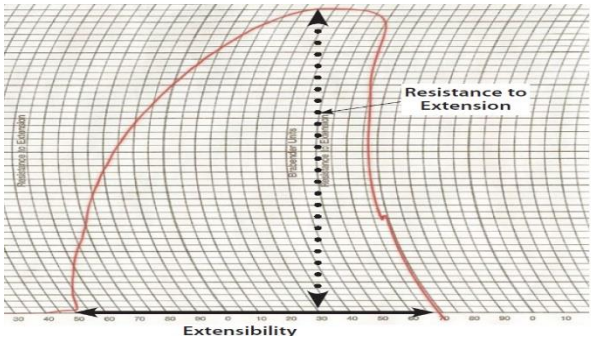


tolerance index. The results are also used to predict mixing requirements for dough development, tolerance to over-mixing, and dough consistency.

Weak Gluten Flour Strong Gluten Flour

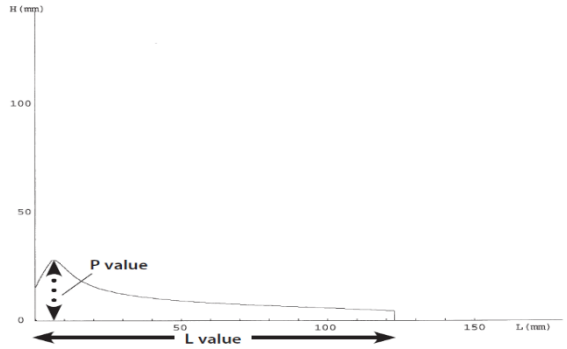
H. **Extensograph:** The extensograph determines the resistance and extensibility of a dough by measuring the force required to stretch the dough with a hook until it breaks. Extensograph results include resistance to extension, extensibility, and area under the curve. Results from the extensograph test are useful in determining the gluten strength and bread-making characteristics of flour.

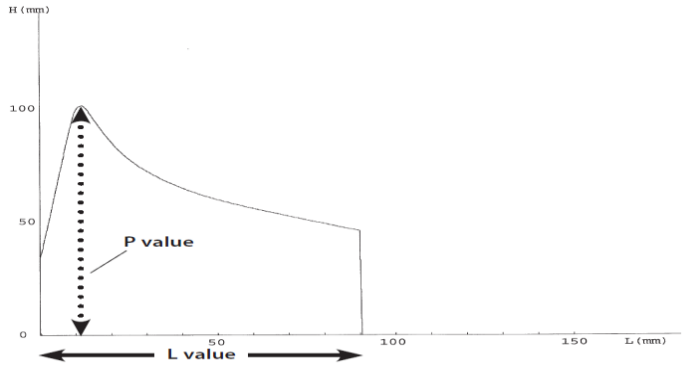




Weak Gluten Flour Strong Gluten Flour

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



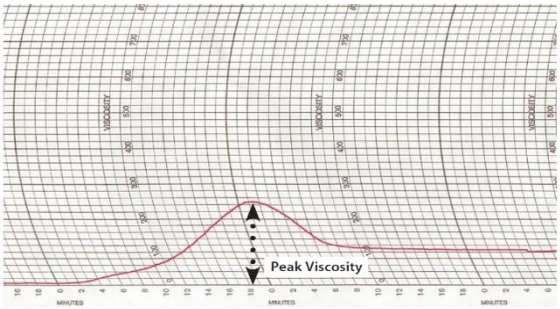


before breaking (L value). A bigger bubble requires more force and will have a greater area under the curve (W value).

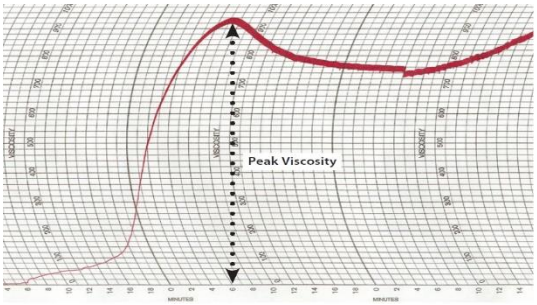
Weak Gluten Flour Strong Gluten Flour

J. **Amylograph:** The amylograph test measures flour starch properties and enzyme activity, which results from sprout damage (alpha amylase enzyme activity). Sprouting in wheat, as indicated by high enzyme activity, produces sticky dough that can cause problems during processing and results in products with poor color and weak texture. Both the amylograph and the rapid visco analyzer measure starch viscosity properties. Theamylograph is more commonly used throughout the world. The amylograph analyzes viscosity by measuring the resistance of a flour-and-water slurry to the stirring action of pins or paddles. When the slurry is heated, the starch granules swell and the slurry becomes a paste. A thicker slurry has more resistance to the pins during stirring and has a higher peak viscosity. Generally, a thicker slurry indicates less enzyme activity and makes better products.

Sprouted Wheat Flour



Sound Wheat Flour



Sweeteners:

History of sugar begins 500 B.C when it was discovered that sugar cane contains a sweet juice. It was soon cultivated and grown. Crude techniques were developed to concentrate the juice, through evaporation and boiling, and the resulting product was traded and became valuable. Before 500 B.C the only sweeteners available were honey and dried figs or dates. By about 1400 A.D. the product had been refined into crystals (Brown sugar). By 1800s sugar beet has been discovered that contains more sucrose than per kg than sugar cane, but its yield per acre is less. In mid 1950s a technique for producing a form of sugar syrup from corn starch was discovered. The resultant product is High fructose corn syrup. There are six types of sweeteners:

- Sugars
- Sugar Alcohols
- Natural Caloric Sweeteners
- Natural zero Calorie Sweeteners
- Modified Sugars
- Artificial Sweeteners

Sugars: These are carbohydrates and contain 4 calories per gram. Found Naturally in many foods including fruit, vegetables, cereals and milk. They can be harmful to teeth and tend to have a high glycemic index. Examples are Sucrose, Glucose, Dextrose, Fructose, Lactose, Maltose, Galactose.

Granulated sugar: is refined sucrose that has been crystallized. They differ in crystal size and commonly used.

Extra fine sugar also known as bar sugar due to its ability to dissolve quickly in cold liquids. It is ideal for cakes.

Powdered Sugar: is finer and dissolve quicker but it contains 3 per cent cornstarch to prevent the sugar from lumping. When powdered sugar is mixed in cold liquid the cornstarch will make liquid cloudy. It is available in different grades of fineness:4X,6X and 10 X(X indicates how fine the sugar is compared to standard granulated sugar, lower the number the finer the grain.)

Brown Sugar: Manufactured by spraying sugarcane molasses onto the beet or cane sugar.

Honey: Natural invert sugar (fructose)produced by bees from flower nectar that has been ingested and then deposited into beehive combs.

Lactose Milk Sugar: Lactose is sugar found in milk and milk powder. It can caramelize at a lower temperature than sugar, and it adds flavor and color (golden brown) to baked goods. Lactose is not fermentable by yeast bit it helps in browning.

Corn Syrup: Sweet syrup obtained from corn. It is resistant to crystallization and capable of retaining moisture.

Sugar Alcohol: Like sugars theses are carbohydrates and occur naturally in small amounts in plants and cereals. Don't cause tooth decay as they are carbohydrates, they should also provide 4 calories energy per gram. But the body is unable to fully metabolize them, and consequently they tend to have fewer available calories per gram. If taken in excess can cause cramps or bloating if taken in excess. Have low glycemic index. Sorbitol, is a sugar alcohol, which the human body metabolizes slowly. It can be obtained by reduction of glucose, changing the aldehyde group to a hydroxyl group. Most sorbitol is made from corn syrup, but it is also found in apples, pears, peaches, and prunes.

Natural Caloric Sweeteners: They are oldest known sweeteners and include honey and maple syrup. They contain sugar but also other nutritive qualities. They tend to have a somewhat lower glycemic index than sugar. They are harmful to teeth. Examples are Honey, Maple syrup.

Natural Zero Calorie Sweeteners: These are not carbohydrates and contain little or no calories. Better alternative to artificial sweeteners its has zero glycemic index and are harmless to teeth. Examples are Stevia, Brazzein, Monellin etc.

Modified Sugars: These are typically sugars produced by converting starch using enzymes. Have high glycemic index and can be harmful to teeth.

Artificial Sweeteners: They have zero glycemic index and are harmless to teeth. Examples are Aspartame, Sucralose, Saccharin, Acesulfame K, Cyclamate.

Saccharin: 200-700 times sweeter than table sugar.

Aspartame: 160-220 times sweeter than table sugar

Acesulfame Potassium: used in bakery because it does not break down when heated.200 times sweeter than table sugar. Sucralose: made from sucrose.

Functionality of Sweeteners in Bakery product:

- Sweetness and Flavour
- Browning and colour
- Creaming and foaming agent

- Shelf life improvement by holding water
- Texturizer and bulking agent

Shortening:

Fats and oils occur naturally in a wide range of sources. The terms "fats" and "oils" are often used interchangeably. Simply put, the difference between a fat and an oil is a matter of consistency; a fat is solid, and an oil is liquid at room temperature. Fats and oils come under three basic food we consume (carbohydrates, proteins and fats), belong to a group of biological substances called lipids. A lipid is a biological macromolecule made up of carbon, hydrogen and oxygen mainly, it is insoluble in water and soluble in alcohol or, hexane. Lipids in foods exhibit unique physical & chemical properties. Their Composition, Crystalline Structure, Melting Properties, & Ability to Associate with Water & Other Non-lipid Molecules are especially important to their physical properties in foods. During their processing, storage & handling of foods, lipids undergo complex chemical changes & react with other food constituents, producing numerous compounds both desirable & deleterious to food quality. Fats are esters of aliphatic carboxylic acids. The molecular structure of fat is relatively simple. Fat molecules are constructed from ***one molecule of glycerol*** and ***three fatty acid molecules***. Therefore, fats are also called triglycerides.

Functions of Shortening:

- **Tenderization:** major function of an oil or fat.
- **Lubrication:** Lubrication is the function of the oil fraction in a fat, oil helps to avoid sticking of the dough to the baking surface. Lubrication is also the main function of oil in laminated products.
- **Aeration:** solid fats provide aeration primarily due to the crystal structure. The leavening gas entrapped in the air cells of fat and increase the volume of the bakery products during baking.
- **Eating quality:** Depending upon the type and quantity of shortening used, the finished product can be soft, tender, brittle, hard or chewy. Generally, higher the shortening, shorter / tender will be the finished product.
- **Heat transfer:** The major use of cooking oil is in frying, where it functions as a heat transfer medium and contributes flavor and texture to foods.

Leavening Agents:

To Leaven" means "to lighten". Leavening" defined as a "Raising" action which aerates the dough / batter during mixing / baking, thus providing greater volume to the resultant product and lighten the same. "the production or incorporation of gases in a baked product to increase volume and to produce shape and texture". Baked products need to have a light porous texture to be of acceptable quality and likeable palatability. Without leavening, the baked products will lack the eating pleasure, enjoyment and digestibility and will be dense and flat with inadequate distribution of moisture.

Classification of Leavening Agents:

A. Common Leavening Agents: Air and Steam:

By mechanical means (creaming and Foaming during mixing), are incorporates in batter. Degree of air incorporation depends on: Type & characteristic of shortening

- Particle size of sugar
- Temperature
- Creaming time
- Type of mixer &
- Mixing speed

When water turns to steam, it expands to 1,100 times its original volume. Because all baked products contain some moisture, steam is an important leavening agent. Timing of the release of the steam is vital and needs to be controlled through temperature controls. Steam, generated after the product is set, does not contribute to leavening and gets dissipated into the oven atmosphere.

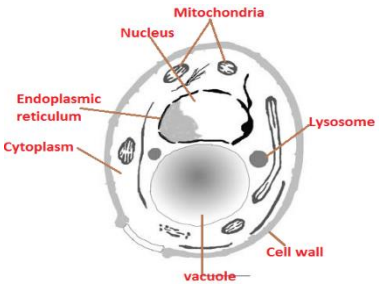
B. Biological Leavening Agent: Yeast:

A microscopic, unicellular plant named "fungi" and the species is Saccharomyces cerevisae. Yeast do the leavening by fermentation action. Liberating carbon dioxide gas in the dough by means of yeast action. Yeast contributes flavor in addition to leavening action. Yeast is the leavening agent in breads, dinner rolls, Danish pastries, and similar products. ***Fermentation*** is the process by which yeast acts on sugars and changes them into carbon dioxide gas and alcohol. CO_2 gas produces the leavening action in yeast products. The alcohol evaporates completely during and immediately after baking.

The following formula describes this reaction in chemical terms:

$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$

Simple sugar carbon dioxide alcohol



The structure of yeast consist of cell wall, cytoplasm and vacuole. It requires food, moisture and temperate climate for its growth and reproduction. The multiplication of yeast occurs by budding.

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

- **Invertase:** convert sucrose into dextrose and fructose.
- **Maltase:** convert maltose into dextrose
- **Zymase:** convert dextrose into CO2, alcohol. And other substances which give the flavor to the product.
- **Protease:** mellow the flour protein and give better searchability to acquire volume and form structure.

When it is combined with the proper food (**flour/sugar**), liquid and warm temperature, yeast produces carbon dioxide, expands and grows. This process causes the dough to expand and rise.Fermentable sugar in bread dough comes from two sources:

- It is added to the dough by the baker.
- It is produced from flour by enzymes that break down the wheat starch into sugar.

Here the term fermentable sugar is used, because some of the sugar present in food (ex. Lactose present in milk) cannot be fermented by *Saccharomyces cerevisae*. That means lactose cannot be broken by yeast into CO2 and alcohol and so, it does not participate in leavening action.

Factor Affecting Yeast Activity: There are foloowing factors that affects the yeast activity

- Water availability
- Temperature
- Oil/fat: slows down the fermenting action as Oil / Fat forms a protective layer between Yeast and the yeast food.
- pH: slows the fermenting action of yeast. Ideal pH range is 4.5 - 4.8.
- Amount and Types of yeast

While deciding quantity of yeast in any formula, following points should be remembered:

- Salt has a controlling effect, so in case if higher amount of salt is used in a dough, yeast quantity should also be increased. Salt also tighten the gluten strand.
- If sugar content is increased in a formula, yeast content should also be increased.
- The same occur with the fat content because fat exert a dead weight on the gluten strand.
- In some bread, for flavor development, doughs are required to be fermented more prolonged time. In such doughs, yeast content should be reduced.
- Weather also has a stimulating effect on yeast requirement. In summer, less yeast is required and in winter more yeast is required.

In general, in a normal straight dough formula, the amount of yeast should be 2-3 %.

Forms of Yeast:

- **Compressed yeast:** also called fresh yeast. It is moist and perishable and is preferred by professional bakers.
- **Active dry yeast** is a dry, granular form of yeast. It must be rehydrated in 4 times its weight of warm water [about 110°F (43°C)] before use.
- **Instant active dry yeast** is also a dry granular form of yeast, but it does not have to be dissolved in water before use. Has higher % of live cells per unit volume.

C. Chemical Leavening Agent:

These chemicals release gases produced by chemical reactions. Chemical Leavening is employed wherever Fermentation is not desirable. Carbon dioxide is produced faster by chemical reaction than by yeast fermentation and hence the products could be baked immediately after the dough/batter preparation. Examples of such chemicals are:
Baking Soda, Baking Powder and Ammonium bicarbonate.

Baking Soda: Most widely used CO2 carrier in the baking industry. It is low in cost, high in purity, easy to handle, and leaves no after taste. Chemically known as sodium bicarbonate "NaHCO3". Baking Soda will liberate carbon dioxide, a leavening gas, when heated or, mixed with an acid. When react with acid, it gives H2CO3 that break down into CO2 and H2O. Since, Na2CO3 is formed, the resultant products will be alkaline and may have a bitter, soapy after taste. Hence, it is preferable to

use Sodium bicarbonate in combination with an acidulant (leavening acid) wherever required (ACID-BASE SYSTEM). Some of the acid ingredients used with soda are: Sour Milk, Honey, Molasses, Invert sugar, Lemon juice, Butter Milk. Now it is not used, as sometimes it destroys acids of food including Vit. C and make it unavailable for the body.

- **Baking Powder:** Mixture of baking soda (CO2 carrier), one or more leavening acids (acidulants), and a filler (Separating agents). Acidulants are selected primarily on the basis of reactivity. The quantity of the acidulant to be used in a system primarily depends on the neutralizing value , rate of reaction and on the pH requirement of the product. Higher the NV, Lesser will be the quantity of Leavening acid required and vice versa. Rate of reaction is the amount of CO2, in percent, released from a defined amount of Sodium Bicarbonate. Depending on leavening acid, it may be single acting, or, double acting baking powder. Separating agents or, filler like starch meals, flours & calcium carbonate ($CaCO_3$) are used in Baking powder. A filler in baking powder is necessary for several reasons. The most important of which are the following:
    - To keep the soda particles and acid particles from intimate contact and thereby minimizing the possibility of premature action.
    - To act as an absorptive medium for free moisture incorporated into the powder during manufacture or assimilated during storage.
    - To facilitate handling and measuring in actual use. Pure white, re-dried corn starch meets all the requirements of a good filler and is the one usually used.

Ammonium bicarbonate:

$[NH_4HCO_3 \rightarrow NH_3 + CO_2 + H_2O]$

These molecules break down into the gases ammonia, carbon dioxide and (water) steam when heated to 60°C or higher. The gases lift the dough or batter (which has air bubbles in it through creaming) before the batter is set as they rise towards the surface of the cookie. As the dough sets up, the bubbles remain but the ammonia, carbon dioxide and steam are dispersed. Only heat and moisture are necessary for it to work. No acids are needed.

Functionality of Leavening Agents:

Leavening agents perform a lot more functions in Bakery products apart from raising the product as below:

- **Grain**: Grain refers to the cell wall thickness and cell size, shape and uniformity of a cookie/cracker. Air and leavening gas, incorporated during mixing of the dough and creaming of sugar & fat, have a major effect on the grain, especially in cookies.
- **Texture**: The tenderness/hardness of the baked product is referred to as 'Texture '.
- **Spread / height**: Leavening agents impart spread as well as height to a baked product, but, as the level of leavening is increased, the product tends to spread more and lose height.
- **Surface cracks:** Surface cracks are a direct result of "spread" and are formed when release of CO_2 delayed from baking soda during the baking process.
- **Color, flavor & pH:** Non-enzymatic browning (Maillard reaction) is accelerated at alkaline pH and is retarded at acid pH. Since Sodium Bicarbonate leaves Sodium bicarbonate, post-baking,

the product pH is likely to be alkaline unless it is neutralized by the required quantities of acidulants.

Egg:

Eggs and egg products constitute important ingredient used by bakers and is the most versatile ingredient. No staple food excels in so many supporting roles: thickener, emulsifier, leavener, and structural foundation.
Egg is composed of three parts. They are as follows:

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

When the egg is freshly laid, the shell is filled. The air cell is formed by contraction of the contents during cooling and by the loss of moisture. A high-quality egg has only a small air cell. The yolk is well-centered in the albumen (due to two, twisted, whitish cord-like objects known as chalazae) and is surrounded by the vitelline membrane, which is colorless. The germinal disc, where fertilization takes place, is attached to the yolk.
The average chemical composition of egg is as follows:

Yolk: more solid part, contains most of the fatty material in a emulsified state. The approximate amount of lecithin fat in yolk is 7-10 % of total fat content. Yolks are used for improved creaming, greater volume etc.

Whites: are either firm or, fluid in nature. The whites closed to the yolk are firm, while closer to shell is fluid. In general, whites are fibrous in nature, they tend to gel or hold together.
Eggs are especially valuable as a source of protein. In fact, egg protein is used as the standard against which the quality of other food proteins is measured. One egg contains about 6 to 7 grams of protein.

Eggs also contain vitamin A, the B vitamins (thiamin, riboflavin, and niacin), and vitamin D.
Eggs also contain an abundant supply of minerals, such as iron and phosphorus that are essential for building and maintaining strong, healthy bodies. But eggs are low in calcium (it is in the shell), and contain little or no vitamin C. An egg provides good nutrition and contains only about 80 calories. So, Individuals on weight-reducing programs find eggs beneficial.
Eggs are commercially available in the form of **fresh eggs, liquid eggs, frozen eggs and dried eggs**. Separated whites and yolk are also supplied in frozen and dried forms.

- **Fresh eggs** refers to the “egg still in its shell”.
- **Liquid egg** refers to the “eggs that have recently been broken or, separated from the shell and placed in can”. They are usually preserved by freezing.
- **Frozen eggs** are prepared from spring laid egg. The eggs are candled, broken, stained, thoroughly mixed, and placed in can. Then quick frozen at -10 to -15-degree F and may be stored at 0 degree F for longer periods without spoiling.
- **Dried eggs** are prepared by spray drying of either yolk or, white or, whole egg. They require no refrigeration and are concentrated, making them ideal for the production and packaging of mixes. For

the reconstitution of dried egg, it must allow to stand for the enough period for complete absorption. These eggs should be stirred periodically to avoid lumping.

Functionality of Eggs in bakery product:

- Leavening
- Form emulsions (lecithin present in egg yolk acts as an emulsifier)
- Build structure and additional stability
- Tenderize
- Add moisture and nutritive value
- Improve flavor and add color (the yolk of the egg provides desirable yellow color which gives the cake a rich appearance.
- Shortening (egg yolk contains fat, that has shortening action)

Salt:

The mere word "salt" in ordinary language refers to one particular salt, namely sodium chloride (NaCl), which is the common salt universally used by everyone as a food in order to supply the body tissues and fluids with the salt which they require. This is the "salt" which is used in bakery products, salted butter, salted meats, and a multitude of other foods as well as for seasoning or flavoring in connection with practically every meal.

Functionality of Salt:

- **Flavor Enhancer:** Salt is used to flavor bread and to enhance the natural flavors of the other ingredients. Bread from which salt has been omitted is insipid and flat in taste and flavor.
- **Effect on Dough Fermentation:** Salt is very important ingredient in leavened bread formulas using yeast because it is used to partially control the growth of yeast. Using the enough salt will prevent the growth of undesirable bacteria and "wild" yeasts and the development of any excessive acidity in the dough which would weaken the gluten and result in a coarse dark loaf of poor flavor. This also helps prevent premature staling and off- flavors for the finished product.
- **Tightening Effect on Gluten, Texture and Grain of Product:** Salt strengthens and tightens the gluten structure, which may be due in part to its inhibitory effect on proteolytic enzymes or more direct interaction of the salt with flour proteins. The additional firmness imparted to the gluten by the salt, enables it to hold water and the gas, carbon dioxide, more efficiently and to expand nicely without tearing. This results in a finer grained loaf of superior texture.
- While salt has no direct bleaching effect on bread, the fine grain and thin cell walls produced give the crumb of the loaf a whiter appearance.
- **Effect on Crust Color:** Salt influence crust color by these ways; It lowers the caramelization temperature of the sugar thus improve the crust color. As salt control the fermentation thus lessen the destruction of sugar in the dough, salt indirectly assists in the promotion of a deeper crust color. Slowing down fermentation rate means that less sugars are metabolized into acids. The result is that the pH of the dough will be higher. A higher pH will speed up the maillard reaction so, the crust color will be darker.

- **Effect on Shelf Life of Product: S**alt is hygroscopic in nature that means it hold or, absorb water from the surrounding. By this way, Salt helps to keep bakery products fresh and keeps it moist for a longer time.
- Certain cakes have more sugar in the formula, so salt helps to cut down the excessive sweetness.

Water:

Water is an essential baking ingredient,
the unique physical and chemical properties of H2O are closely tied with other ingredients. Water interacts with various components/ bakery ingredients. These interactions mainly depend on temperature and particle size. In flour, water interacts with Starch, protein and NSP and form dough, batter. Starch takes almost same amount of water as its weight, gluten takes 1.5-2 times water of its own weight.
NSP can absorb upto 10times water of its weight. Yeast consist of single-cell microorganisms. Water helps them convert sugar into carbon dioxide and alcohols in anaerobic condition. Other leavening agents release CO2 when mixed with water during mixing.

Functionality of Water:

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

Emulsifiers:

Emulsifiers are molecules that have two different ends: A hydrophilic end (water-loving) that forms chemical bonds with water but not with oils because it is polar or charged. A hydrophobic end (water-hating) that forms chemical bonds with oils but not with water because it is non-polar. Although all surfactants are amphiphilic, they have different degrees of hydrophobic (lipophilic) and hydrophilic character. This can be expressed as the hydrophilic/lipophilic balance, or HLB. An HLB scale has been developed, which goes from 1 to 20. Surfactants with a low HLB (3–6) have more hydrophobic or lipophilic character. These would be used to form a w/o emulsion. E.g. glycerol monostearate. Surfactants with a high HLB (8–18) have more hydrophilic character and form w/o emulsions. E.g. SSL.

Functionality of Emulsifiers:

- Emulsifiers are usually applied in the baking industry as dough strengtheners (such as sodium stearoyl-2-lactylate and diacetyl tartaric acid esters of monodiglycerides) and crumb softeners (for example monoacylglycerols and glycerol monostearate).
- They give strength to dough due to the complex formation with gluten proteins. The emulsifier may bind to the protein hydrophobic surface promoting aggregation of gluten proteins in dough.
- A strong protein network results in better texture and increased volume of bread.
- Inhibit firming of crumb, associated with staling Their effect on retardation of baked goods has been proposed to result from their interaction with starch retarding the retrogradation process, and their blocking of moisture migration between gluten and starch which prevents starch from taking up water.
- Sodium stearoyl-2-lactylate (SSL) is an anionic oil-in-water emulsifier that is used to improve the quality of bread. This emulsifier improves mixing tolerance and resistance of the dough to collapse when added to dough. Concerning the final product, this substance improves loaf volume and endows it with resilient texture, fine grain, and slicing properties.
- DATEM used as dough strengtheners. Levels of use are usually up to 0.3% flour weight in a variety of bread and fermented products. When added to dough, they improve mixing tolerance, gas retention, resistance of the dough to collapse, improves loaf volume.
- Distilled Mono Glycerides are the most widely used fat-based emulsifiers in bread and other food systems. These substances can be applied to delay staling and as crumb softeners in bakery products.

Enzymes:

Enzymes are protein. They are substrate specific and highly sensitive to temperature and pH.
Each enzyme has specific role towards its substrate. There are two scenarios regarding the use of enzymes, either the enzymes are used to convert the raw material into the main product, or the enzymes are used as additives to alter a functional characteristic of the product.

Enzymes Functionality in Baking:

Amylase: Amylases provide the key to gas production in all yeast raised bakery products. Amylases act as catalysts in the conversion of starch to fermentable sugars. Amylases contribute to the reduced viscosity of the dough/batter due to the cleavage of the glucose chains. Amylases contribute to the formation of maltose, dextrin & oligosaccharides of various chain-lengths. Amylases help in delaying the staling of Bread during storage and are widely used in Bread production for their contribution to antistaling & anti-firming of Bread. Amylase action is important during proofing stages of bread production, at which stage; damaged starch is converted into maltose & dextrins, thus providing the improved crust color to the finished product.

Cellulase: To break down cellulose, cellulases are needed and they do not break down starch. Pentosans are polysaccharides comprised predominantly of the fivecarbon sugars xylose and arabinose. While they are present in wheat flour in very small quantities, about 2 to 3 percent, they account for as much as one-quarter of the water absorption of dough made from wheat flour. This increases the viscosity of the dough and negatively affects loaf volume. Pentosanases cleave the polysaccharide chains thereby decreasing viscosity and improving loaf volume.

Proteases: Mixing times can be reduced by 25% under proper conditions of temperature, pH and flour strength. Pliable and extensible dough is achieved by the addition of Proteases. Proteases aid in improved sheeting and decreased "Buckiness"(dough tightness). Optimum addition of proteases ensures improved gas retention of the dough as the dough becomes more extensible. The protease-treated dough spreads rapidly and fills the cup evenly (especially useful in Buns & Rolls). The mellowing effect imparted to the dough by the addition of proteases help in achieving better crumb grain & texture, better symmetry, improved softness and improved shelf life to the finished product. The free amino acids generated take part in Maillard reaction providing improved crust color and better flavor of the finished product through production of melanins.

Lipase: Formation of emulsifier during dough mixing. Complexing with gluten proteins. Stabilization of air/water interface. Strengthening of the dough resulting in increased volume. Improves tolerance to processing variations and raw materials. Improves crumb structure. Whitening effect due to better reflection of light.

Flavoring and Coloring Agent:

Flavours cannot be considered a truly basic ingredient in bakery products but are important in producing the most desirable products. Flavouring materials consist of:

- Extracts or essences
- Emulsions
- Aromas
- Spices

The flavours used to make extracts and essences are the extracted essential oils from fruits, herbs, and vegetables, or an imitation of the same. Many fruit flavours are obtained from the natural parts (e.g., rind of lemons and oranges or the exterior fruit pulp of apricots and peaches). In some cases, artificial flavour is added to enhance the taste, and artificial colouring may be added for eye appeal. The flavours are sometimes encapsulated in corn syrup and emulsifiers. They may also be coated with gum to preserve the flavour compounds and give longer shelf life to the product. Some of the most popular essences are compounded from both natural and artificial sources. These essences have the true taste of the natural flavours. Aromas are flavours that have an oil extract base. They are usually much more expensive than alcoholic extracts but purer and finer in their aromatic composition. Aromas are used for flavouring delicate creams, sauces, and ice creams. Emulsions are homogenized mixtures of aromatic oils and water plus a stabilizing agent (e.g., vegetable gum). Emulsions are more concentrated than extracts and are less susceptible to losing their flavour in the oven. They can therefore be used more sparingly.

Natural colors are food additives derived from natural sources and are used to dye foods and beverages. They come from a variety of sources, such as fruits, vegetables, seeds, leaves and minerals. Artificial colors are food additives used to provide or enhance characteristic colors in food products. They are available in liquid, gel, paste and powder forms. Functionality of flavouring and coloring Agents in Baking are:

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

Improvers:

To enhance bakery products quality (texture, appeal, eating attributes) various functional ingredients can be added with basic ingredients. This includes addition of emulsifiers, enzymes, soya flour, gluten, acids, preservatives etc. Improvers can be added directly with premixes or can be added during mixing. Every improver has specific role to play. E.g. to improve the volume, and texture of bread, combination of basic enzymes (amylase, xylanase along with emulsifiers can be used. Some components of improvers are:

- Enzymes and Emulsifiers (discussed above)
- Ascorbic Acid: chemical oxidizing agent that helps to strengthen the gluten network and ultimately to give better stability during fermentation and provide high volume bread.
- Soya Flour: Soya flour gives whiteness to crumb due to oxidative property.
- Gluten: Additional vital wheat gluten can be added to weak flour to strengthen the dough so it can withstand fermentation process and can get high volume product.
- Preservatives: Calcium Propionate is generally added in flour to reduce microbial contamination and in cakes potassium sorbate is been commonly used.

2. Production of Bakery and Confectionery products

2.1 Production of bread, bun, cake, cookies, crackers and Frozen bakery products

Introduction: Bread

Bakery is traditional products and occupy an important place in food processing industry. Bakery products are become a common item of consumption among all classes of people. The bakery segment in India can be classified into the three broad segments of bread, biscuits and cakes. Today, bakery is no longer restricted to bread, biscuits, cakes and pastries as it was traditionally known and now classified in terms of state and art technology. Other bakery products which are becoming popular now a days are pastries, danish pastries, croissants, rusk, pizzas, pancake, crisp bread, bread Sticks, kulchas, crackers, garlic bread, fruit bread, focaccia, buns and Pav, ciabatta, French baguette and rye Bread etc.

Bread is a staple food prepared by baking dough of flour and water. The aim of the bread making process is quite simple: namely to convert wheat flour and other ingredients into a light, aerated and palatable food. Bread is probably the oldest 'processed' food. Bread is the formation of a cohesive mass of dough in which flour has been wetted (hydrated) and subjected to the energy of mixing. This cohesive mass is commonly known by bakers as 'gluten' and once it has formed into a dough it has the ability to trap gases during resting (fermentation and proof) and baking and this allows the mass to expand to become a softer, lighter and even more palatable food after the final heat processing. Bread can be classified by its type and ingredient and these are:

- Sliced bread
- Pav & Bun
- Rusk
- Burgers
- White bread
- Brown bread
- fruit based bread
- Nutritional Bread

Basics Ingredient and their function

The essential ingredients for making bread are Refine wheat flour, yeast, water, salt and other ingredients like sugar, soy flour, oil, gluten, bread improver etc has been use for improving the value of product in terms of sensory and shelf life of product. The ingredients used in bread production and their function are shown in table 1.

Table 1: Function of ingredient for bread

Refine wheat flour	Refine wheat Flour helps to build the structure, it is unique among other cereal flours because when it mixed with water, the insoluble protein (glutenin and gliadin) converts into gluten and form elastic dough and helps to holding and expanding with leavening gases.

Water	Water helps to formation of smooth and uniform dough. It helps to formation of gluten and crust formation during baking.
Yeast	Yeast helps in dough to rise with formation of a network of bubbles entrapped in the gluten matrix. During process it helps to production of alcohals and acids that contributes to the aroma and flavour.
Salt	Salt provides taste to the bread and toughens the gluten and controls the fermentation process.
Sugar	Sugar acts as s yeast food, provides sweetens to the bread and contributes the colour of crust.
Fats/oils	Fat/oils helps to improve the machineability, physical characteristics of the dough and the final bread.
Enzymes	Amylase helps in delaying staling of bread
Improvers	Bread improvers like potassium bromate gives stability to the dough and improved volume of bread.
Preservatives	Preservative like calcium propionate & potassium sorbate help delay the microbial infestation

Formulation & method of bread making

Baking is an exact science that requires precise measuring and accuracy. Accuracy is crucial in baking because most baked products are made from the same basic ingredients: flour, liquid, fat, sugar, salt etc. the difference between baked products are often the proportion of each ingredients in the formula. If the proportions are off, you will end up with a different product or an unacceptable product. The bakers' percentage allows you to change the yield of a formula without changing the quality of final product. A bakers' percentage means that each ingredients is a certain percentage of the weight of the total flour in the formula. Convert the following recipe into bakers' percentage and formula percent

Ingredient	**Weight of ingredient**	**Bakers' Percentage**	**Formula percentage**
Flour	**500g**	**?**	**?**
Water	**300g**	**?**	**?**
Salt	**10g**	**?**	**?**
Yeast	**5g**	**?**	**?**

Solution:

Bakers' Percentage = $\frac{Wt\ of\ ingredient}{Total\ wt.of\ flour} \times 100$

Formula percentage = $\frac{Wt\ of\ ingredient}{Total\ wt\ of\ ingredient} \times 100$

There are three different method for bread making and their difference is shown in table 2.

1. Long Fermentation process: This is traditional method for bread making, In this process long fermentation takes place to develop the dough. The methods used in this process are:

- Straight dough method
- No time dough
- Sponge & Dough Method
- Delayed salt method

2. Mechanical Dough development process: In this process a very short time used for intense mechanical mixing to developed the dough. This process achieved by a special type of mixer.

- Chorleywood bread process
- Do-Maker process

3. Activated dough development: This process used the Enzymes, oxidizing agents, reducing agents and other additives to chemically develop the dough in a very short time.

Table 2: Bread making methods

Method	Process
Straight dough	All the ingredients are mixed as per formulation and the dough fermented as per time.
Delayed salt method	All the ingredient except salt, fat, emulsifier, preservatives are mixed to dough and after desired fermentation hours salt, fat, emulsifier, preservatives are added to the mix and mixed to the desired consistency
No time dough	All the ingredients are mixed as per formulation in one stage. The yeast quantity required for this process is much higher than the other methods. The dough temperature slightly higher than the straight dough method
Sponge & dough method	This method employs the preparation of SPONGE – essentially part of flour(50%), yeast and Sugar(part) along with dough improver is mixed in mixer and kept for fermentation for 45 minutes in a fermentation room (27 degree celcius C/ 75% RH) . The sponge thus produced is taken back to the mixer after the fermentation and mixed with remaining ingredient and water to get a uniform elastic dough.
Do-Maker bread process	This process is to reduce the fermentation time and achieve the desired dough quality by mechanical development of the dough using DO-Maker continuous mixer.
Chorleywood bread process	This process is developed by the Flour Milling and Baking Research Association that was situated at Chorleywood in Hertfordshire. The difference between this process and bulk fermentation or sponge batter processes is that the dough development is achieved by a specially designed high speed highly powered machine capable of giving intense energy to the dough.

	The dough temperature must be controlled at the mixing stage for proper consistency of dough.
Activated dough development	This allowed small bakers to continue using their existing low-speed mixers and eliminate bulk fermentation without purchasing the new high-speed mixers being developed for mechanical dough development processes. This process used the Enzymes, oxidizing agents, reducing agents and other additives to chemically develop the dough in a very short time. The special ingredient, including an improver containing L-cysteine hydrochloride, are mixed and the dough develops in the mixer.

Bread and Bun Processing/bread production

Bread production operations must be carefully planned, for good quality of finished product. These are the various steps in bread processing which is shown in fig 2.

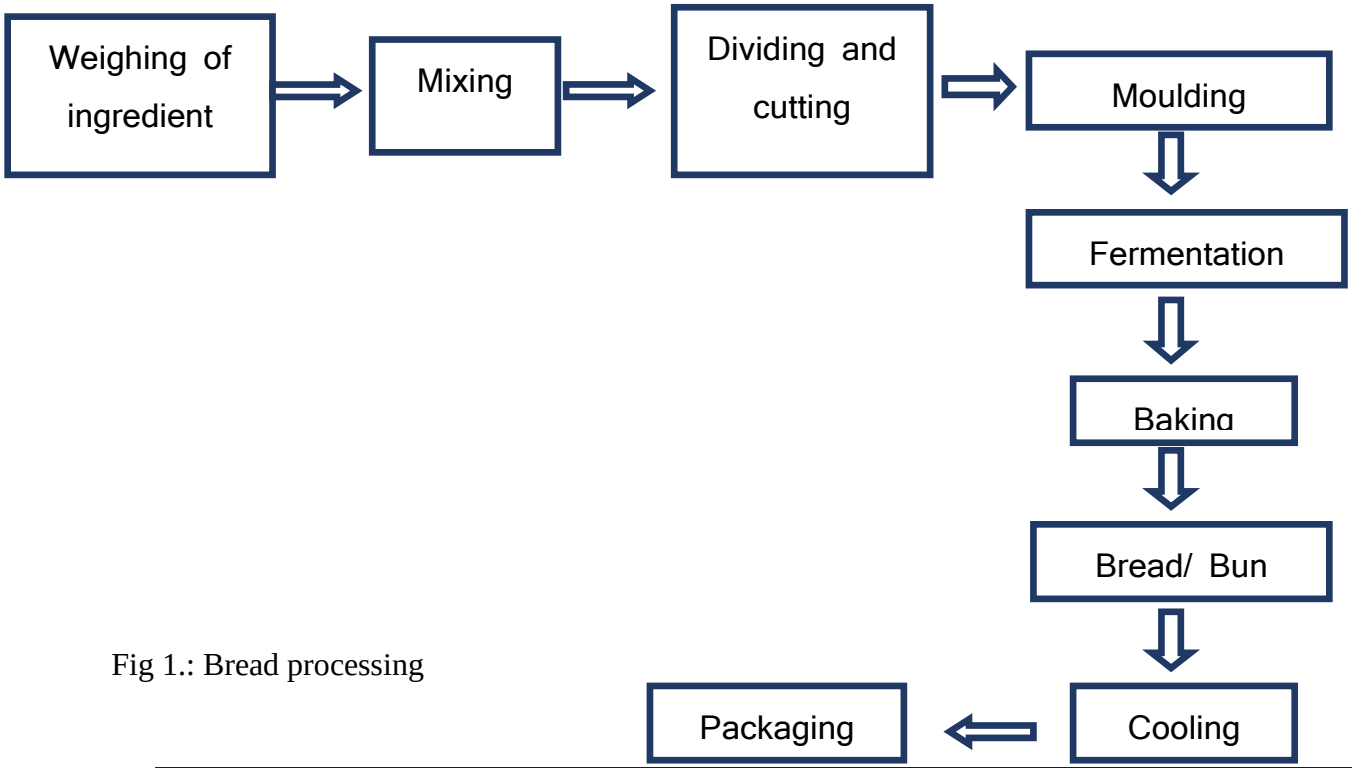


Fig 1.: Bread processing

Mixing

The first stage in dough processing is the mixing. The mixer operator's aim is "getting the dough out in its driest condition, with as high an absorption as possible and at the same time of proper consistency so it will machine well". The basics purpose of ingredient are:

- For uniform incorporation of ingredient
- To hydrate all dry materials completely
- To develop the gluten for proper handling quality and gas retention

- The incorporation of air bubbles within the dough to provide the gas bubble nuclei for the carbon dioxide which will be generated by yeast fermentation and oxygen for oxidation and yeast activity

The temperature of the dough should be recorded directly after mixing is completed. The dough temperature is most important parameter for maintaining the quality of finished product and that can be controlled by water temperature with the help of friction factor.

Dough fermentation:

Dough fermentation signifies all the physical and chemical changes to the dough, which are caused by yeast. Physically, these changes include aeration and modification of dough's elasticity and extensibility. Chemically, yeast produces alcohol, carbon dioxide, heat, hydrogen peroxide, and other substances. These substances result in the unique flavor attributed to fermented products and the modification of dough rheology. The optimum temperature and Rh range for yeast activity is between 32 to 40°C and 80-85% respectively. The following change occurs during fermentation:

- Production of CO2
- Increase in temperature of dough
- Changes in the consistency of dough. The dough becomes soft, elastic as well as extensible.
- Reduction in pH
- Dough rheology

Baking of dough:

The baking process is the final and most important step in bread making in which the dough piece is transformed into a light, porous product under the influence of heat. The baking process involves a series of complex physical, chemical and biochemical reactions. The following changes occurs during baking process:

- Oven-spring
- Yeast activity
- Crust formation
- Starch gelatinization
- Gluten coagulation
- Enzyme activity
- Browning Reaction

The exact temperature required being dependent on the type of bread and size of loaf. Ordinarily the temperature of the oven should be such that the loaves will start to "color" in about twelve minutes after being placed in the oven generally oven temperature kept in the range of 220-250ºC. Controlling the temperature of the oven for baking bread is very important. If the oven is very hot, the coagulation of protein, (forming of crust) on their outer surface will take place very soon. This crust formation will block the easy transmission of heat inside the bread. As a result when gas expands in the inner portion and crust being non stretchable, there will be an exaggerated break in the bread. The crust color will be took dark and the bread may not be baked properly

from inside. Since the early crust formation will check full rise of bread, the volume will remain small and due to uneven expansion, there will be poor shape.

Conversely, if the oven is too cold, coagulation of protein will be delayed and yeast will remain active for longer period, which will result in excessive volume of bread. Due to lack of temperature, bread will be required to be baked for longer duration, resulting in evaporation of more than necessary amount of moisture. Resultant product will be crumbly and will stale faster.

Bread quality control points:

The following parameters are affect the quality of bread production

- Quality of ingredient
- Suitability of bread improver and additives
- Formulation
- Dough mixing, consistency, temperature of dough
- Clean and hygienic handling of dough during make-up
- Accurate dividing, rounding & interproof
- Proper molding and panning
- Fermentation-time, temperature, Rh and dough development
- Temperature and humidity control in baking
- Cooling
- Slicer operations
- Packaging in suitable packaging material

Assessment of bread quality:

The following point are important for assess the quality of bread:

- External quality attributes of bread
  - Product dimensions
  - Volume
  - Colour
  - Crust characteristics
- Internal quality attributes of bread
  - Size, number and distribution of cells in the crumb
  - Crumb color
  - Texture/eating quality of flavour
  - Crumb softness
  - Crumb firmness

Cake Production

Cakes are chemically leavened sweet ,Semi-Moisture foodstuff, prepared by baking a wheat flour-based batter into a compact form. The principal Ingredients for making cake and their function are shown in table 3:

Table 3: Function of ingredient for cake production

Ingredient	Function
Refine wheat flour	Refine wheat flour is the primary structure builder in batter cake and its ability to retain the gases.
Sugar	Sugar is primarily used to provide sweetness and helps to incorporation of air. Sugar acts as as tenderizers and delaying the gelatinization process during baking.
Fat	Fat acts as a tenderizers and they provide lubrication and softness effect. It also helps in air incorporation
Egg	Egg supports the frame work of gluten and provide structure. It helps in colour, flavour and contribute the leavening action.
Milk powder	Milk powder add colour, taste and flavour in product
Leavening agent	Leavning agent like baking powder and baking soda helps in achieving the desired volume and texture. It halso helps to control the Ph of batter/cake.

Cake processing:

The basic process of making cake are weighing of ingredient, mixing and baking which is shown in fig 2. The cakes are classified on the basis of blending method and use of ingredient. Type of cake include Foam cake, batter cake and chiffon cake.

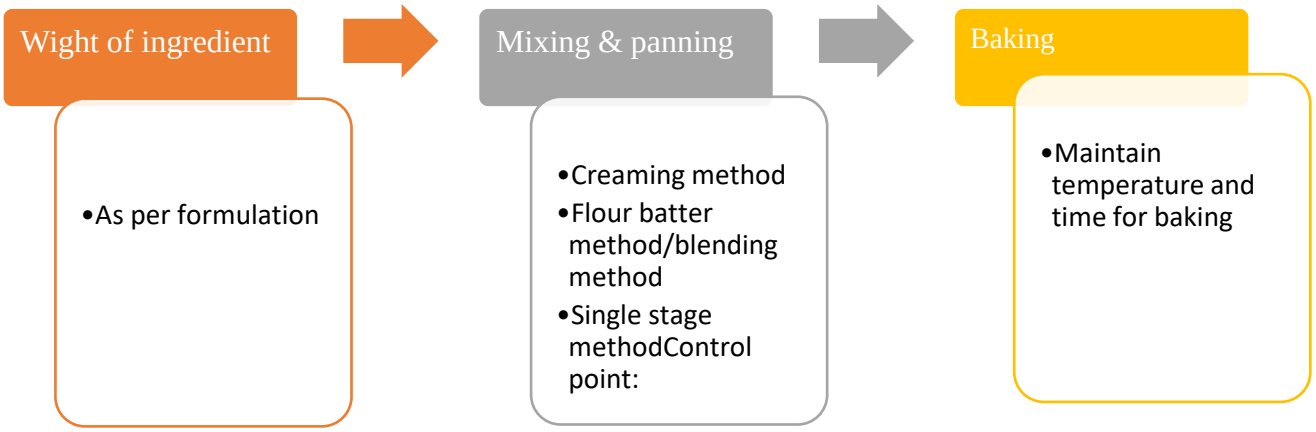


Fig.2: Process of cake making

Stage 1. Formulation and Balancing:

Basic requirement of a cake is that it should have a pleasing appearance, with a thin crust, should be light, even textured and pleasant to eat. In a fruit cake, the fruits should be evenly dispersed in the crumb. For making cake, each ingredient has a definite function. If haphazard quantities of ingredients are used in a cake, the resultant product will vary from day to day. Therefore in order to have consistently good quality product, it becomes necessary that all the ingredients are used in a balanced formulation.The ingredients that are used in cake making are divided according to their functions:

The Toughners –provide structure and form and give shape to the product. These will include flour and egg.

The Softeners –soften the texture of the cake, Include sugar and fat and milk.

The Moisteners –provide the moistening effect in the batter and adjust the consistency.Include milk, egg and liquid sweeteners like golden syrup.

The Driers – are those ingredients which absorb the excess moisture in the batter. Include flour, milk powder, cocoa powder..

The problem in Balancing is that certain ingredients perform more than one function. Eggs provide toughening but are also a moistening agent. Milk is a moistening agent, but milk powder is a drier. The aim of formula balancing is to balance the moisteners with the driers and the tougheners with the softeners. There are three simple rules that govern Formula Balancing:

- The weight of the fat should not exceed the egg (fat ≤egg)
- the weight of the fat should not exceed the sugar (fat ≤sugar)
- the weight of the sugar should not exceed the total liquid (sugar ≤liquid)

Stage 2. Cake Mixing:

In mixing, two or more ingredients are evenly dispersed in one another until they become one product. In case of cake, "Mixing" is a general term that includes beating, blending, binding, creaming, whipping, and folding. The batter temperature, batter viscosity and specific gravity of batter are important control points for maintaining the quality of product. After batter mixing, temperature of cake batter exerts a marked influence on the final cake quality. Batter temperature has effect on batter's viscosity which in turn affect both batter aeration and batter stability. In general, the optimum batter temperature for sponge-type cakes is 27-33 degree celcius, while for butter-type cakes it is 20-25 degree celcius. Specific gravity of batter is essentially the result of the mixing action and its duration, so the importance of the control of mixing time is readily apparent .Specific gravity is the ratio between the weight of a given volume of any substance and the weight of the same volume of water. Specific gravity give an idea about the air incorporation of air in batter. Research shows that Batter specific gravity is a primary determinant of the tenderness, grain, texture and volume of the finished cake. A specific gravity of 0.80 simply means that a substances weighs 0.80 times or 80% of the weight of the same volume of water.

The mixing method are follows as per the requirement of product. The various method of cake mixing are shown in table 4 and the objective of cake mixing are as follows:

- To blend the ingredients into a smooth, even batter.
- To beat the maximum amount of air into the batter.
- To develop the proper texture in the finished product.
-

Table 4. Mixing method for cake

Mixing Methods	**Creaming, A**	**Whipping, B**	**Mixing, C**	**Folding, D**

Creaming Method Or, Sugar Batter Method	Butter + Sugar	Eggs + Sugar	B Into A and Moisture	
Whisking Method Or, Sponge Method		Eggs + Sugar		Flour and Melted Butter
Flour Batter Method Or, Combination method	Flour + Butter	Eggs + Sugar	B Into A and Moisture	
Rubbing Method Or, All-in-one-method	Flour + Butter	All Other Ingredients		

Stage 3. Baking of batter :

Cake baking is last stage of cake preparation but a very important stage to develop a good quality product and oven temperature, time and humidity are the most important factor influencing cake characteristics. Three main stages of cake baking process:

1. Rising
2. Setting
3. Browning

- **Rising: In this process** as the temperature of the cake mixture rises, the gas cells (beaten in during the preparation of the cake mix) expand and the chemical rising agent, releases carbon dioxide (eg baking powder). In this stage, the cake batter becomes slightly thinner and rises rapidly. Rising starts at the sides and moves in toward the centre.

- Setting : In this process, the centre of the cake begins to rise a little higher than the sides. The structure of the cake is beginning to form at this time. On the surface of the cake, some browning begins and small bubbles may appear. This is a very delicate stage and any jarring may cause the cake to fall or lose volume.

- Browning : The cake begins to get firm and the crust continues to brown.

Cake Baking Temperature:

✓ FOR HEAVY CAKE:

- Temperature should be less than 180oC but it will take more time
- For example : Christmas Cake

✓ FOR LIGHTER CAKE:

- Temperature should be 190- 200oC and baking time would be less
- For example : Cup cakes

Effect of Oven Temperature on Cake Characteristics:

- Too low a temperature and the batter solidifies too slowly, allowing the gas cells to expand too far and begin to coalesce, producing a heavy and rough textured cake.
- At too high a temperature, the outside may well char and burn before the whole of the mixture has set, leading to a 'wet-spot' in the cake.

Cake quality Parameters:

The quality of parameters affective by quality of ingredient, balance formulation and control point in different unit operation. The following factors affect the quality of cake:

1. Sequence of addition of ingredient during mixing
2. Batter temperature
3. Batter viscosity
4. Batter Ph
5. Specific gravity of batter
6. Clean and hygienic operation
7. baking temperature and time
8. cooling temperature of cake
9. Packaging in suitable packaging material.

Biscuit, cookies- Crackers

Biscuit is one of most important segment of bakery industry in India. The word biscuit drives from Danis biscoctus which is Latin for twice cooked bread and refers to bread rusks that were made for mariners (ships biscuits) from as long as the Middle Ages. The word biscuit is all embracing in Britain and several other countries. It includes items also known as crackers (that make a noise of cracking when broken). Hard sweet and semi –sweet biscuits, cookies (which is the name that originated from Dutch word koekje meaning a small cake) and wafers, which are baked between hot plates from a fluid batter. Cookies are made from soft wheat flour and are characterized by formula high in sugar and shortening and relatively low in water. Crackers are usually made from developed dough whereas cookies are made from weaker flour. They are all made with flour (usually wheat flour) and all have low moisture content and thereby have long shelf life if protected from moisture and oxygen. The essential ingredients used in cookies/biscuit/crackers are shown in table 5 :

Table 5: Ingredient for cookies/biscuit/crackers

Ingredient	Function

Refine wheat flour	Refine wheat flour form the matrix of protein and helps in structure.
Water	Water helps to mix other ingredient, to control the dough temp and in formation of gluten.
Sugar	Sugar is primarily used to provide sweetness and helps to incorporation of air. Sugar acts as as tenderizers and delaying the gelatinization process during baking.
Fat	Fat acts as a tenderizers and they provide lubrication and softness effect. It also helps in air incorporation in dough/batter.
Egg	Egg supports the frame work of gluten and provide structure. It helps in colour, flavour and contribute the leavening action.
Milk powder	Milk powder add colour, taste and flavour in product
Leavening agent	Leavening agent helps in achieving the desired lift, biite and texture. It also helps to control the Ph of dough/batter.

Classification of biscuit:

There are basically two types of biscuit dough; hard and soft. The difference is in the consistency which in turn is determined by the amount of water available to hydrate the flour. When there is high water content (therefore low level of fat) the blending with the flour involves the formation of gluten which requires mechanical work, kneading and thus hard doughs are developed. When the quantity of fat is higher, water needed is less and the mixing is designed so that little or no gluten is formed as the flour hydrates, this is called short dough. Biscuits may be classified in various ways.

1. Based on the texture and hardness.
2. Based on the method of forming dough and dough pieces e.g. fermented, develop laminated, cut, moulded extruded, deposited, wire cut, co extruded etc
3. The enrichment of recipe based on fat and sugar.
4. Cookies can be classified into four major groups depending upon the kind of equipment used to form the individual places.

A. Rotary-moulded cookies

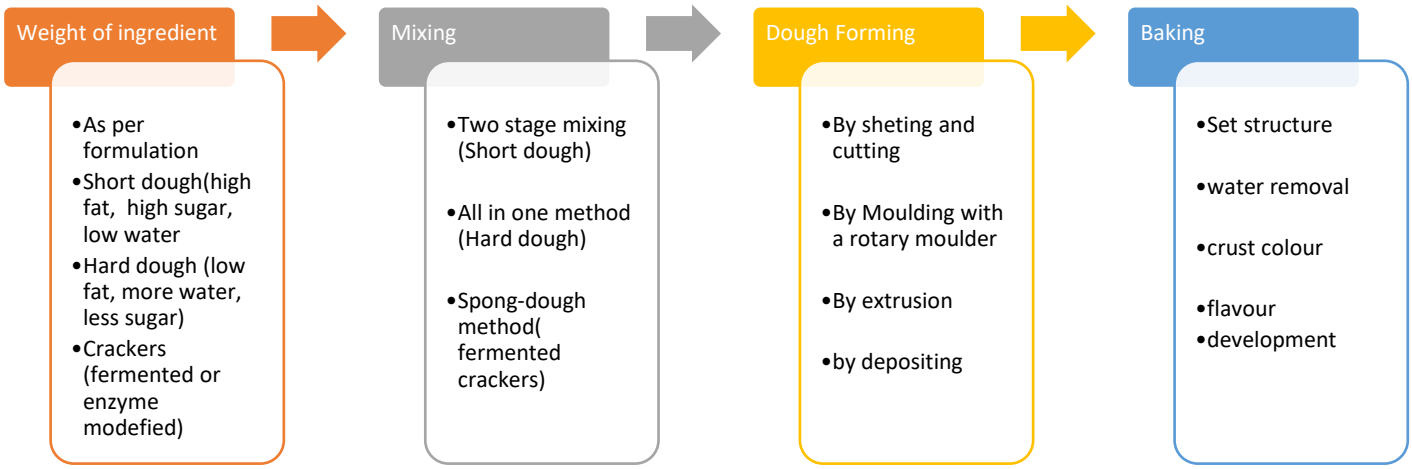
B. Wire-cut cookies

C. Deposit Cookies and

D. Cutting machine cookies

Production of biscuit:

The steps involve in manufacturing of different types of biscuit is shown as:



Mixing Process:

Mixing of ingredient is one of the most important process for developed the dough as per requirement of consistency. The purpose of mixing is to evenly distribute the ingredients and transform ingredients into a cohesive, extensible, machinable dough that can be sheeted or laminated into a continuous sheet prior to cutting. The proper mixing achieved through formulation balancing, sequence addition of ingredient, mixing time, rest time required at various stages, speed of mixer blades, dough temperature and pH after every stage of mixing

Baking process:

The baking process control the structure, rate of moisture loss, color formation, flavor development, and attributes of size and thickness. The baking temperature range from 170-200 degree celicus for 10-20 min. The following physical and chemical changes are occurs during baking:

- Any gases, including air and carbon dioxide from leavening agents, will expand, causing the biscuit to expand.
- Water will be converted into steam, also causing the biscuit to expand. This expansion is the oven spring.
- The proteins present will start to denature and the starch will start to gelatinise. These processes cause the structure to set.

Major issue/check point during processing of biscuit:

The following are the major check point for maintaining the quality of finished product:

During Mixing:

- Maintain consistent dough temperatures in mixing
- Maintain consistent mixing time from batch to batch
- More thorough blending of ingredients to counteract checking
- Preperation of Use lecithin/emulsifiers or any other additives

During Forming:

- Maintain the dough wt and size during cutting.
- Minimize dough weight difference across the conveyor belt
- Keep dough weights similar for various geometric shapes
- Keep scrap return to the dough feed rolls hopper as warm as possible

During Baking:

- Maintain the dough temp. and time as per required

During Post Baking:

- Cool the product as slowly as possible.
- Use covered tunnels rather than open air conveyors
- Cool the product when possible in a humid environment
- Avoid sudden, very cool drafts
- Packed in suitable packaging material.

Preservation of bakery Product

The principal mechanisms involved in the deterioration of bakery products are as follows:

1. Microbiological spoilage sometimes accompanied by pathogen development.

2. Chemical and enzymatic activity causing color, odor, flavor, and texture changes.

3. Moisture and/or other vapor migration/ oxygen changes flavor and texture of product

Formulation and processing variables which affect these mechanisms and which can be used to control deterioration include:

- Moisture and water activity
- pH
- Temperature and humidity
- Emulsifier systems
- Good Hygienic practice during process of product
- HACCP
- Preservatives and additives and
- Packaging.

Frozen bakery products:

Baking is also one of the oldest crafts in the world. However, most breads have a short shelf-life as a result of staling. Hence, frozen dough technology has been developed since the early twentieth century. This technique provides customer benefits by permitting the baker or retailer to provide fresh bread at almost any time. As a result, this technology has become one of the most important technologies

practiced by today's baking industry. Currently, frozen dough is being used all-over the world, resulting in economic advantages to the producer and increasing convenience for the user. The steps for making frozen dough, partial baked dough and fully baked bread are as shown in fig 3.

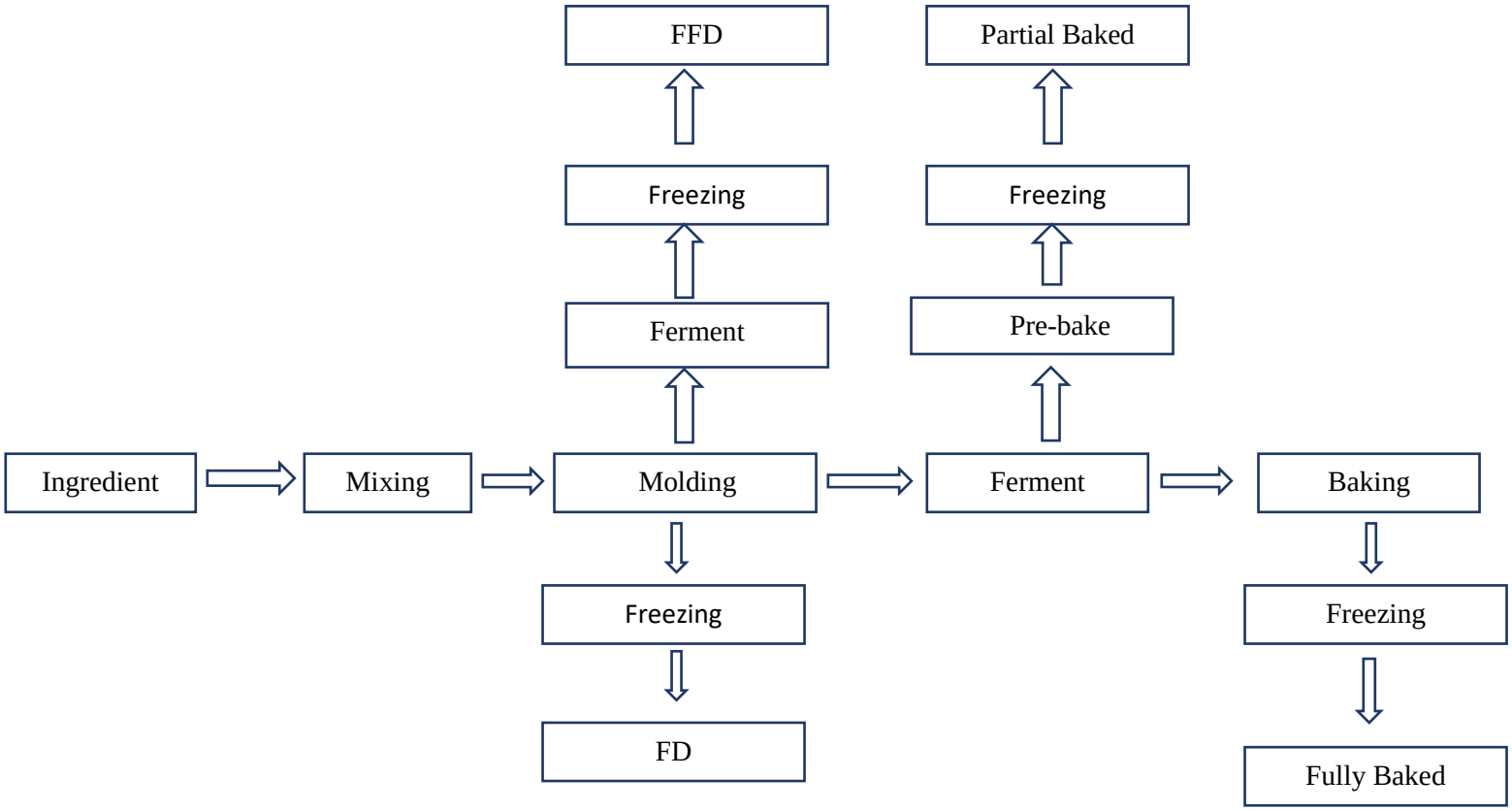


Fig 3: Steps for making different types of freeze product: FD- Freeze dough, FFD-Fermented freeze dough

2.2 PRODUCTION OF CHOCOLATE, FONDANT, CARAMELS, FUDGE, TOFFEE AND PASTRIES.

PROCESSING OF COCOA *(Theobroma cocoa)*

- **History of cocoa**

Cacao residues on pottery in Ecuador suggest that the plant was consumed by humans as early as 5,000 years ago. It was also found that the emperor of Aztec (Mexico) had regularly consumed a drink called “Chocolatl” which was prepared by roasting and grinding the cocoa nibs and mixed with water, maize, and spices. Thereafter, In the 18th century the Swedish botanist, Carolus Linnaeus, renamed the cocoa tree giving it the Greek name Theobroma Cacao, now its official botanical name, which literally means 'food of the Gods'. The drink has been so popular it has been used as nuptial aid during wedding ceremonies.

- **Distribution of cocoa tree**

It is a small tree mostly native to American tropics. However, now started growing all over the world. West African countries Ghana, Nigeria, Ivory Coast, Brazil and Brazil produces about 70% of world cocoa beans. The Ivory Coast and Ghana are by far the two largest producers of cocoa, accounting for more than 50 percent of the world´s cocoa. India also started producing cocoa beans but primarily as an intercrop in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh.

- Structure and Composition of cocoa pods

Figure 1. Cocoa pod

Figure 2. Cocoa pod with pulp

The cocoa tree measures about 4-5 meters with large branches and flowers directly on the trunk producing 10-80 fruits (also called as pods) containing 20-50 beans (2 cm length) in rows. The seeds/beans are generally found to have embedded in white or pinkish pulp as shown in figure 2. These seeds are of great significance in making nutritious beverages and chocolate all over the world.

The main component of cocoa beans is lipid fraction (cocoa butter), approximately 54%, mainly constituted by oleic, stearic, palmitic and other fatty acids along with 30-31% carbohydrates, 11% proteins (albumin and globulin), 3% polyphenols with less than 1% mineral content. The composition is illustrated in figure 3.

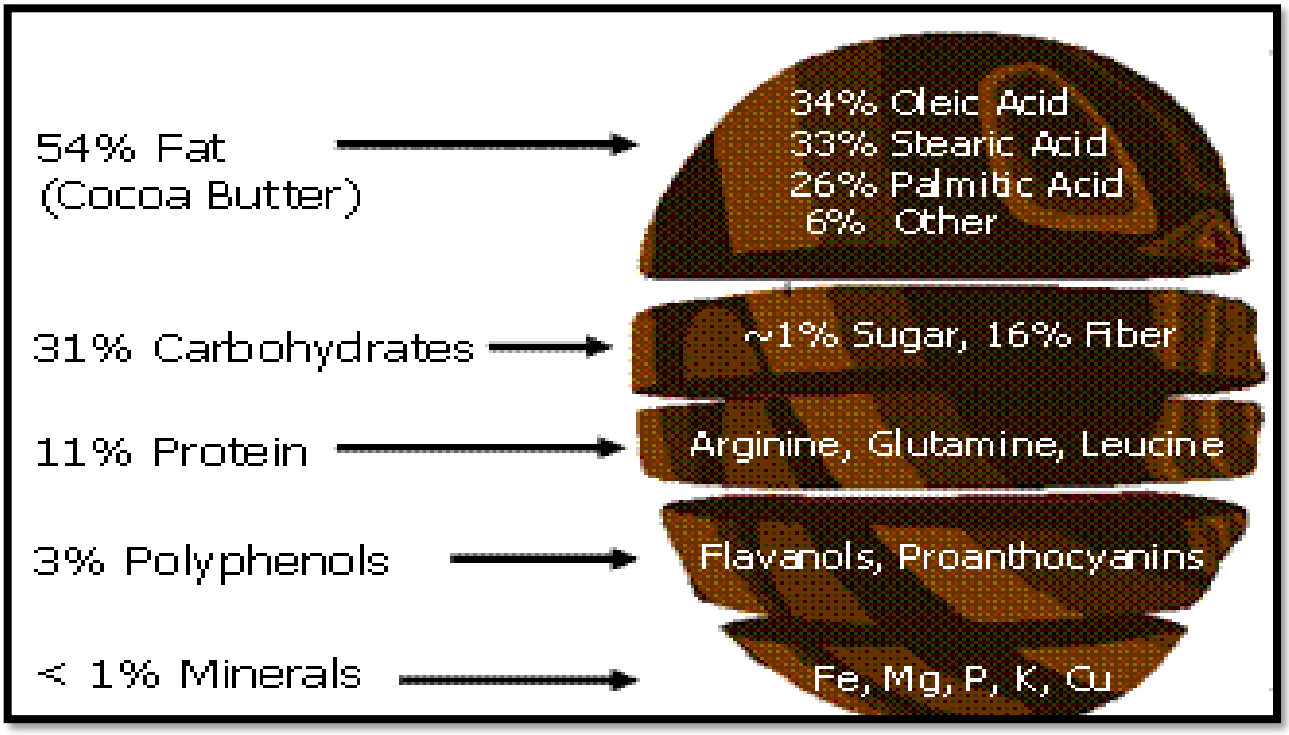


Figure 3. Composition of cocoa bean

- **Need of cocoa processing**

One cannot able to cocoa unless it is been processed as raw cocoa has bitter and astringent taste, lacking chocolate flavor as well. The chocolate flavor only comes after processing. Also it was observed that, biochemical processes for development of chocolate flavour start during fermentation and continue during drying, roasting and conching.

- Harvest and Postharvest processing operations

The first vest takes place after approximately three years (hybrid/improved variety) or 4 – 5 years (traditional variety coming from the nursery) after planting. The cocoa tree can produce twice a year for more than 30 years. Harvest the pods at regular intervals of 10 - 15 days (do not go over three weeks). Harvest the pods at optimum maturity (when the fruit turns three quarters yellow, vermilion, orange or red, depending on the pod colour of the variety).

Figure 4. Pod color of different varieties during the harvest

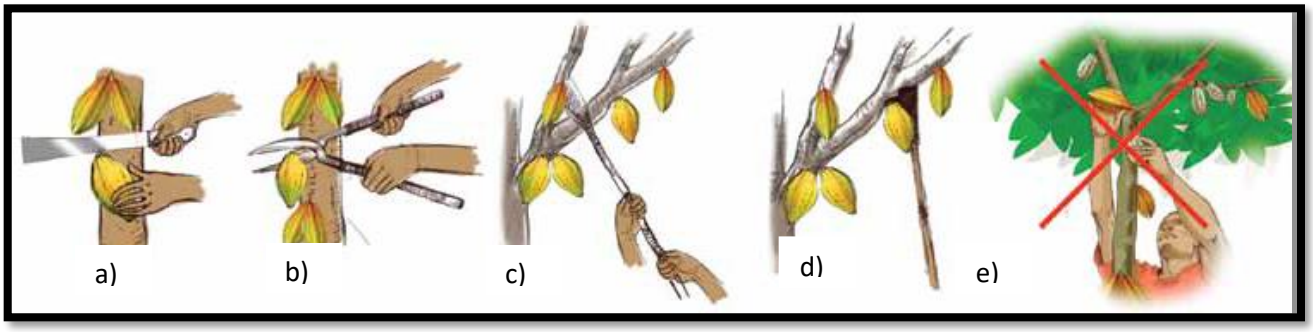


Figure 5. Types of harvesting of pods. a) Machete, b) Pruning shears, c) Pruning pole, d) Sickle, e) Never harvest by hands

Processing of cocoa is divided into 2 types; Primary processing and secondary processing

A) Primary processing :

(a) Breaking of pods :

The pods are broken no more than 5 days after harvesting. Separate the healthy pods from the damaged pods to differentiate between the grades. Open the pods with sticks that have no sharp edges so as to extract the seeds without damaging them.

Figure 6. Breaking of pod by hand

Generally, machetes or similar kind of knife is used to remove mature pods from tree. However, other methods such as pruning shears, pruning pole, sickle can also be used. But, bare hands are strictly avoided for removing pods from tree. After a day or two, pods are split open. The internal pulp and beans are removed by hands or hand implements.

(b) Fermentation :

Fermentation is process of removal of pulp and waste from the cocoa fruit. Beans are subjected to natural fermentation (for about 5-10 days) to assist in removing the adhering pulp and to prepare the beans for drying. The freshly extracted beans are placed on banana leaves (or cocoyam leaves) inside baskets, wooden boxes as shown in figure 7. Fermentation is essential for rapid reduction of the beans' ability to germinate and to develop the flavour and aroma precursors of the chocolate. At the end of fermentation, the pulp breaks down and there is a change in color of the seeds from pale yellow or violet

to brown. The endogenous enzymes, activated by the heat of fermentation bring about changes in proteins and polyphenols in the Kernel and there is also a reduction in the astringency of the kernel. The beans are then dried to 6-8% moisture level in sun or in artificial dryers. The bean is then ready for export or further processing to manufacture cocoa products. Fermentation process generates aromatic compounds such as pyrazines, aldehydes, alcohols, ketones and esters.

Figure 7. Cocoa bean fermentation process

- Other methods of fermentation :

a) Basket fermentation b) Box fermentation c) Heap fermentation

Figure 8. Types of fermentation methods for cocoa

- Stages of fermentation:

Micro-organisms are responsible for the breakdown of the pulp that surrounds the beans. Mostly anaerobic yeasts, lactic acid bacteria and acetic acid bacteria are responsible for fermentation due to which the fermentation process is divided into 3 stages depending upon its action. Their activities result in the death of the beans and they create the environment that enables the formation of cocoa flavor precursors

Stage 1 : Action of Anaerobic yeasts

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

Stage 2 : Action of Lactic acid bacteria

This converts sugars and acids to lactic acid

Stage 3 : Action of acetic acid bacteria

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

Figure 9. Beans after fermentation. Purple colored are slaty and underfermented while brown are properly fermented cocoa

- Judging the end of fermentation

At the end of fermentation, Bean colour changes to brown, becomes plump and filled with a reddish brown exudates. Also testa becomes loose and gets detached from cotyledons. Longitudinal halves of cotyledons show bleached appearance in the centre with a brownish ring at the periphery. When 50 % of beans show these signs, the lot can be taken out for drying.

(c) Drying :

After fermentation, remove the remains of the pulp by washing the beans or mixing them with sawdust and dry banana leaves. The beans are then dried naturally or artificially to get final moisture content of 6-7%. Natural or solar drying is the simplest and most popular method and takes 3-4 days. In small operations, the beans are often spread out on bamboo or straw mats placed in the sunlight, on sheets of black plastic, etc. Stir them around frequently for 5 days. Sort them to remove defective or flat beans. Once dry, their average weight is one gram with a moisture content of approximately 7 %. Place them in a dry, sheltered and well-aerated spot to protect them from damp (rain, humid nocturnal air) and avoid the risk of mould developing.

Drying lowers the strong acid/sour flavor, acetic acid content from husk. Drying also causes oxidative browning causing reduction in astringency and bitterness. Also flavor forming reactions are also occurred during drying.

Types of drying : There are many methods are utilized for beans drying. Some of them are discussed below

a) Sun drying :

Figure 10. Sun drying of cocoa beans

In this method, fermented beans are spread in thin layer (1-2 inch deep) and kept exposed to sun until drying with occasionally turning. Sun drying can be small scale or large scale. As it is natural process, it has advantages and disadvantages as well. Advantages includes improved quality, cheap method while disadvantages includes, it is time consuming, requirement of labour, uncertainty of weather and mold attack.

b) Mechanical drying :

Figure 11. Mechanical drying of cocoa beans

Unlike sun drying, mechanical drying is not depended upon sun, need short time (14-48 hrs), no excessive man power required, devoid of external contamination

(d)Storage :

Figure 12. Jute bags containing cocoa beans

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

B) Secondary processing :

It includes processing of fermented beans. The schematic diagram of steps involved in secondary processing is shown 13.

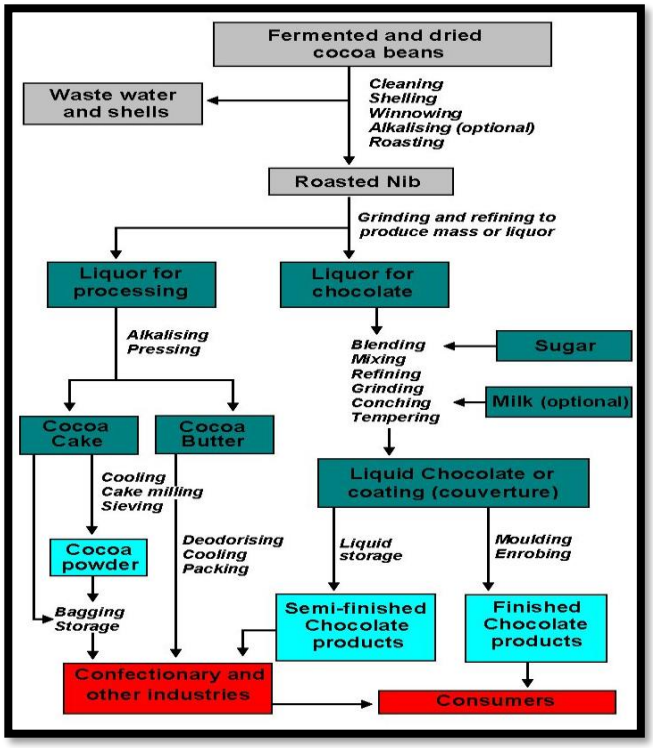


Figure 13. Secondary processing of cocoa processing

a) Alkalization

Cocoa alkalization is a value-added process in cocoa processing to produce alkalized cocoa mass or powder. It involves the treatment of cocoa beans with a food-grade alkali solution to raise the pH, producing darker colors and stronger flavors.

b) Roasting

The nibs/beans are roasted in special ovens at temperatures between 105-120℃. The actual roasting time (generally 20-30 minutes) depends on whether the end use is for cocoa or chocolate. During roasting, the cocoa nibs darken to a rich, brown colour and acquire their characteristic chocolate flavour and aroma. This flavour however, actually starts to develop during fermentation.

During roasting, organic acids, volatile astringent compounds gets evaporated along with chemical modification on tannins which reduces the bitterness

Figure 14. Small scale roasting

c) Winnowing

The dried beans are cracked and a stream of air separates the shell from the nib, the small pieces used to make chocolate.

d) Grinding

The roasted nibs are ground in stone mills until the friction and heat of the milling reduces them to a thick chocolate-coloured liquid, known as 'mass' or ‘Chocolate liquor’ or ‘Bitter chocolate’. It contains 50-55% cocoa butter and solidifies (at about 30℃) on cooling. This is the basis of all chocolate and cocoa products.

e) Processing of cocoa liquor

The cocoa mass is pressed in powerful machines to extract the cocoa butter, vital to making chocolate. The solid blocks of compressed cocoa remaining after extraction (press cake) are pulverised into a fine powder to produce a high-grade cocoa powder for use as a beverage or in cooking.

According to ISI specifications, cocoa used for beverage should contain 20 % cocoa fat. Medium fat cocoa, containing between 10 – 20 % fat, and low fat cocoa, containing less than 10 % fat are made.
(1) Cocoa butter : It is pale yellow colored, chocolate flavoured, brittle below 25°C containing Palmitic, Stearic, Oleic and Linoleic acid
Types : a) Prime pressed cocoa butter – Obtained from nibs by mechanical (hydraulic) pressing without any refining. b) Expeller pressed cocoa butter – Nibs undergoes steaming and further use of expeller. The obtained product has very mild. c) Solvent extracted cocoa butter – It is extracted from the cake residue after expeller pressing and subjected to refining such as degumming and deodorization precesses.

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

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

(3) Chocolate :

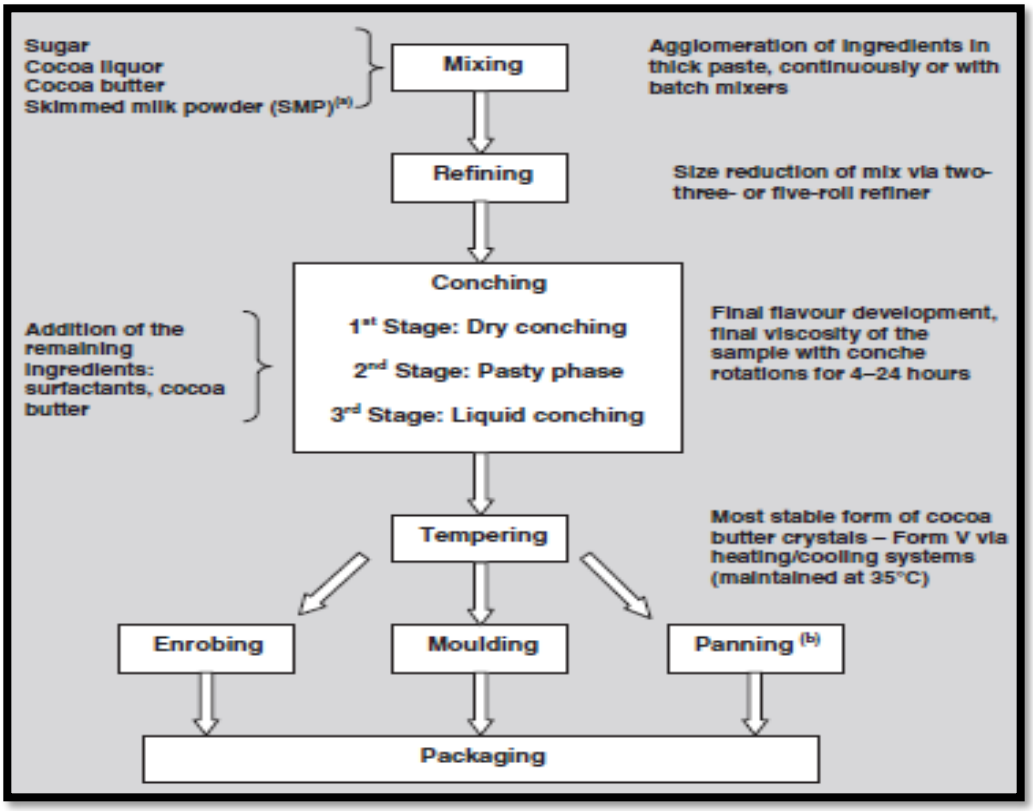


Figure 15. Chocolate manufacturing process

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

3.1 Mixing :

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

3.2 Refining :

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

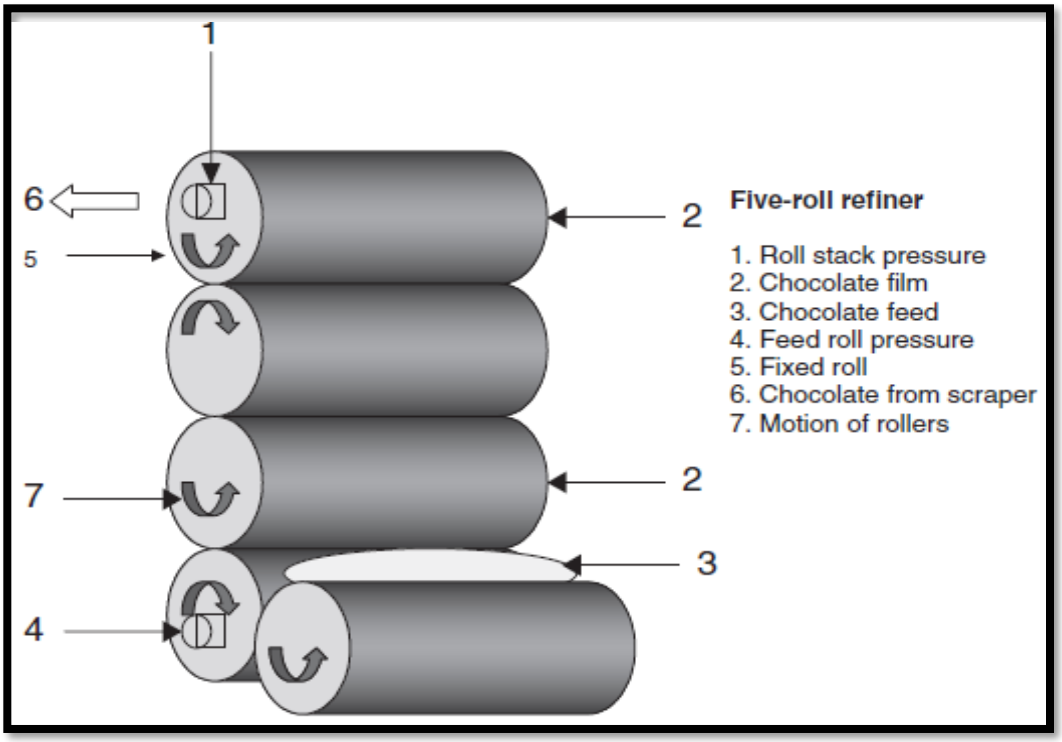


Figure 16. Five roller refiner

3.3 Conching

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

Figure 17. A typical conching machine

3.4 Tempering

The final process is called tempering. Uncontrolled crystallization of cocoa butter typically results in crystals of varying size, some are even can be seen with the naked eye. This causes the chocolate of improper texture. The uniform sheen and crisp bite of properly processed chocolate are the

result of consistently small cocoa butter crystals produced by the tempering process. The primary purpose of tempering is to assure that only the best form is present.

3.5 Moulding

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

3.6. Storage of chocolate

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

Chocolate defects

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

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

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

FONDANT

Fondant is called many things – *wedding cake icing, rolled icing, plastic icing, white icing, Ready To Roll icing (RTR) icing,* etc. It is an icing, which is rolled out using a rolling pin & gives a fantastic finish to a decorated cakes. Fondant is made by mixing it with sucrose (sugar) in water. At room temperature, water can only contain so much sugar. Even when heated to boiling point, water can hold over twice as much sugar.

The best fondant is made by mixing boiling water and sugar together until it forms a soft ball. Cream of tartar is sometimes for extra stability. Once it is ready, mix it up with corn syrup to produce poured fondant or roll into sheets to produce rolled fondant. Fondant is very pliable. It can be kneaded and molded into all sorts of shapes. It can also be colored with various dyes. These features make it ideal for decorating cakes. Many cake artists drape sheets of rolled fondant over their basic cakes to cover them before decorating with finishing touches.

Types of Fondant

There are two main types of this kind of fondant: poured and rolled.
– **Poured fondant** is creamy and liquid, and is often used as a filling or coating for cakes, pastries, candies, and other desserts. Poured fondant is made mainly of sugar, water and corn syrup.
–**Rolled Fondant** is the most common fondant, which looks like smooth pie dough and is often wrapped on top of the cake to cover them, as well as cut into strips or shapes for decoration. Like poured fondant, it is made with sugar, water and corn syrup. To make pliable dough, gelatin and/or glycerine is added. It's then rolled out into sheets that can be colored and used to decorate cakes.

Fondant must be handled with care if the loss of gloss is to be prevented when it used in cake decoration. Having the correct temperature is a key factor in handling fondant. Fondant consists of minute sucrose crystals suspended in saturated sugar syrup with sufficient invert sugar or glucose to prevent the growth of crystals.

In preparing fondant for use it should be heated in water-jacket pans with the appropriate amount of stock syrup to produce the desired consistency, because in this way there is less danger of overheating. Thermostatically controlled pans are desirable.

The temperature should not greatly exceed 38°C if a good gloss is to be retained. If overheated, the crystals redissolve and, on cooling, recrystallise into larger crystals, which do not reflect as much light, and the result is that the gloss will be spoiled. If it is under-heated the fondant will not set firm, but will be sticky and runny.

The bulk fondant should therefore be heated carefully to no more than 39°C, stirred continuously, then thinned down to the required consistency and used immediately. At 37°-39°C, approximately 115% of the sucrose crystals dissolve, and a recrystalisation cement the remaining crystals together and thus produce a firm dry surface.

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

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

The best thinning agent to use is sugar syrup as it is the most cost effective and easier to regulate in amounts to be used.

1 part sugar with 1 part water Aromatics may be added but then all those flavours go into everything Bring to boil then cool and store for further use as required.

Preparation of fondant

Ingredients (for 1 kg cake)

1. Grain sugar: 450 gm
2. Liquid glucose: 1 table spoon

3. Water: 150 ml.

Method:

- Put sugar water and liquid glucose in a pan and heat over a gas burner
- Stir occasionally
- Allow it to boil and stop stirring once it starts boiling
- When the mixture reaches 160 degree centigrade stop cooking. You have to check the temperature with the sugar thermometer.
- Pour the syrup over a white marble top in a spiral motion. Allow the mixture to cool. As it cools, the syrup starts turning white.
- When the syrup has completely cooled, take a damp metal scrapper and begin lifting the edges of the syrup and folding them in towards the centre.
- Then work in figure of 8 motion carrying this on the on for about 5 minutes till it becomes glossy and viscous
- After that, stir the mixture with a long handled wooden spoon. It will become easier to stir
- The mixture will gradually become white and crumbly. Moisten your hands and work the crumble mixture into a ball. Knead it for about 10 minutes till it becomes smooth.
- Wrap it in a cling film and store it in a sealed container in the fridge. It will keep for about four week.

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

Caramel, Fudge & Toffee

Introduction

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

❖ **Structure of caramels**

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

❖ **Structure of fudge**

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

❖ **Structure of toffee**

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

Major Raw Materials:

1) Sugar

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

2) Invert sugar

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

3) Corn syrup

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

4) Milk

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

5) Milk products

- **Fresh milk:** it contains 13% solid and rarely used due to high moisture content.
- **Sweetened condensed whole milk:** It is mostly used and consist of 27% water, 44.3% added sugar,8.1% protein, 8.7% milk fat, 11.4% lactose.
- **Sweetened condensed skim milk:** It contains 28% water, 42% added sugar,10% protein, 0.3% milkfat, 16.3% lactose.
- **Condensed milk, evaporated milk:** it is concentrated solid product contains 33% solid. It is generally consisting of 9% protein, 9% fat, and 1.4% lactose. Also it is available in fat free form. Condensed milk generally sold in truckloads for large scale operation and evaporated milk sold in can. Evaporated milk is a favorite in retail candy kitchens, gives a rich creamy flavor, must be added slowly to boiling batch to avoid curdling.
- **Milk powder:** It is dried milk powder (skim milk or whole milk), generally used in caramel and fudge. Reconstitution of milk powder needs careful attention. It requires 24 holding period after premixing to ensure maximum hydration. Milk powder use may form the rough texture and inferior flavor. Milk powder can be prepared by using spray drying, roller drier.
- **Whey powder and protein concentrate:** It contains protein 12.9% Lactose 73.5% Ash 8.0%. it is used as partial replacement od milk in caramel and fudge. But it can produce the inferior quality of product due to poor flavor, lack of body as protein contain no casein. The higher lactose content leads to excessive color development and also form rough texture if crystallization in finished product. Milk protein concentrate contains lower lactose level.

6) Fat

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

7) Emulsifier

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

8) Starch protein gum gelling agent

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

9) Salt

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

10) Flavour

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

- **Caramel and Toffee Processing**

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

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

1) Pre-Mixing

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

2) Emulsification

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

3) Cooking / Caramelizing

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

4) Cooling

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

5) Forming

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

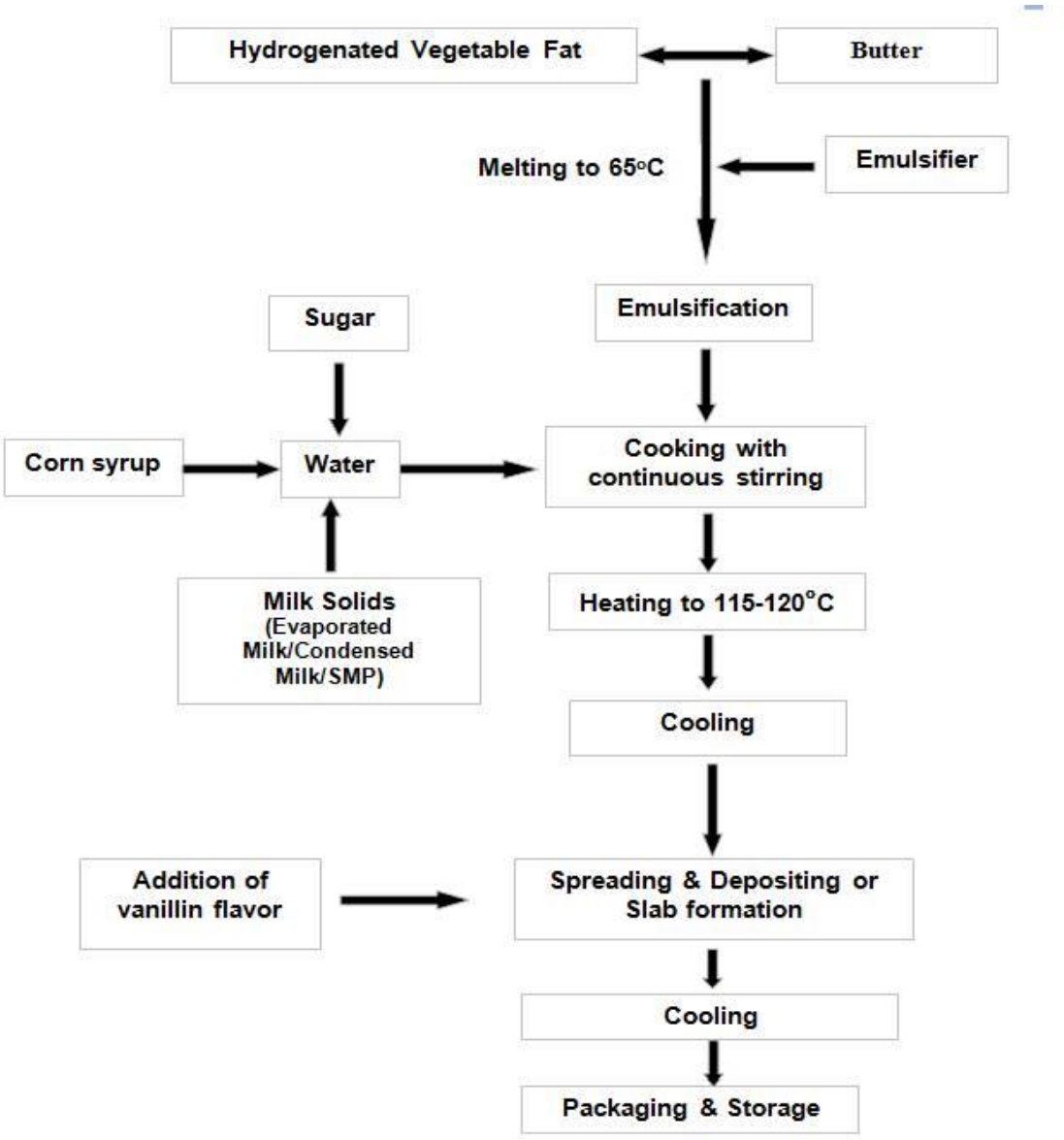


Figure. Caramel processing

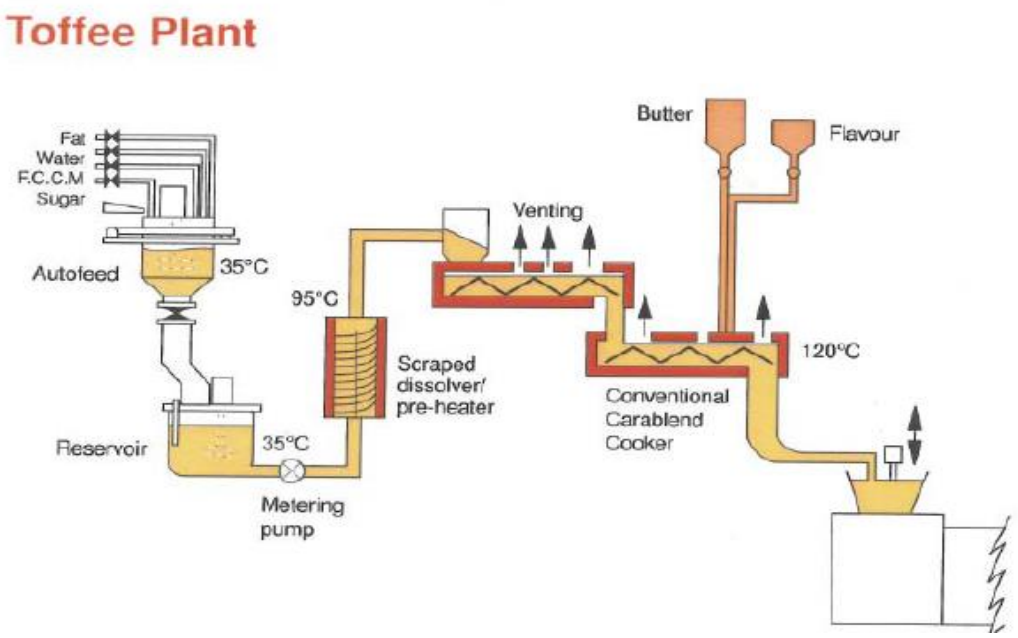


Fig. Toffee processing

- **Fudge Processing**

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

Graining

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

Forming

There are many ways to form fudge into a finished product i.e. Extruder, Bar Forming, Depositing (starch or starch less), Filling into plastic or foil trays, Cut and wrap, Stamping into shapes.

3. Bakery machinery and equipment

Bakery machinery and equipment

Every food processing operation is combination of several unit operations and the operations are performed in a sequence. Below are the list machinery and equipment used in any typical bakery unit. Capacity and level of automation depends on volume and budget.

Flour sifter: It is used to separate or remove lumps or foreign material from the flour, sugar, salt or any other ingredient. It mainly consists of one inlet port (sometimes two or more, based on capacity) and two outlet ports. Out of the two outlet ports, one is called rejection port and other is called product outlet. It contains sieve of different size as change part and the sieves are selected based on the process requirement. Sieve size is normally called by mesh number i.e., 10 mesh, 20 mesh etc. or 1mm, 1.5 mm, 2mm etc. in many cases sifters are mounted with magnet to trap ferrous materials.

Sifter

Grinder/Pulverizer: grinder or Pulverizer is used to reduce the particle size. Selection of the grinder is done based on capacity and required particle size at the output. Grinders and pulverisers are also mounted with magnet to trap ferrous materials.

Grinder/Pulverize

Pin Mill: It is also a size reduction machine, used to grind crystals and brittle materials

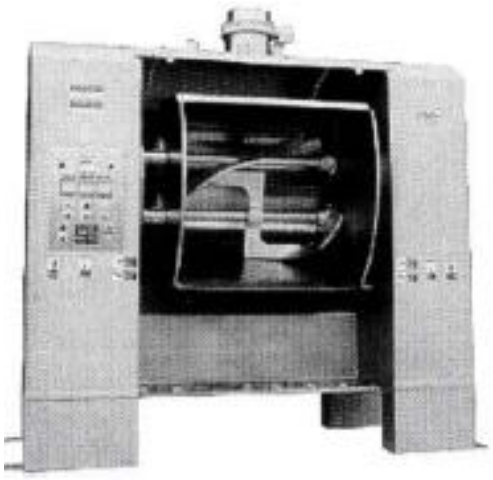
Pin Mill

Hammer Mill: It is also a size reduction machine. It is most commonly used grinding machine. It is used to crush or granulate the material

Hammer Mill

Mixers: Mixer ensure thorough mixing in minimum time. Commercial mixers are a must-have for any bakery unit. It is used to prepare a multitude of food items, from glossy icings and fluffy frostings to cake batters, cookie doughs, and bread doughs. Different types of mixers are shown below in the picture.

Single Arm Mixer



Mixer-double arm

Spiral Arm mixer

High Speed

Planetary mixer: Planetary mixers have a shaft to which an agitator is attached. The agitator rotates around a fixed mixing bowl, similar to how the planets rotate around the sun, giving this piece of equipment its name.

The adaptability of a planetary mixers depends on different types of agitators that can be attach to the shaft. Basic attachments are

a. Whisk: Used for light mixtures like whipped creams, frostings, and meringue
b. Beater: used for medium mixtures like cake batters and cookie doughs
c. Dough Hook: Used for heavy mixtures like bread and pizza doughs

Planetary Mixer

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

Vertical Twin Spindler mixer

Dough Mixer/Spiral Mixer:

A dough mixer is a specialized mixer, used to prepare bread and pizza doughs. Unlike planetary mixers, dough mixers have a stationary shaft and a moving bowl that goes around the fixed agitator. The movement of the bowl allows for a more uniform distribution of dough.

Dough Mixer/Spiral

Dough Divider: Dough divider is used to cut large volumes of dough in very short time. The dough divider has a large press equipped with blades at the head of the machine. Flattened dough is placed on a reel plate, which is inserted under the head and push down a hydraulic or mechanical lever that presses the blades to the dough. This creates equally cut small pieces of dough almost ready for baking.

Most of the dough dividers come with a built-in rounder that automatically forms the small pieces of dough into little round shapes. Specialty units can also turn them into squares, hexagons, or other shapes.

Dough Divider

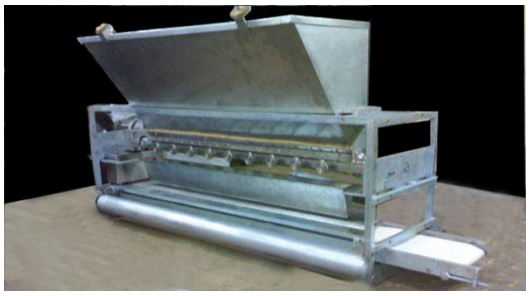
Dough Sheeter: Dough sheeters are useful for making dough for flatbreads, croissants and pie crusts. You can also make cake fondant using a dough sheeter as it eliminates all the kinks and folds that will inevitably show up on your finished product. These work much, much faster than manual labour and opens up your time to work on other kitchen tasks while reducing the damage done to the gluten.

Dough Sheeter

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

Bread Moulder

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



Sugar Sprinkler

Proofing Cabinet

Breads, donuts, and croissants need to rise before they are put in the oven for baking. Proofing cabinets creates the ideal environment for yeast to thrive and allow the dough to rise properly after it has been worked into its final shape. Yeast cells grow less below 68° F and

start to die off at 140°F. Proofing cabinets are designed to maintain temperatures between 75° F to 85° F, which is ideal for allowing dough to rise properly.

Proofing

Ovens in Bakery industry

Ovens are one of the most important components of any bakery unit. It is a thermally insulated chamber, and used for heating, baking or drying. Good ovens are equipped with many accessories and mounting to control and monitor the operation. There are intelligent ovens, which are programmed as per the recipe and controls the operation in sequence.

There are several types of ovens, and selection is done on the basis of capacity, product and budget.

1. Rack Oven: Rack ovens or revolving ovens are used in bakeries producing high volumes of breads, bagels. In this oven racks revolve around a central shaft above a heating element typically situated at the bottom of the baking chamber. A typical rack oven
2. has several shelves made of metal or stone. These shelves are connected to a central horizontal shaft. An external motor spins
3. the shaft, which, in turn, moves the shelves around and revolving motion of the shelves creates uniform baking.

Rack Oven

4. Deck Oven: Deck ovens have multiple decks, which is normally made of ceramic or stone. The food items to be backed is placed on the deck. There are two heating methods
5. in the deck oven. It is called conductive heat, which is transferred directly from the deck to the dough and the other
6. is radiant heat, which comes from the hot air in the baking chamber and penetrates the dough to cook it further. Sometimes, deck ovens have steam injection system which releases water vapor into the cooking chamber. It gives a perfect crisp, brown bread crusts covering a soft and fluffy inside. Artisan breads, such as baguettes, ciabatta, and sourdough bread, are best made in deck ovens.

Deck Oven

7. Conveyor Oven: It is a continuous process, used when volumes are high. It consists of a belt conveyor which move through a baking chamber. These ovens cook baked goods which are placed on conveyor belts. The oven creates jets of hot air and blows this air to the food. The force of the heated air allows it to easily break the barrier of cold air around the uncooked food, thus leading to faster cooking. Since the speed of the belt remains constant throughout the baking process, all items come out of the chamber similarly cooked as every other item. Conveyor ovens are very simple and easy to use. They have programmable controls that take care of the time and speed settings for you. The conveyor ovens have got some limitations. It cannot bake everything. The openings typically measure 3" to 5" in height, severely limiting the items you can bake to those not taller than the narrow opening. Cakes, breads, puff pastries, and other baked goods that need to rise or retain their moisture may also break down or dry out under the strong blasts of hot air.

Conveyor Oven

Conveyor Oven

Bakery Refrigerator

Bakeries need a refrigerator for keeping raw materials such as eggs, fresh fruits, milk, butter etc. cool and fresh. Refrigerators are used for keeping finished goods also. There are several types of refrigerators used in industry. The selection is again made based on the production volume and budget. Few of them are

1. Reach in Refrigerator: This refrigerator is very common and is used in almost all commercial kitchens, can store variety of items.

2. Freezer: Freezers are also available in many configurations. The most common freezer is the upright cabinet, which is very much similar to reach-in refrigerator. It has multiple shelves.
   High-volume bakeries may invest in bigger units, such as roll-in and walk-in freezers for bulk storage. These models are large enough to let you roll in entire oven racks straight into the freezer.

3. Worktop Refrigerator: These are multi-functional units that have a refrigerated interior for storing ingredients and a sturdy worktop for preparing your food products.

Refrigerator

Worktop Refrigerator

Blast Chiller

Blast chillers bring down the temperature of the cooked items quickly and then stored in the refrigerator or freezer. IQF (Individually Quick Frozen) is also used in many cases for frozen bakery items.

Blast Chiller

Bread Slicer

Bread slicer is used to cut loaves of bread into several slices in a single swoop. Commercial slicers typically have sharp blades spaced out at standard dimensions. A lever on the side lets you lower the blades to the loaf, cutting it into equal sizes that can then be packed into a bread bag.

Bread Slicer

Weighing scales

Other items

1. Bakery Tables and Racks: Strong and sturdy tables are used to accomplish most of the baking tasks, from hand-rolling, kneading, and cutting dough to slicing, peeling, and chopping ingredients and decorating your cakes, pastries, and other baked goods. It has a smooth, polished surface that is easy to clean and sanitize.
2. Oven Racks: Oven racks are useful for holding large quantities of full-size and half-size sheet pans. These racks can be transferred in refrigerator for cooling, in the proofing cabinet for proofing, or in the oven for baking, oven racks let you move and processes high volumes of food items at once.

Working Table

Oven Rack

4. PACKAGING OF BAKERY AND CONFECTIONERY PRODUCTS

Definition:

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

Packaging, although is a subject of recent technological origin, the art of packaging is as old as primitive humans. Use of leaves for wrapping of meat, animal skins for storage and carriage of water were practices as old as the human race. With the passage of time and continual technological growth. Systems have undergone change and along with them grew the packaging scene, though at a much slower pace.

But today, packaging is no more considered in isolation. It has been considered an integral part of production, marketing and distribution. In other words, if packaging is to perform its function properly, its requirements should be considered at as early a stage as possible i.e. at the design/formulation stage of the product itself. The other related area is marketing. These interlinked responsibilities of a package lead to the fact that the packaging function is closely associated with

many other functions in an organization. Effective communication is, therefore, important because of the diverse disciplines represented by packaging – these include chemistry, physics, engineering, marketing, design, law, accounting etc. similarly, in an or organizational set- up the packaging function is inter-related and is illustrated in diagram 1.

Two major functions are purchase and marketing. The purchasing function i.e. "buying" is responsible for all developments. Liaison with outside suppliers and appraisal of the developmental personnel, of new materials systems techniques etc. form a major responsibility.
Marketing involves keeping a close liaison with those in overall product responsibility including packaging.

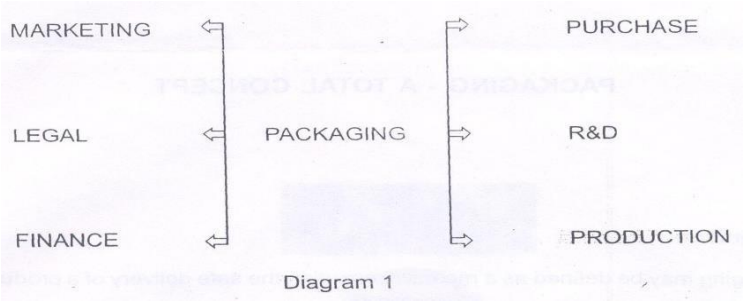


Diagram 1

They act as the chief sources of information and obtain feedback from the market and help the developmental team to effect changes as, how and when required. The responsibility assumes greater dimension during new product introductions and product cycles and duration. During the initial stages of new product development, the marketing and consumer research functions, together with designer's work with the packaging team to assess and develop package shape, quality, material and design. Legal exports are consulted on the validity of pack copy and on matters affecting trademark. The research and technical team is involved in the development of product and of packaging. The role of finance needs little emphasis.

It could therefore be seen that to function effectively and efficiently the packaging man needs knowledge of various disciplines and techniques used in these interlinked and interdependent departments to achieve the objective.

PACKAGING CRITERIA

Package development is based on and influenced by many entities and could be broadly classified into five criteria groups:

a) Appearance
b) Protection
c) Function
d) Cost
e) Disposability

These are the main considerations when developing a pack. The relative emphasis placed on them depends on the product and on its marketing requirements.

A. APPEARANCE

The appearance of a package is important from many angles and this aspect gains greater importance with the growing supermarkets and cash-carry systems of marketing distribution. It helps to:

I. Identify the product throughout the distribution channel.
II. Carry instruction for use and disposal.
III. Carry information about contents and satisfy legal requirements.
IV. Carry brand name/ manufacture's name.
V. Act as an important sales aid.

The appearance of a package is dependent on shape and surface decoration. While the shape relates to the mechanical aspects providing a physical contribution, surface decoration is mainly a marketing tool. Further, the package appearance must be eye caching.

B. PROTECTION:

Protection required by the product will vary enormously with the nature of the product, the final destination, the distribution system and the total time (shelf life) that the protection is required for the nature of protection expected of the package will also vary with the package system. Protection is normally required from environmental and physical hazards. While a unit package must provide protection from physicochemical and biological hazards, a bulk package is expected to protect the contents against the rigors of handling, storage and transportation. Another important aspect with the unit package system is product package compatibility. Pilferage, what can be done is to evolve

suitable design to make it more difficult to Pilfer and identify easily such attempts.

(c) **FUNCTION:**

The functions a package is expected to perform will depend on the end user requirements and the requirement to suit the packaging line/ system.

End use performance is important because defects and limitations will adversely affect customer satisfaction resulting in reduction in sales. End use package functions include display, easy of opening, convenience, dispensing, and reuse quantity level.

Display includes surface decoration for sales appeal and impulse buying and has been dealt with later. The second factor is product visibility. Not air products can be packed in display cartons with provision for visibility, as many products need protection from direct exposure to environmental conditions. When visibility is required, it is usually an aid to environmental conditions. When visibility is required, it is usually an aid to identification or to add sales appeal to the finished pack. This trend is on the increase in large chain stores.

Ease of opening is a customer aid and is an addition to the sales feature. This, however, is a difficult function to satisfy since it combines the need to maintain seal or closure integrity till pack is opened. Such in built devices become more useful where a pack is difficult to open without loss of content like a plastic pouch for liquids. Many innovations are made that include tear tape for film overwraps, pull off rings and the like.

The need for convenience in packaging has led to the growth of packs where package and product are integrated. The term convenience revolves round many other factors which include ease of dispensing, easy of handling etc. Product-package-integrated system also helps control dispensing quality. Typical examples of convenience pack are boll-in-bags, dinner packs, aerosols etc.

As discussed earlier, dispensing is in a large way integrated with ease of opening and convenience. Many devices are developed for easy dispensing- like pourers, spouts, taps etc. These not only aid easy dispensing but also control quantity, thereby helping the consumer dispense product in required/measured quantities and prevent product loss.

Performance of a package material on a machine in the packaging line is of significant importance

as it affects production. Material properties and container design play a major role in this direction. It is difficult to separate a package from a machine which is used to handle it, fill it and seal it – all in a one line operation or individually. Package and machine design are often interdependent and so packaging/ machinery interface must be taken into account at an early stage. Modern approach is to ‘’product filled packaged’’ from film or sheet without any intermediate package, being formed. Introduction of any new materials and designs can pose great problems particularly with the above type of machines. A change of design may necessitate changes in filling equipment ranging from a simple modification to a complete filling line.

(d) <u>Cost:-</u>

The definition on packaging quoted earlier emphasized the delivery of the product in a sound condition at minimum overall cost. Thus the cost factor has a direct impact and the components of ‘overall cost’ need to be clarified. It is needless to stress that costs associated with packaging are incurred right through any operation and that basic material or container costs should never be considered in isolation. The factors contributing to the overall cost of packaging a particular product are:

- Package cost (materials purchased).
- Storage and handling costs of empties.
- Quality control cost.
- Packaging line operations costs.
- Storage costs of filled packages.
- Costs due to package/ product loss/spoilage.
- Costs due to loss of goodwill affecting sales,
- Effect of the package on Sales.

The above should thus be a reminder for those who consider having achieved economy through a direct saving in material/ package cost. In deciding package cost, one must consider the effect of potential loss of customer goodwill. If alternate systems are developed for the packaging of a product, one must decide whether to maintain the same packaging cost and reduce the loss rate or to reduce the packaging cost and keep the loss rate constant, also taking into consideration the effect on customers.

The preparation and implementation of a package cost reduction programmer is one of the main responsibilities of the packaging function. Modern management methods such as value analysis are valuable aids to this task.

(e) Disposability:

The packaging industry, particularly in the developed countries, comes in for severe criticism on the ground that it contributes appreciably to environmental pollution and is a major waste of the earth's resources. Thus disposal of packaging materials after use assumes greater importance, although
It was considered a minor problem hitherto. The term disposability can mean, any way in which the packaging material can be eliminated or converted at the end of its useful life as a package. This can be achieved through three methods.

Recycling: this is not entirely a new concept. It involves the use of the discarded package to produce new packaging.

Non packaging applications: This approach has not been widely and commercially adopted, although it appears to be one of the possible and acceptable solutions to the problem. There are typical instances where non packaging applications are in vogue. To cite a few examples: use of waste glass as filler in asphalt road making material. Shredded plastics are partially granulated, foams as heat insulating in-fill for building panels, metal(beer) cans for free seeding, and granulated expanded polystyrene waste as soil conditioners.

None withstanding the above, it appears certain that normal waste disposal methods will account for the major proportion for some time to come. The commonly adopted three methods of
disposing waste matters are- sinking in the seas, burying underground and burning. However, landfill and incineration are two major methods employed.

The issue of packaging waste is discussed at various levels and in many developments studies are in progress. Over packaging, non- returnable packages are two specific areas in this direction, which have their advantages and disadvantages. Development of degradable package assumes significant importance.

CONCLUSION

There has been an enormous growth in the packaging industry during the last three decades, as also in the fields of materials and machinery. The integrated concept of packaging with product design or formulation, production, marketing and distribution only emphasis that packaging and its development are of ever growing importance to every organization.

FUNCTIONS - PACKAGING OUTLINE

1. **Packaging** - an integral part of production
   - part of physical distribution
   - a tool for marketing

2. **Functions of package**
   Contain
   Preserve
   Protect
   Present
   Dispense

3. **Package is selected in accordance with the product characteristics**
   Packaging characteristics of a product are:

   i) Physical
   (a) Physical State
   (b) Weight
   (c) Stability
   (d) Rigidity
   (e) Surface Finish

   ii) Physico-chemical effect of
   (a) moisture
   (b) Oxygen
   (c) Mould-bacteria, fungi
   (d) Ambient temperature

4. **Package is selected taking into account the nature of protection needed.**

5. **Other attributes of a package are:**

   i) Easy to open
   ii) Easy to close
   iii) Easy to dispose of

iv) Easy to dispense
v) Easy to recycle
vi) Easy to identify
vii) Inform
viii) Eye appeal
ix) Warn

6. When designing the pack the following are also borne in mind :

i) Process of manufacture of the product
ii) Machinery used for packaging operations
iii) Machineability of the materials
iv) Scale of operation

7. From the point of view of storage, handling and transportation, the package should be ;

i) Easy to handle
ii) Provided with handling facilities like lifting hooks
iii) Amenable to quick examination of contents.
iv) Easy to stack

8. The packages for shipment are designed taking into account the hazards of the journey.

i) Drop
ii) Vibration
iii) Impact
iv) Comparison
v) Rolling
vi) Environment
vii) Other - minor hazards like tear, tension, etc.

9. Packages can be evaluated for their export worthiness, transport worthiness through simulated tests in a laboratory.

10. Packaging materials available in India are :

i) Black Plate (mild steel plate)
ii) Tinplate (tin coated on steel plate)
iii) Tin-free steel
iv) Aluminium container
v) Aluminium foil
vi) Aluminium slugs for manufacture of collapsible tubes
vii) Paper - Poster paper

- Kraft paper
- Brown paper for packing and wrapping
- Coated paper

Speciality papers-Tissue
Parchment
Greaseproof
Glassine
Coated paper : wax

vii) Paper board Pulp
Duplex
Triplex
Grey
Mill
Solid
Corrugated
Moulded

ix) Plastics Polyethylene - High Molecular High Density
Low density
Linear low density
Shrinkable film Tape (of HD)

Polypropylene - Homopolymer - Copolymer
Polyvinyl chloride- compounds
Polystyrene - General purpose High impact Polyester for film
For Bottles (chips)

x) Cellulose film (Regenerated)
xi) Glass - Tubes
Bottles
Vials
Ampoules

xii) Wood and Plywood
xiii) Jute/Cotton textile
xiv) Laminates/of paper/PE/foil/cellulose/PP/nylon/PVC/PET/coatings -PVDC Ionomer, EAA,EVA

11. Some specialty packages are :

i) Aerosols of aluminium and tinplate
ii) Strip packaging using laminate/coatings
iii) Blister packaging - using foil & PVC and paperboard
iv) Skin packaging - using PVC
v) Multiwall sacks - of paper

vi) Shrink packaging - using polyethylene, PVC and PP Shrink films
vii) Polyethylene and PP woven sacks
viii) Fibre drums - using paper and metal or wooden ends
ix) Composite containers - of tinplate/paper
x) Stretch wrapping - tinplate/plastic

12. New developments are :

i) Automatic strapping and sealing using PP straps
ii) PET & PVC bottles - Stretch blow moulded
iii) Leak proof composite containers using paper and foil and plastic films
iv) Multilayer plastics - three to five layers
v) Cast PP films
vi) Metallised BOPP and cellophane
vii) Expanded use of stand-up pouches
viii) Edible oil packaging in pouches of plastics
ix) Linear low density polyethylene film
x) Tetrapack (Fruit) and Tetra Brik (Amul)
xi) Laminated collapsible tubes
xii) Nesting aluminium collapsible tubes
xiii) Thermoformed packages of processed foods
xiv) Formed containers for foods - e.g. Yoghurt - Icecream
xv) Pad printing on plastic containers
xvi) 'Twist-on-Twist-off' cap of tinplates for glass bottle - 4 lug finish
xvii) Containers for fast foods - PS Mould

PACKAGE COMPONENTS

Package serves mainly as a protection device to avoid deterioration of the quality of the contents against external agencies. However, in many instances packages have also to be designed taking into account the marketing considerations such as sales appeal, easy openability, handling convenience and distribution factors etc. It will thus be desirable if important package components be classified and studied to know what are their functions and duties. A broad classification of package components is given below:

1. Unit pack

2. Intermediate pack

3. Outer or shipping container

4. Inner packaging components

5. Closures

6. External reinforcements.

1. **UNIT PACK**

It is considered that unit package should be able to protect the product against quality deterioration. The quality deterioration can be due to a number of factors such as water, watervapour, light, microorganisms, gases like oxygen etc. Naturally the material selected for unit pack should have adequate functional qualities to serve such function.

When unit package serves as retail pack it may have to have good sales appeal, easy operability or reusability also.

Some of the common types of until packages are given below

1. Metal containers such as aluminium containers, tinplate cans, collapsible tubes etc.

2. Composite containers made from tinplate and paperboard, plastics and paperboards.

3. Glass bottles.

4. Plastic containers

5. Cartons made from paperboards.

6. Pouches made from various flexible materials, plastic films.

ii. INTERMEDIATE PACK

The purpose of adoption of intermediate packs can be

i) Unitisation

ii) Marketing requirement

iii) Display value

Various materials are used for intermediate packages and some of them are given below.

i) Paperboards such as greyboard, duplex board, corrugated board etc.

ii) Flexible materials used as wrappers/ covers - Kraft paper, bitumen sandwiched Kraft,

plastic films.

iii) Shrink and stretch films.

iii. OUTER/SHIPPING CONTAINER

Shipping containers are supposed to carry out following functions:

I) To protect the contents from journey hazards such as shocks, vibrations, drops and climatic hazards like rain, dust, seawater etc.

ii) To provide for easy handling, storing and transportation.

iii) To provide for identification.

Principal shipping containers are:

i) Timber/plywood cases/crates
ii) Wooden barrels
iii) Steel and aluminum drums
iv) HDPE /LDPE drums
v) Fiber board drums
vi) Solid/corrugated fiberboard and combination board boxes
vii) Sacks of paper/plastic/jute/textile/laminate
viii) Bales.

IV INNER PACKAGING COMPONENTS

Inner packaging is given within the package (outer container or unit pack) for protection/barrier purposes. Inner packaging components can be in various forms and some of them are indicated below:

i) Positioning devices and supports
ii) Separators
iii) Clearance - blocks/pads
iv) Suspension devices
v) Cushioning materials
vi) Barrier materials to achieve - Protection from dust, oils, watervapour etc.
vii) Labels.

For the purpose of various devices in (I) to (vii) above, the materials used are - wood plywood, fibreboards, cushioning materials etc.

The different cushioning materials used are polyurethane foam, polystyrene foam, rubberized chair/hair, springs, felts, wood wool, etc.

Various barrier materials used to prevent dust, water vapour, oil etc. are generally plastic films and their laminates.

For labels, materials like paper, plastic or foil laminates are used.

iv. CLOSURES

Closure is the weakest point in the pack. Depending upon the type of pack, materials used for closures differ. Some of the devices for closures are indicated below:

i) Nails for wooden box.
ii) Screw type closures for some type of tin containers and glass bottles
iii) Adhesive or gum tapes/C.R tapes for fibreboard boxes
iv) Plastic caps for bottles, collapsible tubes.

VI. EXTERNAL REINFORCEMENTS

I) Strengthening the shipping containers
II) Improve stacking strength
III) Avoid bursting in case of failure
IV) Increase weight carrying capacity
V) Protect the corners/edges

THIS CAN BE ACHIEVED BY

i) Providing Girthwise battens to wooden containers
ii) Steel/wire strapping in girth direction for wooden containers
iii) Giving corrugated bends to cylindrical drums
iv) Using L angles
v) Using steel corners for wooden containers
vi) Rayon/Nylon/PP straps for corrugated board container

FOOD PACKAGING TECHNOLOGY FOR PACKAGING OF BAKERY PRODUCTS

Introduction

Bakery products are becoming a major part of the international food market, the baking industry is undergoing a period of rapid change. Baking industry must try to satisfy the healthy eating trends and the consumer demands for fresh products. Food technologists have to select the suitable type of packaging that will ensure the necessary shelf life for bakery products. The success of the product in the market must be based on the design and the production both with the very best raw materials and advanced technology.

The principal function of food packaging is to minimize reactions that affect the stability of the product. Mold spoilage is common in the bakery industry and in many cases; mold growth determines the product shelf-life of both high-moisture and intermediate-moisture baked. Baking destroys most molds. However, during cooling and packaging, recontamination can occur and cause growth to take place.

Table - Cause of deterioration and their prevention for bakery products

Bakery food	**Cause of deterioration**	**Prevention**
Bread and Cake	Improper hygienic conditions during production	Proper hygienic conditions during production
	Fungal growth	By using modified atmospheres containing 70±100% CO_2 and 0±30% N_2 or by removing O_2
	Staling	High H_2O barrier material
Cookies and Crackers	Crispness	Proper moisture barrier in the package
	Oxidation of the fat fraction	Low O_2 atmospheres with high O_2 barrier packaging materials, On-translucent packaging materials (light-induced oxidation)
	Fat bloom and Breakage	Control temperature

Packaging Material Used for Bakery Products

Different packaging material is used for different products depending on the type and composition of the product

Packaging materials used for cereal based food packaging

Food application	**Packaging materials**
Fresh bread, sandwich	Waxed paper Nitrocellulose coated cellophane (MS) Low density polyethylene (PE-LD) Polypropylene (PP)

Bread bags, sandwich bags, frozen food bags Crusty bread, pies, Bread crumbs Biscuits	Linear low-density polyethylene Cellulose/Polyethylene/Cellulose Polyethylene/Polypropylene Paper/ Polyvinilydene chloride/Polyethylene Paper/Polyethylene/ Polyvinilydene chloride (PAP/PE/PVDC) Oriented polypropylene/ Oriented polypropylene (OPP/OPP) Oriented polypropylene/Paper (OPP/PAP) Oriented polypropylene /Paper/Aluminium foil (OPP/PAP/Al) Oriented polypropylene/Aluminium foil/Hotmelt (OPP/Al/Hotmelt) Coextruded oriented polypropylene/ Coextruded oriented Polypropylene (OPPcoex / OPPcoex) Coextruded oriented polypropylene/ Coextruded metallized oriented polypropylene (OPPcoex/OPPcoexmet) Polyvinylidene chloride coated cellophane (MXXT)
Cakes, biscuits, Crisps, snack foods, biscuits	Aluminium foil/Paper Polyvinilydene chloride coated polypropylene/ Polyvinilydene chloride coated polypropylene (PVDC-PP/PVDC-PP)
Cereal meals Baked products	Paper/Polyethylene Polyethylene terephthalate /Polyethylene (PET/PE) Polyamide (Nylon)/ Low density polyethylene (PA/PE-LD)
MAP - Baked products	Polypropylene/ Ethylene vinyl acetate (PP/EVAC) Metallized polyethylene terephthalate /Polyethylene (PETmet/PE) Polypropylene/Low density polyethylene/Ethylene vinyl Acetate (PP/PE-LD/EVAC) Oriented poly (ethylene terephthalate)/ Polyvinilydene chloride/ Polyethylene- Polyvinyl chloride/Polyethylene (OPET/PVDC/PE-PVC/PE) Oriented metalized poly (ethylene terephthalate)/Polyethylene (OPETmet/PE) Oriented polyethylene terephthalate/ Polyvinilydene

Flexible packaging

Flexible packaging is the oldest form of packaging. It is produced by converting paper, film, or foil, alone or in combination, for use in consumer and industrial applications. Most flexible packaging is printed. It includes casting, extruding, metallizing, coating, printing, embossing, slitting, laminating, folding, sheeting, or heat sealing of flexible or semirigid materials, converted from films, foils, and paper. Social and economic factors have stimulated new technology in the flexible packaging industry. The reduction in the size of the average family unit, the rising number of older people, and the increasing number of single-person households have created a need for convenience foods and single-portion servings and small package sizes. These stimulate new product designs, new materials, and new manufacturing processes. Flexible packaging includes a diverse group of products such as candy wrappers, snack bags, bread wrappers, clothing, grocery bags, and multiwall bags.

Wrapping Styles

There are several popular wrapping styles, which are applied widely to a variety of biscuits (of all shapes and sizes) and other bakery products. Biscuits packed using the following two wrapping styles must be of common size and shape with a certain consistency and rather narrow tolerances in their dimensions.

Endfold Wrapping

This wrapping style is the classic, traditional biscuit wrapper. A portion of biscuits standing on edge is roll wrapped or fold wrapped into a heat sealable film. The longitudinal packet seal is sealed tightly in a fin seal style. The packet ends are folded neatly and heat-sealed. Due to the neat and tight surrounding of the film, this packet gives utmost mechanical protection and acceptable barrier properties for hard and semi hard biscuits and many other cracker types. Enfold wrapping is considered the most effective in terms of presentation by many marketing specialists - not only due to neat and impeccable shape, but also due to its ability to clearly distinguish the product amongst the host of pillow pack items on the retail shelves.

Pillow Pack Wrapping

This is the standard wrapping style for smaller biscuit packs (snack packs/single serve packs) containing one or more piles of biscuits. In addition, pillow pack wrapping is used for bigger packets with products standing on edge (Slug wrapping) as well. In this configuration, it often serves as a primary wrapper, to be overwrapped by a carton to improve presentation and acceptance. The main advantage of pillow packs on edge, is its flexibility with regard to the slug length. For instance, it allows the machine to automatically adjust the length during wrapping by means of tendency-controlled check weighers. This feature ensures the highest weight accuracy. Additionally, the pillow packs typical fin seal style sealing is somewhat tighter than the enfold wrap. This disadvantage of pillow pack slug wrapping is its limited mechanical product protection due to its rather loose packing. Further, the presentation of products packed using the pillow pack style is considered by most to be less attractive than enfold packets.

Packing for Odd-sized Biscuits

Besides enfold wrapping and pillow pack wrapping, which by the way cover about 85-90% of all biscuit products, there are some specialty biscuits with their own unique wrapping needs. These include an assortment of small cocktail crackers filled in bags by vertical FFS (film forming style), machines and cookies of uneven sizes whose tolerance do not allow a standard wrapping.

Modified atmosphere packaging (MAP)

Modified atmosphere packaging (MAP) is used to increase the mold free shelf-life of bakery products.

Table-15.3: MAP gas mixture for bakery products

Food	Gas mixture		Storage Temperature °C	Shelf life	
	CO_2	N_2		MAP	In air
Fresh pasta	50	50	0 to+5	3–4 weeks	1–2 weeks
Bakery products	50	50	0 to+5	4–12 weeks	4–14 days
Pies	50–70	30–50	+4to+6	2–3 weeks	3–5 days
Cakes	20–40	60-80	+20 to+25	Even one year	Max. Some Weeks
Rye wheat bread	20–40	60-80	+20 to+25	2 weeks	Max. Some Days
Pre-baked bread	80–100	0-20	+20 to+25	20 days	5 days

Shelf Life of Packaged Bakery Goods

There are different types of product changes that can limit the shelf life of food. Essentially, the shelf-life of a food, i.e. the period it will retain an acceptable level of eating quality from a safety and organoleptic point of view, depends on four main factors (a) formulation (b) processing (c) packaging and (d) storage conditions. In today's modern processing terminology these factors are addressed in the HAACP (Hazard Analysis Critical Control Point) concept, a comprehensive quality control-quality assurance methodology that aims to ensure both food safety and high quality.

Packaging materials used for atmospheric (air), modified atmosphere (MAP) and active packaging of bakery products:

Bakery products	**Packaging material (Thickness)**	**Gas permeability ($cm^3/m^2.day.atm$) WVP ($g/m^2.day$)**	**Packaging conditions**
Bread	Laminate with EVAL	CO_2 = 2.3 O_2 = 0.45	
Bread	PE		Air+Ca-propionate
Wheat bread	Laminate with EVAL (95µm)	O_2<2 CO <2.3 WVP<1	Air; 100 CO_2; 50% CO_2+ 50% N_2
Wheat bread	PP film		AP: O_2absorbent
Wheat bread	PE		AP:O_2-absorbers+ K-sorbate
Soy bread	PVDC/PET/PVDC	20% CO_2+80% N_2	

Soy bread	PE-LLD/PA/EVAL/PA/ PE-LLD	MAP: 50/50; 20/80 CO_2/N_2+Ca-propionate	
Bread slices	Cryovac^R BB4L bag (60μm)	O_2=35 CO_2=150 WVP=20	Air-, Different MAP+/− Ca-propionate Different MAP+
Wheat and Rye bread	OPP/(PE-LD/EVAL-PE-LD) (70μm) PA/EVAL/PE (160μm) PA/EVAL/PE (160μm)	O_2=3 WVP=1 O_2=2 WVP=7 O_2=3 WVP=1.5	AP:O_2-absorbers AP: mustard oil AP: mustard oil + different MAP 80% CO_2+1%O_2+AP: mustard oil in 96% ethanol; Air
Pre-baked buns	PE-LD (80μm)		AP: ethanol emitters
High moisture/pH bakery Products	High-gas barrier bags (Cryovac^R) VF 52 metallised bag O_2=0	O_2=4 O_2=0	AP: water-ethanol and mastic oil-ethanol emitters
Meal ready –to-eat bread	PET/Al/PE		AP:O_2-absorbers
Sponge cake	OPP/(PE-LD/EVAL/PE-LD)/PE-LLD (95μm)	O_2=2 WVP=1	
Sponge cake	PA/PE (90μm)	O_2=19.9 CO_2=164.9 WVP=2.6	Air; Different MAP+/− O_2-absorbers
Pre-baked pizza dough	Bicor^{TM} MB777 (21μm)		Air; Different MAP+/− Ca-propionate
Fresh lasagna pasta	PVDC/PE (80μm)	O_2=8.63	AP: O_2-absorbers

With respect to shelf life, key factors include the moisture content (or a_w), pH, and the addition of microbial preservatives and antioxidants. Once the food leaves the processing stage its keeping properties and the extent to which it will retain its intended at-tributes is a function of the microenvironment in the package. The important parameters are gas composition (oxygen, car-bon dioxide, inert gases, ethylene, etc.), the relative humidity (% RH), pressure or mechanical stresses, light, and temperature. These parameters are dependent on both packaging and storage conditions.

Major modes of deterioration, critical environmental factors and shelf- life by food product:

Food product	**Mode of deterioration (assuming an intact package)**	**Critical environmental factors**	**Shelf life (average)**
Fresh bakery products	Staling, microbial growth, moisture loss causing hardening, oxidative rancidity	Oxygen, temperature, moisture	2 days (bread) 7 days (cake)
Breakfast cereals	Rancidity, loss of crispness, vitamin loss, particle breakage	Moisture, temperature, rough handling	6-18 months

Pasta	Texture changes, staling, vitamin and protein loss	Too high or low moisture, temperature	Pasta with egg solids 9-36 months; Macaroni and spaghetti 24-48 months

Conclusion:

Packaging of bakery products improve the shelf life of the products and ease of storage and transportation. Packaging technologies, such as MAP, help to maintain the quality and freshness of the products. Still, there is a scope to develop new packaging technologies to minimize the risk associated with packaging material.

5. PLANT LAYOUT AND MAINTENANCE FOR BAKERY AND CONFECTIONERY PROCESSING:

Hygienic Engineering

Food Safety" can be consistently achieved by adherence to various Hygienic Engineering concepts. A hygienic engineering concept can be as simple as "washing hands when entering production areas" or as complex as "using metal detectors in interlock with production process". Hygienic Engineering (HE) refers to application of concepts by which a manufacturing facility is designed and constructed for sustainable production of "safe, reliable and consistent products". HE aims to avoid product contamination. This requires deep knowledge of process and product. Each product group or process area needs own specific hygienic requirements. Hygienic engineering aims to eliminate sources of contamination and restrict movement carriers.

Hygienic Engineering captures many concepts, from simple to complex, but ultimately is use of **"common sense"** towards ensuring production of **"safe, reliable and consistent products"**.

Hygienic Engineering is easy to implement in Project Design, extremely difficult to implement during Project Execution, and impossible to implement after completion of project. Therefore, **"start early"**

Means to Hygienic Engineering

1. Building Design

It includes the building and several building components that are meant to provide a safe place for processing, packing, and storage of food products. Building Must not become a source of contamination, nor facilitate growth of microorganisms or ingress of pests.

2. Zoning and Air Handling Design

It Includes optimally providing for the environment conditions and control for each part of

the food factory. Considerations on parameters of temperature, humidity, filtration, and positive pressure. And in no case must become a source of contamination, nor facilitate growth of microorganisms.

3. Equipment Design and Installation

Design for contamination free processing of food products, Installation for cleanability and maintainability, A poorly designed equipment cannot manufacture safe products and Even the best design equipment if poorly installed will be a constant food safety risk.

4. Work like an Engineer

What an engineer must do is- Systematic project execution facilitating Hygienic Engineering in Basic Design, Detail Design, Execution and Commissioning stage.

Building Design

1. Basic Design and Concept

Design buildings as per functions e.g., production, industrial services, stores and warehouses, laboratories, canteens and amenities, administration block, truck/ car parking, etc. Adhering to statutory and legal compliances, Control of Foreign Bodies e.g., rainwater, pests, external contaminated air, etc., Other Considerations.

2. Masterplan Document

A good masterplan should show site limits and external access, building outline and internal roads, production and service areas and surroundings, categorization of areas basis hygiene zones, cleaning practices, function , man and material movement, potential problems sources: nearby housing, industry, etc., waste collection area and movement, connection point to public utilities: sewer, water, power, etc., future provision and expansion plans.

3. Room Design

Design must suit operations carried out in them e.g., placement of equipment, storage of materials, facilitate cleaning and maintenance, etc. and must control access of personnel and material using designated pathways to prevent cross-contamination of the product.

4. Boundary Walls and Fences

Boundary Walls and Fences should have a combination of 2.1m high masonry wall with barbed wire on top while Plant Main Gate to be Sliding or Swing Doors with separate man and vehicle movement paths. Well- constructed security cabin, visitor waiting room, etc. with CCTV and ample space in front and inside to manage man/ vehicle congestion.

5. Building Structure

Types of Building Structures are Reinforced Concrete Construction (RCC) with Masonry walls, Structural with Sheeting (including Pre-Engineered Building - PEB), EPS/ Puff Panel, etc. or Fully Reinforced Concrete Construction (RCC)

6. Visitor Gallery

Design as per need and requirement. visitors do not need to access production area to see the plant. It is generally isolated from manufacturing zone.

7. Loading and Unloading Dock

Use of dock levelers, dock shelters, overhead/ high speed doors, air curtains and strip curtains are advisable. Controlled movement of raw material vehicles and drivers covered reception area with appropriate lighting and Open structures designed to prevent bird sittings, and pests with Air Lock room between plant warehouse and loading/ unloading dock.

8. External and Internal Walls

Wall types are- Traditional (on-site masonry or concrete), Prefabricated (sandwich panels or pre-cast concrete blocks), Combined (prefabricated panels on traditional wall)

General considerations include light colored, dense, tough, impact resisting, durable, rust proof, impervious, non-absorbent, washable, water repellent and constructed of non-toxic materials, Joints at wall to wall/ ceiling chamfered and sealed and no horizontal surfaces and sills .

9. Building Roof

Basic types, Pitched, and Flat. Recommended practices is to have flat concrete roofs to have 2% slope on top with waterproof and self-draining capability and easy access and clean ability.

10. Ceilings

Ceilings are the visible upper surface of a room/ area, which may be Lower surface of upper floor or lower surface of roof structure. Types of ceilings are real ceilings, false ceilings, and Walk-on ceilings.

11. Floors and Finishes

Basic Types, Traditional (not-recommended) – cement based, kota stone, etc and Industrial Tiles, Epoxy, Polyurethane, other resin based self-leveling joint free flooring

Selection criteria is hygiene level and zone type (inside / outside factory), Strength/ impact resistance required (man movement, material movement), Nature of cleaning (Dry/ Wet) and other operational requirements.

12. Doors

Door selection or classification is as per location, design, material of construction and requirement. Recommended practices are SS 304 doors for Wet Process and Powder coated MS doors for Dry Process areas, having Color as per zoning, e.g., Emergency – Red, Normal – Blue, High Speed – Orange, etc.

13. Windows and Louvers

Windows let in light while separating two rooms or zones, while Louvers provide ventilation between them. Windows can be Single/Double, Insulated, Safety, Opaque; while Louvers can be made of Glass, Metallic, Concrete, UPVC.

14. Machinery Foundations

Design for minimum floor supports to enable maximum access for floor cleaning. Examples of good concepts are raised Civil Plinths- 100mm or higher concrete plinths, chamfered SS-304 base plates, coving, having adjustable Ball Feet: SS-304 adjustable ball feet providing 150mm clearance from floor level and Equipment Skids: Multiple equipment supported with minimum floor supports.

15. Structural Platforms

Generally used for access to equipment for operation, maintenance, cleaning, etc. Traditionally, constructed of angles/ channels with stitch welding and numerous points of microbial risk due to lack of cleanability.

16. Staircases

Basic types, continuous or civil type, discontinuous or structural are types of staircase. Recommended practices are to compliant to local regulations for width, mid-landings, etc. Safe and ergonomic with standard tread, risers, etc., to be easy to clean & self-draining. Handrails must be made of flat bars in high hygiene zones.

17. Lifts and Elevators

Lifts and Elevators are used where there is requirement of frequent travel by operators, with or without material as part of production. While they bring ease of movement, they are complex in construction and usually not designed for food factories, therefore special emphasis is needed

18. Drains

Drains are used for the evacuation of liquids, comprising Grating, Basket and Siphon. Choice of drain basis type of cleaning, hygiene level of area, and sensitivity of the product. It must not act as air duct from low to high hygiene area and rendering airlocks useless.

19. Wastewater Treatment

Purpose of WWTP is to equalize the wastewater load and flow, reduction of dissolved organic solids, and removal of specific nutrients (e.g. Nitrogen, etc.). WWTP are more related to environmental demands on the factory than hygiene requirements. However, their potential influence on status of hygiene within process area necessitates their Hygienic Design.

20. Canteen

Basic elements include-stores for food items frozen, chilled, dry vegetables, meat, etc., Stores for cleaning items tools, chemicals, waste. Wash area with separate equipment for cooking utensils & eating plates and separate serving area for hot & cold food to avoid cross-contamination.

21. Locker Rooms and Toilets

Basic requirements include change of clothing before entering working area with personal care before & after work and after use of toilets.

Zoning and Air Handling Design

Key topics include Zoning Plan, Zoning Barriers, Air Locks, Need for Air Handling, AHU

Design, Ducting Design, Compressed Air and Waste Handling

1. **Zoning Plan**

Zoning Plan is a drawing which shows process areas with their respective hygiene level, necessary barriers and planned traffic ways. The Zoning Plan should show Hygiene level of the area, Cleaning method of the area, Temperature, Humidity, Filtration classes, Positive Pressure of the environment air. Zoning can help to prevent cross contamination, prevent raw product from contaminating finished product, limit allergens to specific locations, and limit airborne contamination risk

2. **Zoning Barriers**

Objective is hygiene and product protection, plant security, fire protection, personnel safety Can be classified into Physical or Structural: Walls, windows, doors, filters, shoe-change benches, split conveyors, etc. Virtual or Procedural: Pallet-change, shoe-change, removal of outer packaging, floor markings, etc.

3. **Air Locks**

Air Locks/ Anti-rooms help in Zoning via physical separation of two hygiene zones, especially to implement GMP procedures of shoe change, uniform change, etc.

4. **Need for Air Handling**

All rooms do not require same air quality e.g., warehouse vs filling room. Air Environment control is necessary for food factories because humidity variations can cause condensation and sweating affecting hydroscopic products, temperature variations can cause microbial growth, sweating, melting, etc., dust infiltration can cause bacterial growth and contamination, room pressure variations can lead to cross- contamination and entry of contamination.

5. **AHU Design**

General Categories of AHU Systems are filtered Air Systems, filtered and dehumidified Air System s and Air Conditioning with filters being an integral component

6. **Compressed Air**

Compressed Air forms an integral part of many food processing operations e.g., conveying, etc. Contaminants from compressed air can be categorized into three categories: Solids from atmospheric air – dust, compressor wear – metal particles, dryer – desiccant dust, airline corrosion – rust, receiver corrosion – rust, maintenance – dirt, rust, paper, cloth, etc.

- Moisture- from atmospheric air, cooling jacket leaks, separator failure, dryer failure, poorly specified dryer, after cooler failure
- Oil from atmospheric air, compressor lubrication, oil separator failure

ISO 8573.1 defines the air quality classes. 1.4.1 is good for Instrument Air, but not for food contact which needs 1.2.1 quality air.

7. **Waste Handling**

Waste materials are as clean as the source generating them but become a potential source of contamination when kept too long under conditions for bacteria growth. Their transport conditions (e.g., means and routes) and storage conditions (e.g., time, temperature, moisture) are critical parameters for food safety.

1. Needs and Basic Requirements (URS)

Hygienic design of equipment is necessary to create in-built food safety in manufacturing systems. Compliance with below standards is simple way to ensure food-safe design.

- 3-A Sanitary Standards (http://www.3-a.org/)
- NSF (National Sanitation Foundation) (http://www.nsf.org/)
- EHEDG (European Hygienic Engineering Design Group, http://www.ehedg.org/)

2. Equipment Layout

Two main types of Layout flow are Horizontally placed and Vertically placed.
Processing equipment placed in a simple, logical, and functional way in relation to the process flow sheet and manufacturing step. Avoid congestion in process areas, or insufficient material storage space.

3. Materials of Construction

Can be classified in two main groups- Food grade, e.g., stainless steel or Non-food grade, e.g. cast iron.

4. Surface Finish

Product contact surface is defined as a surface in direct contact with product, or where product residue can drip, drain, diffuse, or be drawn. These surfaces, if contaminated, can result in product contamination. Non-product contact surfaces are those parts of the equipment that do not directly contact product. However, contamination of non-product contact surfaces can cause indirect contamination of the product.

5. Cleaning in Place (CIP) Systems

CIP, considered as the first step to production, consists of cleaning production lines without dismantling equipment or pipes. In some cases, disinfection or sterilization are integral steps of CIP.

Six main steps, called 6 T, are necessary to achieve a good CIP

- Titration – correct chemical concentration
- Turbulence – necessary mechanical forces for cleaning
- Temperature – optimal for type of residue
- Time – right contact between cleaning solution and soils
- Technology – suitable design of equipment
- Training – continuous and sustainable performance

Validation of CIP ensure that the first 4Ts parameters have been selected to meet acceptance criteria basis type of product/process. Localized CIP systems have major flexibility, less volume of cleaning solutions, low
operational cost while Centralized CIP systems have single area for equipment & chemicals, operation easy to supervise.

6. Flow Separation

Flow Separation is critical to food safety, as in general, both production and cleaning (CIP) is going on simultaneously in a food manufacturing facility. Selection of system based upon Automation Level, Complexity, Cost, Labor Optimization, Hygiene Level, Flexibility, Ease

of Future Expansion, etc.

7. Process Piping Systems

Hygienic Process Piping design is essential as any risk of contamination during product transfer will affect the final product quality and food safety.

8. Energy and Utility Systems

Typically include Piping or Ducting: overhead, attached to walls, floor level, vertical or horizontal, with or without insulation, carrying liquids/gases forms of various Temp.

9. Internal Transport Systems

Include all vehicles and mobile items transporting goods and circulating within the factory like forklift trucks, pallet trucks, Automated guiding vehicles in warehousing, wheeled containers: totes, ingredient containers, waste containers, trollies, etc.

10. Basic Electrical Design

Key objectives include safety of individuals and property, and Continuity of power supply and maintainability of the installations, and Flexibility for future extensions. Typical elements include cables and their supports, control and Power panels, Junction & Distribution boxes.

11. Electrical Installation

General considerations for electrical panels are to have dedicated rooms for power panels, close to control panels, Wall mounted panels and junction boxes. Floor mounted panels on 100mm raised civil plinth, IP protection of panels, switches, instruments, etc. basis zoning and cleaning procedures.

12. Lighting

Basic Types include- Main room lighting, Units to light a specific process step and Lights integrated into equipment for absorbing product.

Global and Local Standards – An Overview

Standards, certification, certifying agencies are the one we need to look up for Global and Local Standards. Project team should have knowledge to give a required output.

Standards can be specific to operations, internal company standards or specific to geography.

Plant Maintenance

Maintenance is a key point to have smooth running facility. From maintenance perspective, Breakdown Maintenance, Preventive Maintenance, Pre-emptive Maintenance and Use of Artificial Intelligence, Big Data, and Cloud Computing **"Industry 4.0"** must be considered.

A Concept – Total Cost of Ownership

The Typical and Traditional way to look at procurement cost of any equipment or item is "BUYING" cost, because it is easy, tangible, immediate. This is also called Capital Cost. A much Better and Emerging way to look is the "Total Cost of Ownership", which also includes the Operations Cost and the Maintenance Cost.

Bad suppliers, consultants, project teams tend to focus ONLY on the capital cost, to achieve objectives of low initial project cost, etc. but sacrifice the long-term benefits and gains. Total Cost of Ownership is applicable to procurement of both material and services.