
HNSEC-04 TECHNIQUES OF FOOD PRESERVATION-

Block Introduction:

The course is designed for an over view of processing and preservation techniques used in food preservation. Age old methods for preservationare drying/dehydration and fermentation. Modem methodologies for preservationsuch as Pasteurization and Sterilization Food Irradiation Vacuum Packing Canning and Bottling were developed in last three decades and they have replaced most ofthe old practices thus avoiding losses. Food preservation aims to get a quality product in higher quantity, reduce the losses during processing, and get value-added products with enhanced shelf life. The basic principles of preservation include removal of moisture content and lowering of water activity, reduction of chemical reactions responsible for the self-decomposition of food, inactivation of enzymes,and microbial activity causing food deterioration. The course details are given in two blocks covering most aspects of preservation techniques.

Block 1deals with **concept of food preservation and preparation of dehydrated products** in which two units are there. first unit deals with **concept of food preservation** while 2nd unit givesan idea about**preparation of various dehydrated products**

Block 2deals with **preservation by using sugar, chemicals, salts and advanced preservation** which comprises of three units. third unit gives details about **preservation by using sugar** role of pectin in preserved foods stages in sugar cookery sugar concentrates and principles of gel formation several preserved foods explained. in fourth unit it is described how **preservation by achieved by using chemicals, salts and fermentation** and fifth unit explained about **preservation by advanced preservation technology**

BLOCK-I CONCEPT OF FOOD PRESERVATION AND PREPARATION OF DEHYDRATED PRODUCTS:

UNIT-I CONCEPT OF FOOD PRESERVATION:

Importance of Food Preservation, Types of Food spoilage by Microorganisms and by Enzymes Basic Principles of Food Preservation Food preservatives- Use of Salt, Acid, Sugar, natural food preservatives and artificial preservatives Starting a food preserving unit Product Promotion strategies and marketing skills.

UNIT-II PREPARATION OF DEHYDRATED PRODUCTS:

Methods of drying &dehydration, different types of driers, freeze drying- lyophilisation, packing & storage Drying methods for the selected products -Rice, Sago, Wheat, Maida, Rice flakes, black gram dhal, green gram dhal, Horse gram dhal Roots and Tubers General tips with drying foods Preparation of salted, dehydrated, preserves (Traditional Indian varieties of chips, Papads, Khakharas, etc and Masala Powders, onion, garlic, ginger powder etc.).

Hands-onexperience: Drying of vegetables- peas, potato, carrot, French beans, Reconstitution of dried vegetables, Drying & preparation of powders- garlic, ginger, spices mix etc.

BLOCK-I CONCEPT OF FOOD PRESERVATION AND PREPARATION OF DEHYDRATED PRODUCTS

Despite the fact that techniques for drying food have advanced over time, dehydration is still one of the oldest ways of food preservation. Food can be conveniently preserved at home for many individuals by dehydrating it.Foods can be dried in a number of ways, including the sun, an electric dehydrator, a regular oven, a microwave (just for herbs), air drying, and solar drying.

UNIT 1 CONCEPT OF FOOD PRESERVATION:

Structure

1.0 Objectives

1.1 Introduction

1.2 Methods of Food Preservation

1.3 Importance of Food Preservation

1.4 Types of Food spoilage by Microorganisms and by Enzymes

1.5 Basic Principles of Food Preservation

1.6 Food preservatives- Use of Salt, Acid, Sugar, natural food preservatives and artificial preservatives

1.7 Starting a food preserving unit Product Promotion strategies and marketing skills.

OBJECTIVES:

After reading this unit you should be able to:

- know about food preservation;
- learn various methods of food preservation;
- know about types of food spoilage;
- study different types of food preservatives; and
- learn various scope of food preserving unit

1.1 INTRODUCTION

Human beings has engaged in substantial food preservation practices for thousands of years. It was essential to provide a year-round supply of food. With the development of the economy, food storage has grown in significance. Life now would not be feasible without the stockpiling of food. Early food preservation techniques included smoking, drying, and salting. Early man was aware of the utilization of ice and snow to preserve perishable goods. Agricultural produce fermentation has also been recognized since ancient times. Alcoholic beverages were traditionally made from barley, rice, and fruit liquids. Since 2,000 BC, fermented soybean products have been consumed in the East. Food preservation should also halt the biochemical degradation of tissues and the change of their cell contents. Heat, cold, drying, fermentation, radiation, and chemicals are used to accomplish this. Any one of these methods can also cause food to deteriorate. The method used should ensure that microorganisms are eliminated or hindered, biochemical attacks are reduced, and the food is still preserved.

Food preservation is the practice of treating and handling food in such a way as to stop or greatly slow down its spoilage (loss of quality, edibility, and nutritional value) caused or accelerated by microorganisms and to prevent food-borne illness while maintaining the food's nutritional value, texture, and flavour. Drying, spray drying, freeze drying, freezing, vacuum packing, canning, preservation in syrup, sugar crystallization, and food preservation are common ways to apply these techniques. irradiation and adding preservatives.

1.2METHODS OF FOOD PRESERVATION

The common methods of food preservation are as follows:

1.Asepsis: Keeping out microorganisms is known as asepsis.

2. Removal of microorganisms e.g., filtration, centrifugation.

3. Maintenance of anaerobic conditions, e,g., in a sealed, evacuated container.

4. Use of high temperatures e.g., pasteurization, oven drying, sterilization

5. Use of low temperatures e.g., refrigeration, cooling, freezing

6. Drying: it is the process of securing water with solutes, hydrophilic colloids, etc.

7. Using chemical preservatives that have been either added or created by microbes.

8. Irradiation.

9. Mechanical destruction of microorganisms, e.g., by grinding, high pressures, etc. (not used industrially).

10. A mix of two or more of the strategies mentioned above. One technique rarely works well on its own; most often, several are used in combination. For instance, meals that are preserved in canned form are heated up and sealed in an evacuated can.

Thermal Processing objectives

(i) Effect of thermal processing on microbial activity

(ii) Effect of thermal processing on enzyme activity

(iii) Effect of thermal processing on food quality

Thermal Processes

(i) Blanching: enzyme inactivation

(ii) Pasteurization: the destruction of pathogenic microorganisms

(iii) Sterilization: Complete destruction of microorganism0

Food Drying/ Dehydration

(i) Heat requirement for vaporization

(ii) Heat transfer in drying

(iii) Drying and water activity

Cooling and freezing

(i) Air freezing

(ii) Plate freezing

(iii) Liquid-immersion freezing

(iv) Cryogenic freezing

1.1.5 Food Preservation using Chemicals

Chemical agents which serve to retard, hinder or mask undesirable changes in foods caused by microorganisms, enzymes in foods and chemical reactions.

(i) Salt and sugar preservation Ex.: High concentration of sugar – jams and jellies

High concentration of salt – pickles and sauces.

(ii) Other preservatives Ex.: Sorbic acid, Sodium or potassium metabisulphites which are colorless and sodium benzoate which is colored.

Other Emerging Techniques

(i) Modified atmosphere packaging (MAP)

(ii) Controlled atmosphere storage (CAS)

(iii) Genetic engineering

1.3IMPORTANCE OF FOOD PRESERVATION

Food preservation uses a variety of techniques, such as drying, freezing, pickling, and irradiation, to reduce or eliminate food spoilage

Benefits of food processing and preservation include better nutrition, a longer shelf life, and more employment opportunities.

Any technique used to modify food in order to lower the number of undesirable microorganisms, increase its stability, and increase its safety margins makes the food more suited for human ingestion.

1.4TYPES OF FOOD SPOILAGE BY MICROORGANISMS AND BY ENZYMES

Spoiled food is a byproduct of harm or injuries that render it unfit for human eating. Food becomes deteriorated due to microbial activity, insect damage, physical harm, and enzymatic degradation. Depending on the quality features of the meal, all foods experience variable degrees of deterioration or spoilage, which may be physical, chemical, or biological. Foods go through physical and chemical changes that make them unsafe to eat or inedible as they deteriorate. All meals can be divided into one of the following three classes based on how easily or quickly they spoil:

Non-perishable foods: As the name implies, these are foods that can be kept for at least a few months and do not go bad unless handled and stored carelessly. Cereals, legumes, sugar, and other non-perishable food items are examples.

Semi-perishable foods: Semi-perishable foods, like non-perishable foods, can last for a few weeks or even a few months without showing any obvious signs of decomposition. Environmental variations, such as differences in temperature and humidity, have greatly altered these meals. Examples include foods derived from grains and pulses such as wheat flour, refined wheat flour, semolina, vermicelli, broken wheat, and bengal gramme flour (besan), as well as roots and tubers such as potatoes, garlic, some fruits such as apples and citrus fruits, as well as fats and oils.

Perishable foods: These are the items with a very high-water activity (aw) that degrade quickly within a day or two unless specific preservation techniques are applied, such as all animal goods like milk and milk products, meat and meat products, fish, poultry, and eggs, as well as the majority of fruits and vegetables. The factors which lead to food spoilage are as below.

a) Microorganisms' development and behaviors, primarily those of bacteria, yeasts, and moulds

b) Food enzyme activities include enzymatic browning, for example.

c) Infestation by insects, parasites and rodents

d) Chemical modifications to food include, for example, the rancidity-causing chemical oxidation of fats and the non-enzymatic browning reaction.

e) Physical changes, or the damages caused by freezing or drying etc.

f) Presence of foreign bodies, and

g) Physical abuse i.e., contamination with chemical agents

Main causes of Food Spoilage:

• Growth of microorganisms like bacteria, yeast and moulds.

• Action of enzymes that usually found in food

• Additional causes of spoilage are non-enzymatic reactions like oxidation, mechanical damage like brushing, by rodents and insects.

Microbial food spoilage: The primary cause of microbial food deterioration is that when the organisms multiply, they release their own enzymes into the liquid around them and absorb the byproducts of external digestion, which reduces the nutritional value of the meal itself.

Enzymatic food spoilage: Activities of food enzymes are also responsible for causing deteriorative changes and spoilage for instance, enzymatic browning. The microbial enzymes hydrolyze fats to yield free fatty acids (FFA) and glycerol. Some fungi and bacteria secrete pectolytic enzymes causing rot which is characterized by the softening of the tissue due to their pectolytic action. The autolytic enzymes (self-digesting) do play an active role in the deterioration of meat, poultry and fish apart from the microorganisms. The psychrotrophic bacteria produce enzymes such as proteases, lipases and other enzymes. The proteases while hydrolyzing the milk proteins, impart a bitter flavour. The lipases are responsible for the rancid off-flavour.

1.5 BASIC PRINCIPLES OF FOOD PRESERVATION

1. Prevention or delay of microbial decomposition

a) By keeping out microorganisms (asepsis)

b) By removal of microorganisms, e.g., by filtration

c) By hindering the growth and activity of microorganisms, e.g., by low temperatures,drying, anaerobic conditions, or chemicals

d) By killing the microorganisms, e.g., byheat (pasteurization, sterilization) or radiation (radicidation, raddurization, radappertization)

2. Prevention or delay of self-decomposition of the food

a) By destruction or inactivation of food enzymes, e.g., by blanching

b) By prevention or delay of enzymatic action and purely chemical reactions, e.g., prevention of oxidation bymeans of an antioxidant (natural/synthetic)

3. Prevention of damage because of insects, rodents, animals, mechanical causes, etc.

1.6 FOOD PRESERVATIVES- USE OF SALT, ACID, SUGAR, NATURAL FOOD PRESERVATIVES, AND ARTIFICIAL PRESERVATIVES

A material or combination of substances that is added to food as a result of any step in its production, processing, storage, or packaging is referred to as a food additive. Chance contamination is not included in the phrase" (WHO, 1965). In this definition, the idea that a food additive is an intentional addition is emphasized. **Chemical preservatives** are those food additives that are particularly applied to stop a portion of food from deteriorating or decomposing. These deteriorations may be brought on by dietary enzymes, bacteria, or merely chemical processes. One of the primary goals of using chemical preservatives is to prevent the development and activity of germs. By interfering with their cell membranes, enzyme function, or genetic pathways, preservatives can inhibit microorganisms. Other preservatives can act as antioxidants to prevent the oxidation of unsaturated fats, acidity neutralizers, stabilizers to stop physical changes, firming agents, coatings or wrappers to prevent microbial growth, water loss, or undesirable microbial, enzymatic, and chemical reactions.

Sugar and Salt

These substances have a negative impact on microbes by lowering the aw. In brines and curing solutions, as well as when applying it directly to food, sodium chloride is used. Only enough may be added to allow an acid fermentation to occur, or just enough to delay or halt the growth of microorganisms. According to reports, salt has the following effects: (1) it results in high osmotic pressure, which leads to plasmolysis of cells; (2) it dehydrates foods by drawing out and tying up moisture as it dehydrates microbial cells; (3) it ionizes to produce the chlorine ion, which is harmful to organisms. The amount of salt required to inhibit growth or harm the cell depends on the microorganism; (4) it reduces the solubility of oxygen in the moisture, (5) it sensitizes the cell against carbon dioxide, and (6) it interferes with the action of proteolytic enzymes. The relationship between the temperature and the concentration of NaCl is direct. The capacity of sugars to prevent organisms from accessing water and their osmotic impact are what give them their efficiency as preservatives. Examples of these sugars include glucose and sucrose. High sugar content foods like sweetened condensed milk, fruit sirups, jellies, and sweets are examples of foods that are preserved.

Significance of different preservatives

Sodium chloride: Antimicrobial, dehydrating agent, used as brine

Sugar: Preservation of foods due to the high osmotic pressure

Sulfur dioxide: Prevents the growth of undesirable microbes during wine making, prevents browning of dried and cut fruits

Nitrate and Nitrite: Color stabilizer in the curing of meat and antimicrobial in action

Sorbic acid: Sodium and potassium salts inhibit the growth of moulds and yeast in cheese and bakery products, fruit juices, wines and pickles

Acetic acid: Vinegar (4% acetic acid) is used to preserve pickled vegetables, acetates of sodium, potassium and calcium are used to prevent ropiness and growth of moulds

Propionic acid: Sodium and calcium salts are effective against moulds and some bacteria; Controls *Bacillus mesentericus* causing ropy bread

Benzoic acid: Active agent against yeast and bacteria, well suited for the preservation of acid foods such as fruit juices, carbonated beverages, pickles and sauerkraut

Parabens: Effective inhibitors of molds and yeast, they are alkyl esters of p-hydroxybenzoic acid; Methyl, ethyl, propyl and heptyl esters are used

Epoxides: Antimicrobial cyclic esters, used as preservatives—ethylene oxide and propylene oxide; to reduce load of microbes in spices

Antibiotics: Antimicrobial agents used in the control of bacteria in fish and poultry products; Chlorotetracycline and oxytetracycline

Diethyl pyrocabonate: Used as an antimicrobial agent in fruit juices, wines and carbonated beverages

1.6 STARTING A FOOD PRESERVING UNIT PRODUCT PROMOTION STRATEGIES AND MARKETING SKILLS.

With the moderate climate over the Indian subcontinent, there are no wide fluctuations in the availability of fruit and vegetables, and the need for food preservation has not been felt in India.

Scope

- The scope for expansion of food preservation market domestically and internationally is immense.
- The scope and significance of food processing are enormous, and a variety of techniques are employed to get various outputs. Numerous techniques, such as canning, freezing, dehydration, pickling, and irradiation, can be used to treat and preserve food.
- Cooking, which can be used to prepare food in many ways for consumption, is perhaps the most used form of food processing. Either at home or in a business environment like a restaurant or factory, anyone can cook.

- All the procedures needed to turn uncooked agricultural produce into wholesome food items are referred to as food processing and preservation. To guarantee accessibility to healthy, wholesome, and delectable foods at affordable prices, food processing, and preservation are essential.
- Food processing enhances the shelf life of food through various ways such as microorganism control, low-temperature storage, dehydration, and removal of oxygen. In order to appeal to consumers, it also modifies the nutritional content, flavour, and texture of food products.
- The processing of food is a significant sector of the Indian economy. About 15 million people are employed by it, and it contributes about 10% of India's GDP.
- By 2022, the sector is predicted to grow significantly to a value of Rs. 2,58,000 crores. The food processing industry offers strong returns on investment and has a wide range of investment opportunities.
- The food processing sector in India faces a number of difficulties, including inadequate infrastructure, a skilled labour shortage, poor access to financing and raw materials, high energy costs, inadequate storage facilities, and limited market exposure.
- The growth of India's economy depends heavily on the food processing sector. By fostering a climate that would stimulate investments in infrastructure, research, innovation, and technology advancement, the sector needs to be incorporated into the nation's inclusive growth strategy.
- Additionally, the government ought to promote the growth of the food processing sector and raise public awareness of the value of processed foods. We can only hope that the sector will expand and help India's economy grow.

The requirement for establishing a food preserving unit is as follows

a) Use of a cost-effective packing system

b) Due to large production, there has been an alignment of quality management systems like ISO 9000, ISO 22000, and HACCP (Hazard Analysis Critical Control Point).

c) The chain of food supply has been seen to be fragmented. The handling of the post-harvest needs to be improved. Sorting, packaging, and storing after cleaning.

d) Food consumption has changed over time in response to demand, taste, lifestyle, level of living, and advancements in R&D production, processing, preservation, and storage.

e) Creation of a retail trade network with excellent and sanitary storage facilities.

Product Promotion strategies and marketing skills

It can seem overwhelming to market your goods and company, but it doesn't have to be. Consider drafting a thorough marketing strategy that will aid in defining and formalizing your marketing concepts and ideas. You can maintain focus and make sure that your marketing objectives are in line with your entire business goals and strategy by outlining your plans in writing. You may use it to create projects and deadlines and make sure your resources are being used properly and efficiently. Additionally, it will give bankers and lenders a clear picture of how you intend to maintain and expand your firm.

Write a thorough marketing plan for your food product and company using the eight components below as a reference.

1 **Executive Summary**

You should always write your executive summary last. It should succinctly summarise and emphasize the most important ideas from each area of your marketing strategy. Your executive summary needs to be brief and not more than one page long.

2 **Market Research**

Examine the prospective customer base for your culinary item. Utilize a variety of primary research methods, including: - fieldwork, interviews, surveys, focus groups, experiments, and trials

- secondary research, including previous studies, journal publications, trade journals, and web data

3 Branding

To create a powerful brand, you must outline the fundamental principles of your business, such as your:

- a mission statement that outlines the main goals and priorities of your business
- positioning statement - identify your target market and how you want your brand to be perceived in the marketplace
- vision statement - specify your company's high-level goals for the future
- unique selling proposition (USP) - specify why customers should buy your product by stating what value

4 Target Market

Using the results of your market research, pinpoint the target market for which your product will be most valuable.

Everyone will not be a possible customer for your product, which is quite unlikely. Avoid attempting to sell to everyone. Analyze your data to demonstrate that your food product is in demand in your target market.

5 Competitor and Business Analysis

- Utilize the data you have obtained from your market research to identify and analyze your competitors.
- Compare the strengths, flaws, opportunities, and threats of your business to those of your rivals.
- Determine the competitive edge your business enjoys over its rivals.
- Determine the projected rate of sales growth for your food category over the next one to three years.
- Analyze your competitors' production capabilities and resources to see if they can satisfy existing and future food category market demand in your target market. If they do, you might want to adjust your target audience.
- Identify your USP, which will set your product apart from that of your competitors.

6 Marketing Action Plan and Strategy

Review your target market profile before developing a marketing strategy and action plan. Determine the most effective strategies for attracting potential customers to your business, piquing their interest and motivating them to buy your food product.

7 Marketing Goals

- Establish marketing goals that are realistic, quantifiable, and timely. Increased sales, increased brand recognition, the introduction of a new product, and the targeting of new markets or consumers are a few examples of marketing aims.

- Identify the KPIs you'll use to gauge the success of your marketing initiatives. For instance, you might choose to monitor website traffic, social media activity, and referrals if your marketing goal is to raise brand awareness.

- To be sure you're getting good results from any marketing activity, measure and document it beforehand, during, and after. If not, you now have the chance to enhance your marketing campaigns and assist with future planning

8. Financial Projections

Include the following current financial data to demonstrate financial viability over a given time period (usually a 12-month timeframe) in your financial projections

KNOW YOUR PROGRESS

Check Your Progress Exercise

Note: Use the spaces given below for your answers.

1) What is the requirement for establishing a food-preserving unit?

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2) What are the principles of food preservation?

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3) Discuss briefly the methods of preservation.

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4) enlist different types of preservatives used in food preservation.

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LET'S SUM UP

In this unit, we have learnt about what is preservation along with various methods of preservation. Preservation is mainly important to prevent microbial entry into the food which causes food spoilage. Spoilage is based on the quality characteristics of the food itself as well as its susceptibility to getting spoiled. Preservation helps to reduce enzymatic spoilage as well as the self-deterioration of food through various chemical reactions. Various methods of preservation are discussed briefly in this unit.

REFERENCES BOOK

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UNIT-II PREPARATION OF DEHYDRATED PRODUCTS

Structure

2.0 Objective

2.1 Introduction

2.2Methods of drying & dehydration

2.3different types of driers, freeze drying- lyophilisation,

2.4 Packing & storage Drying methods for the selected products -Rice, Sago, Wheat, Maida, Rice flakes, black gram dhal, green gram dhal, Horse gram dhal Roots and Tubers

2.5General tips with drying foods Preparation of salted, dehydrated, preserves (Traditional Indian varieties of chips, Papads, Khakharas etc and Masala Powders, onion, garlic, ginger powder etc.).

Hands-onexperience: Drying of vegetables- peas, potato, carrot, French beans, Reconstitution of dried vegetables, Drying & preparation of powders- garlic, ginger, spices mix etc

2.0 OBJECTIVES

After reading this unit you should be able to:

- know about methods of drying and dehydration;
- learn various methods of food drying;
- know about types of driers;
- study drying of various types of cereals and pulses
- study different types of salted, dehydrated, preserves

2.1 INTRODUCTION

One of the earliest techniques for preserving fruits and vegetables is drying. It is currently a flexible and common approach in the food industry and a persistently fascinating topic in food research. Due to the high energy need of the process (caused by the low thermal efficiency of dryers), drying is a crucial step in the processing of dehydrated products. Fruits and vegetables are dried primarily to remove moisture up to a point when microbial spoilage and deterioration chemical reactions are significantly reduced. In addition to preserving the product, dried foods are less expensive to package, handle, and transport due to their less weight and reduced bulk. The majority of food products are also dried for better milling or mixing properties during subsequent processing.

2.2 METHODS OF DRYING & DEHYDRATION

The number of microorganisms that are reduced by heat delivered during a drying process depends on the types and numbers of microorganisms that were initially present as well as the drying method used. All yeasts and the majority of bacteria are often destroyed, however, spores of bacteria and moulds, as well as vegetative cells of a few species of heat-resistant bacteria, frequently survive. As we'll see later, unfavourable drying conditions might even promote the growth of microbes.

Solar Drying

Solar drying is only possible in hot, dry locations and on a few types of fruit, including raisins, prunes, figs, apricots, nectarines, pears, and peaches. On trays, the fruits are dispersed and may be turned while drying. Sun drying is also an option for cereals like rice and fish. Drying by Mechanical Dryers

The majority of artificial drying techniques include either passing heated air over the food to be dried or passing the food through air with a set relative humidity. A variety of equipment is utilized in some operations for controlled air circulation and air reuse. The simplest drier is the evaporator or kiln, which is occasionally used in farm homes. Here, the food is dried by natural draught caused by the rising heated air. Systems that use forced-draft drying circulate hot air across the food, typically in tunnels.Liquid foods, like milk, juices and soups, may be evaporated by using relatively low temperatures and a vacuum in a vacuum pan or similar device, drum-dried by passage over a heated drum, with or without vacuum, or spray-dried by spraying the liquid into a current of dry, heated air.

Freeze Drying

For a variety of items, including meats, poultry, shellfish, fruits, and vegetables, freeze drying—or the sublimation of water from a frozen food by use of a vacuum and heat—is being used. Foods with low sugar content that are frozen in thin layers can be dried without a vacuum by sublimating moisture while a dry carrier gas passes over them.

Drying During Smoking

Food moisture removal aids in preventing bacterial and fungal growth, which could harm meals that have been preserved. Smoking is a method of drying that also flavours the food (often meat products), and smoke deters insects that transport bacteria while the food is drying. Food can be smoked using two different techniques: **hot smoking** and **cold smoking**.Modern electric kilns or the smokehouse can be used for hot smoking, which is typically done for a brief length of time, only long enough to cook the meat. ...

Hot smoking: Hot smoking is subjecting food to heat and smoke in a controlled setting, such a smoker oven or smokehouse. It calls for the employment of a smoker, which generates heat from a heated element inside the smoker, a heated element on the stovetop, or an oven. Food is hot smoked by cooking and flavouring with wood smoke at the same time. 52 to 80 °C (126 to 176 °F) is typically the range in which hot smoking takes place. Food is fully cooked, moist, and tasty when smoked at these temperatures. Foods may shrink excessively, buckle, or even split if the smoker is allowed to reach temperatures higher than 85 °C (185 °F). Because both moisture and fat are fried while smoking at high temperatures, the yield is likewise decreased.

Cold Smoking: In contrast to hot smoking, cold smoking involves keeping the food uncooked throughout the procedure rather than cooking it. Cold smoking is commonly carried out in smokehouses with temperatures ranging from 20 to 30 °C (68 to 86 °F). Foods get a smoky flavour at these temperatures while still being largely wet. Foods should be completely cured before cold smoking because cold smoking does not cook meals. Items like cheese or almonds can be cold-smoked to add flavour, in addition to meats like chicken breasts, beef, pork chops, salmon, scallops, and steak.

Other methods of smoking are as follows

Liquid Smoke: Liquid smoke, a substance made from smoke components in water, is sprayed or dipped onto foods.

Smoke-roasting: Any procedure that combines the characteristics of roasting with smoking is referred to as smoke-roasting. Barbecuing or pit-roasting are other names for this smoking technique. It can be done in a smoker that can reach temperatures exceeding 121 °C (250 °F), a closed wood-fired oven, a barbeque pit, or a standard oven by spreading a pan of hardwood chips on the oven's floor so that they can smoulder and create a smoke-bath.[14] This type of smoking is frequently referred to as "barbecuing," "pit baking," or "pit roasting" in North America.

Warm smoking: Foods are heated at temperatures between 77 and 104 °F (25 to 40 °C).

Other Methods of drying

Electronic heating: Electronic heating has been suggested for the removal of still more moisture from food already fairly well dried. Foam-mat drying, in which liquid food is whipped to a foam, dried with warm air, and crushed to a powder, is receiving attention, as is pressure-gun puffing of partially dried foods to give a porous structure that facilitates further drying. Tower drying in dehumidified air at 30 C or lower has been successful with tomato concentrate, milk, and potatoes.

A consideration of the proper control of dehydration includes the following factors.

1. The temperature employed. This varies with the food and the method of drying.

2. The relative humidity of the air. This, too, is varied with the food and the method of drying and also with the stage of drying. It usually is higher at the start of drying than it is later.

3. The velocity of the air.

4. The time of drying.

Improper control of these factors may cause case-hardening resulting from more rapid evaporation of moisture from the surface than diffusion from the interior, with a resulting hard, horny, impenetrable surface film that hinders further drying. different types of driers,

The Value of Drying

- Enables grain to be stored for a long time without deteriorating
- Enables year-round, continuous product supply
- Allows for an early harvest, minimizingfree field damage and shattering loss
- Enables farmers to produce higher-quality goods
- Makes things accessible outside of peak times

Drying theory

- The removal of moisture from a product by convection Agricultural products'
- water contents are expressed as moisture contents, and they gain or lose moisture depending on the meteorological circumstances
- The differential in vapour pressure between the atmosphere and the product determines whether moisture migrates into or out of that product.
- When grain vapour pressure exceeds air vapour pressure, moisture is transferred from grain to atmosphere.

- If the air vapour pressure is higher than the vapour pressure of the grain, the grain will absorb atmospheric moisture.

Drying rate periods: Divided into 3 periods

- Constant rate period
- First Falling rate period
- Second falling rate period

Constant rate period

The rate of moisture migration from a product's inside to its exterior is equal to the rate at which water evaporates off the surface. This process continues until a threshold moisture content is achieved. When constant rate drying stops and falling rate drying begins, the moisture content of the product reaches this point. For agricultural products, this phase is quite brief. Sand and washed seeds are dried during the constant rate period.

Falling rate period

The movement and distribution of moisture within grains' interiors regulates the drying process, which is how most agricultural goods are dried. Controlled by: Removal of moisture from the surface Moisture migration from the core of grains to the top surface as a result of water vapour diffusion it isdivided into two periods

- First falling rate period
- Second falling rate period

First falling rate

- Unsaturated surface drying
- Fraction of wet surface reduces to zero, marking the end of the initial decreasing rate
- drying rate decreases as wet surface area declines

Second falling rate

- Sub surface evaporation takes place & it continues until the equilibrium moisture content isreached

Mechanism of drying process

 Movement of moisture takes place due to

 Capillary flow– Liquid movement due to surface forces

 Liquid diffusion– Liquid movement due to difference in moisture concentration

 Surface diffusion- Liquid movement due to moisture diffusion of the pore spaces

 Vapour diffusion– vapour movement due to moisture concentration difference

 Thermal diffusion- vapour movement due to temperature difference

 Hydro dynamic flow– water and vapour movement due to total pressure difference

2.3 TYPES OF DRIERS

Thin layer drying

Process in which all grains are fully exposed to the drying air under constant drying conditions i.e. at constant air temp. & humidity.it utilizes up to 20 cm thickness of grain bed as thin layer. All commercial dryers are designed based on thin layer drying principles

Represented by Newton's law by replacing moisture content in place of temperature

$M-Me/Mo-Me = e^{-K\theta}$

M – Moisture content at any time θ, % db

Me- EMC, %db

Mo – Initial moisture content, %db

K – drying constant

θ - time, hour

Deep bed drying

- All grains are not fully exposed to the same condition of drying air
- Condition of drying air changes with time and depth of grain bed
- Rate of airflow per unit mass of grain is small
- Drying of grain in deep bin can be taken as sum of several thin layers
- Humidity & temperature of air entering & leaving each layer vary with time
- Volume of drying zone varies with temp & humidity of entering air, moisture content of grain & velocity of air

Deep bed drying characteristics at different depths

Continuous flow dryer

- Columnar type dryer in which wet grains flow from top to the bottom of the dryer
- Two types
- Mixing

 Non-mixing

Mixing

 Grains are diverted in the dryer by providing baffles

 Use low air flow rates of 50-95 m3/min/tonne

 Zig-zag columns enclosed by screens are used to achieve mixing

 High drying air temperature of 65°C is used

Continuous flow dryer (Mixing type)

Baffle dryer

 Continuous flow mixing type dryer

 Consists of receiving bin, drying chamber fitted with baffles, plenum fitted with hot air inlet

 Baffles are fitted to divert the flow & also for mixing

 Grain fed at the top & move downward in a zig-zag path where it encounters a cross flow ofhot air

 Bucket elevator is used to recirculate the grain till the grain is dried to desired moisture level

 Uniformly dried product is obtained

Mixing type baffle dryer

Non-mixing

- Grains flow in a straight path
- Baffles are not provided and drying takes place between two parallel screens
- High airflow rates can be used
- Drying air temp. of 54°C is used

Continuous flow dryer (non-mixing)

Recirculatory Batch dryer

- Continuousflow non mixing type
- Consists of 2 concentric circular cylinders, set 15-20 cm apart
    - Bucket elevator is used to feed & recirculated the grain
    - Centrifugal blower blows the hot air into the inner cylinder, acts as a plenum
    - Grain is fed at the top of the inside cylinder; comes in contact with a cross flow of hot air
    - The exhaust air comes out through perforations of the outer cylinder
    - Grain is recirculated till it is dried to desired moisture content
    - Drying is not uniform as compared to mixing type
    - Recirculating batch dryer

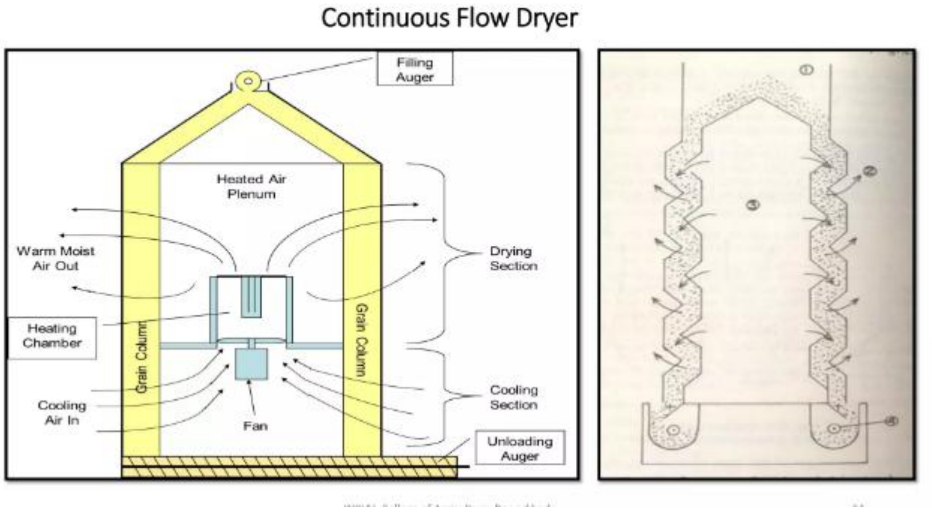
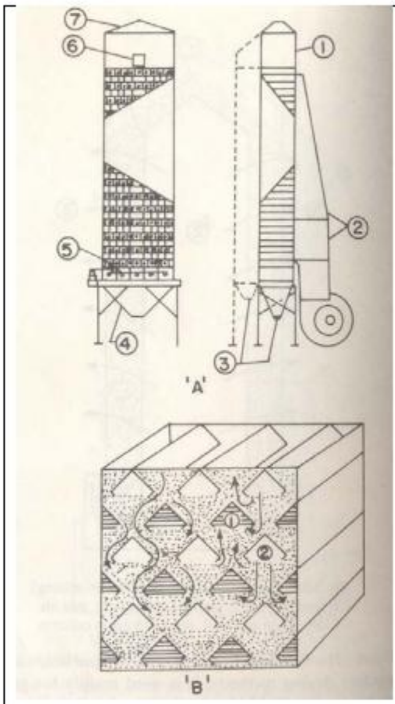


Fig 2.1Continuous flow dryer LSU dryer

- Developed at Louisiana state university (LSU) It is a continuous mixing type dryer
- Developed specifically for rice to ensure gentle treatment, good mixing & good air to grain contact
- the instrument consists of a rectangular chamber, holding bin, blower with duct, grain discharging mechanism and air heating system
- Layers of invertedV-shaped channels are installed in the drying chamber; heated air is introduced through these channels at many points
- Alternate layers are air inlet & outlet channels; arranged one below the other in an offset pattern
- Inlet port consists of fewfull-size ports & two half size ports; all ports are of same size arranged in equal spacing

- Ribbed rollers are provided at the bottom of drying chamber for the discharge of grain (capacity varies from 2-12 tonnes, air flow rate is 60-70 m3/min/tonne, air temp. are 60 &85°C for raw & parboiled paddy)
- Uniformly dried productcan be obtained
- Can be used for different types of grain
- only limitation is high capital investment

LSU Dryer



1. Garner
2. Duct
3. Dry material outlet
4. Hopper
5. Continuous flow
6. Door
7. Roof

Fig 2.2 LSU Dryer

LSU Dryer

Tray driers

 In tray dryers, the food is spread out, generally quite thinly, on trays in which the drying takes place.

 Heating may be by an air current sweeping across the trays, or heated shelves on which the trays lie, or by radiation from heated surfaces.

 Most tray dryers are heated by air, which also removes the moist vapours.

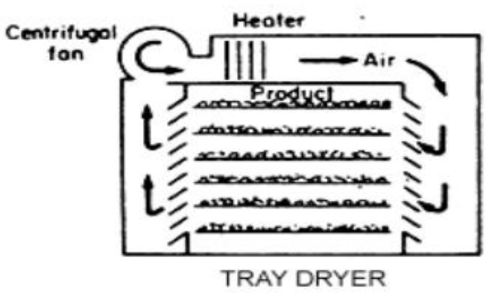


Fig 2.3 Tray Dryer

Fluidized Bed Dryers

In a fluidized bed dryer, the food material is maintained suspended against gravity in an upward-flowing air stream.

Heat is transferred from the air to the food material, mostly by convection

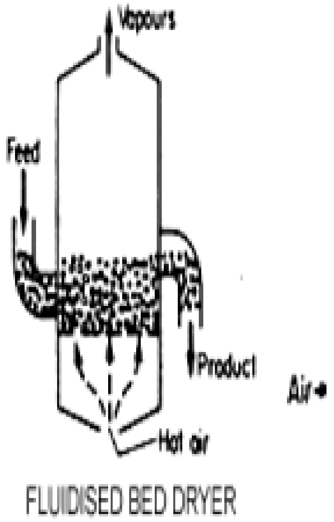


Fig. 2.4 Fluidized Bed Dryers

Pneumatic Dryers

 In a pneumatic dryer, the solid food particles are conveyed rapidly in an air stream, the velocity and turbulence of the stream maintaining the particles in suspension.

 Heated air accomplishes the drying and often some form of classifying deviœ is included in

the equipment.

 In the classifier, the dried material is separated, the dry material passes out as product and the moist remainder is recirculated for further drying

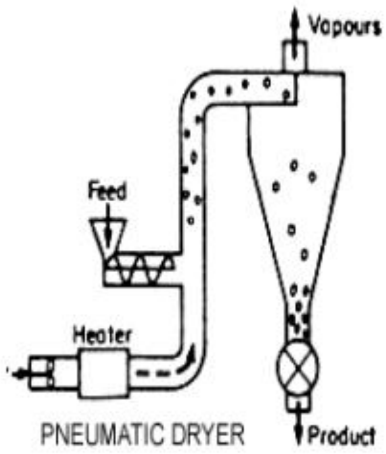


Fig 2.5 Pneumatic Dryers

Rotary Dryers

- The foodstuff is contained in a horizontally inclined cylinder through which it travels, being

heated either by airflow through the cylinder or by conduction of heat from the cylinder walls.

- In some cases, the cylinder rotates and in others the cylinder is stationary, and a paddle or

The screw rotates within the cylinder conveying the material through

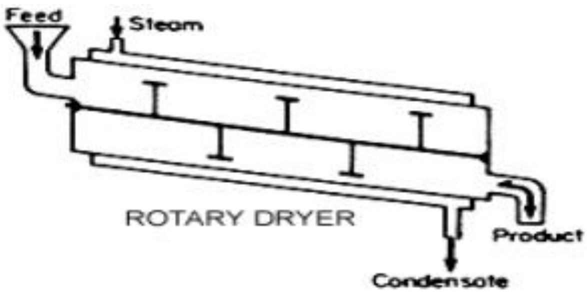


Fig 2.6 Rotary Dryers

Freeze drying- lyophilization,

Freeze drying, or the sublimation of water from a frozen food by means of a vacuum plus heat applied at the drying shelf, is being used for a number of foods, including meats, poultry, seafood, fruits, and vegetables. Frozen thin layers of foods of low sugar content may be dried without vacuum by sublimation of moisture during the passage of dry carrier gas.

2.4PACKING & STORAGE DRYING METHODS FOR THE SELECTED PRODUCTS -RICE, SAGO, WHEAT, MAIDA, RICE FLAKES, BLACK GRAM DHAL, GREEN GRAM DHAL, HORSE GRAM DHAL ROOTS, AND TUBERS GENERAL TIPS WITH DRYING FOODS

Farmers store grain all over the world, whether in hot or cold climates, more developed or less developed nations; they may store it in granaries, pits or earthen pots, either in bulk or in a moderately sophisticated elevator; the primary goal of storage is simply to prevent grain quality degradation; the management goal during the storage period is to reduce metabolic activity to such a low level that the grain mass is sufficiently stable with minimal change in composition.

Drying of cereals:a) Wheat: Wheat is classified into two groups: hard and soft. Hard wheat is higher in protein compared to soft wheat. Wheat is classified into two groups: hard and soft. Hard wheat is higher in protein compared to soft wheat. Wheat is classified into two groups: hard and soft. Hard wheat is higher in protein compared to soft wheat. Wheat is classified into two groups: hard and soft. Hard wheat is higher in protein compared to soft wheat.

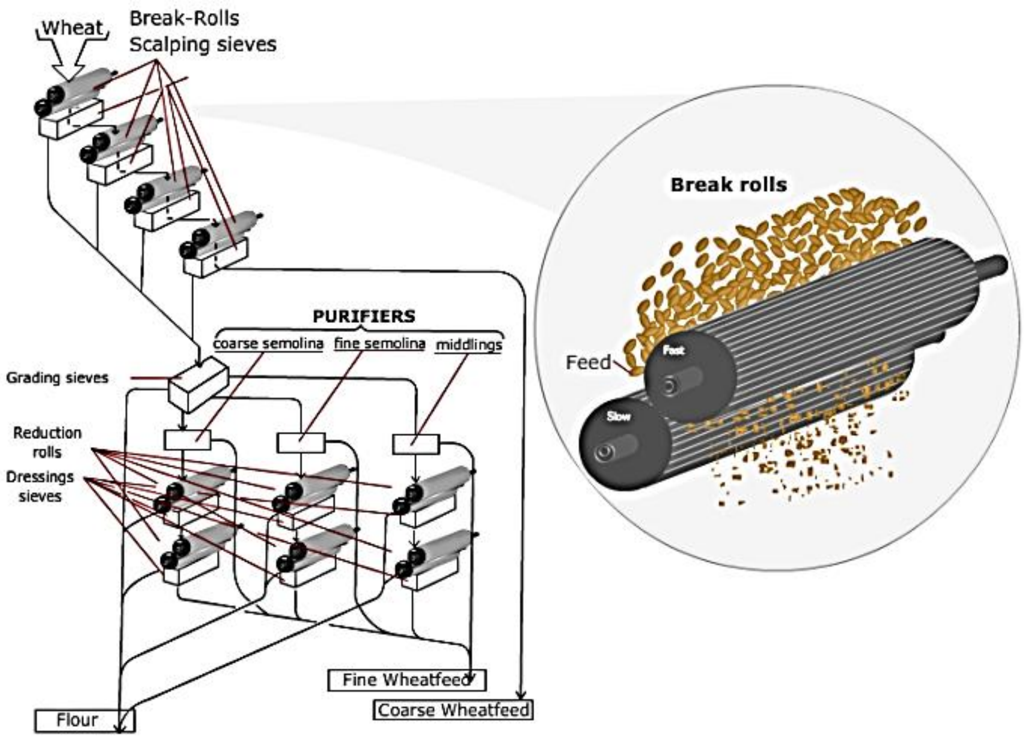


Fig 2.7Wheat milling (Source [www.iaritopper.com)](http://www.iaritopper.com)

Maida/refined flour:

The finest sort of wheat flour, refined flour is used to make your favourite foods like pizza, bread, samosas, kachoris, puris, cakes, and biscuits. It has a high-calorie content but little nutritional value. The glycemic index of refined flour, often called maida in India, is higher than that of wheat flour. The endosperm, the starchy white portion of the grain, is used to make maida. The endosperm and germ are separated from the bran, which is then refined by passing through an 80-mesh-per-inch (31-mesh-per-centimeter) sieve.

Various flour types and their uses

Flour, all-purpose. Anything is best used for

The Hard Flour. The best uses are for bread, buns, and donuts.

The cake flour. Tender cakes and pastries are what it is best utilised for.

Whole-wheat flour. Best used for: thick cakes, bread, and cookies.

Rice flour; Noodle flour; Cooking flour.

b) Rice: rice (*Oryza sativa*, Linn.) is one of the oldest and most important food crops of the world. It is a staple food for more than half of the World's population. Rice belongs to the Gramineae or grass family and the tribe Oryzeae. Rice is a semi-aquatic plant that can thrive under flooded soil conditions.In modern rice milling the steaming is done separately using a steaming unit. The steam is produced usually from a boiler unit under pressure. The soaked paddy is then dried. In modern rice mills usually LSU driers with hot air from steam-heated exchangers are used for drying.

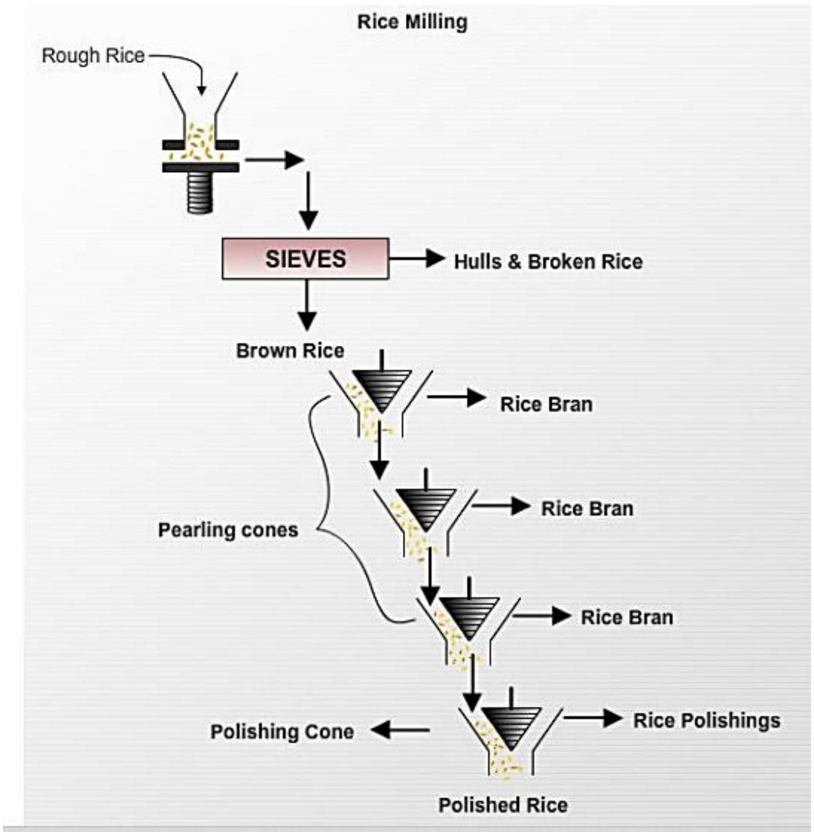


Fig 2.8 Process of rice milling (Source www.iaritopper.com)

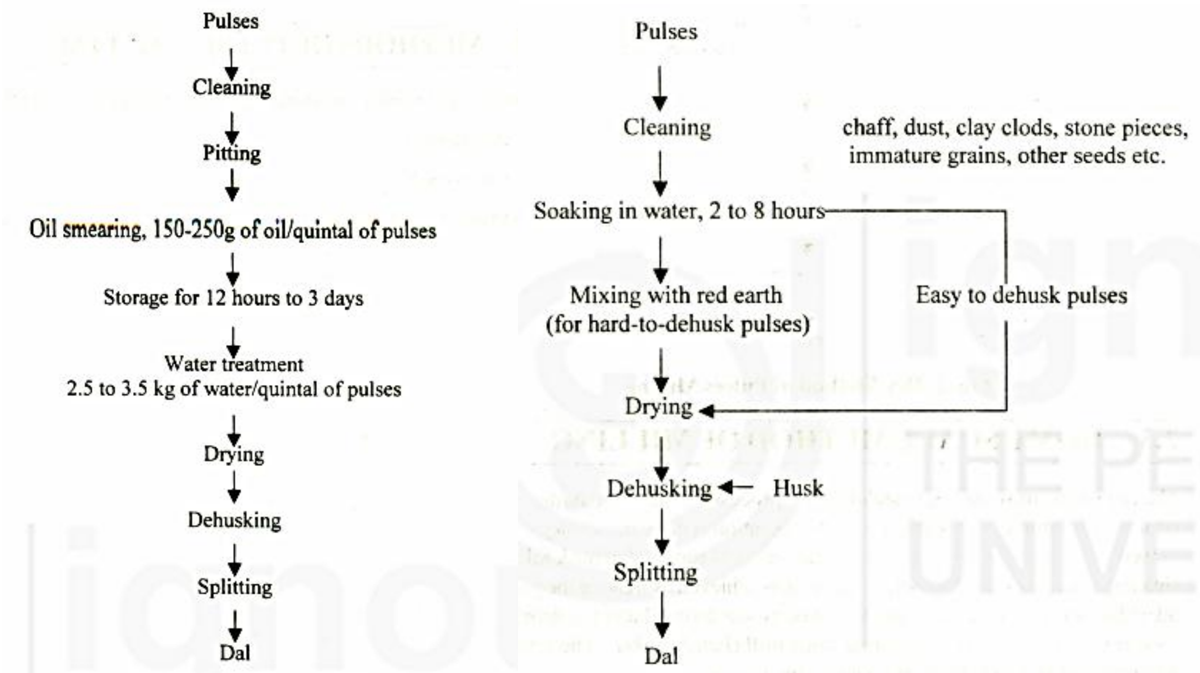
Flaked/Rough rice

Parboiled rice is used to make flakes of rice. To soften the kernel, paddy is first soaked in water for two to three days (or heated water between 70 and 80 degrees for 20 minutes). After cooking, the water is removed, the paddy is heated in a shallow clay jar to between 250 and 275 degrees Celsius until the husk splits open, and then it is pounded with a wooden pestle and heavy iron rollers to flatten the rice kernel and remove the husk. Winnowing removes the husk.

Sago: The starchy root crop known as cassava (Manihot esculenta Cralztz) is a staple meal used mostly in underdeveloped nations. Around 500 million people and more around the world eat the leaves and root tuber, which are both edible. Tapioca refers to the root tuber. The processed edible starch that is derived from tapioca and sold as sago (saboodana) comes in the form of tiny globules or pearls.

Pulse drying:

Pulse seeds are also sources of other nutritionally important materials, such as vitamins and minerals. Milling of pulses is the removal of outer husk/hulls and splitting the grain into two equal halves. The husk/hull is more tightly held by the kernel of some pulses poses problems. The alternate wetting and drying method are used to facilitatethe de-husking and splitting of pulses.



A **B**

Fig.2.9 Dry and wet milling of pulses (IGNOU study material)

Pulses can be divided into two general categories according to the difficulty faced in dehusking riz. (i) hard-to-dehusk pulses namely arhar, urad and moong and (ii) easy-to-dehusk pulses namely channa (Bengal gram), masoor (Lentil), and field pea.

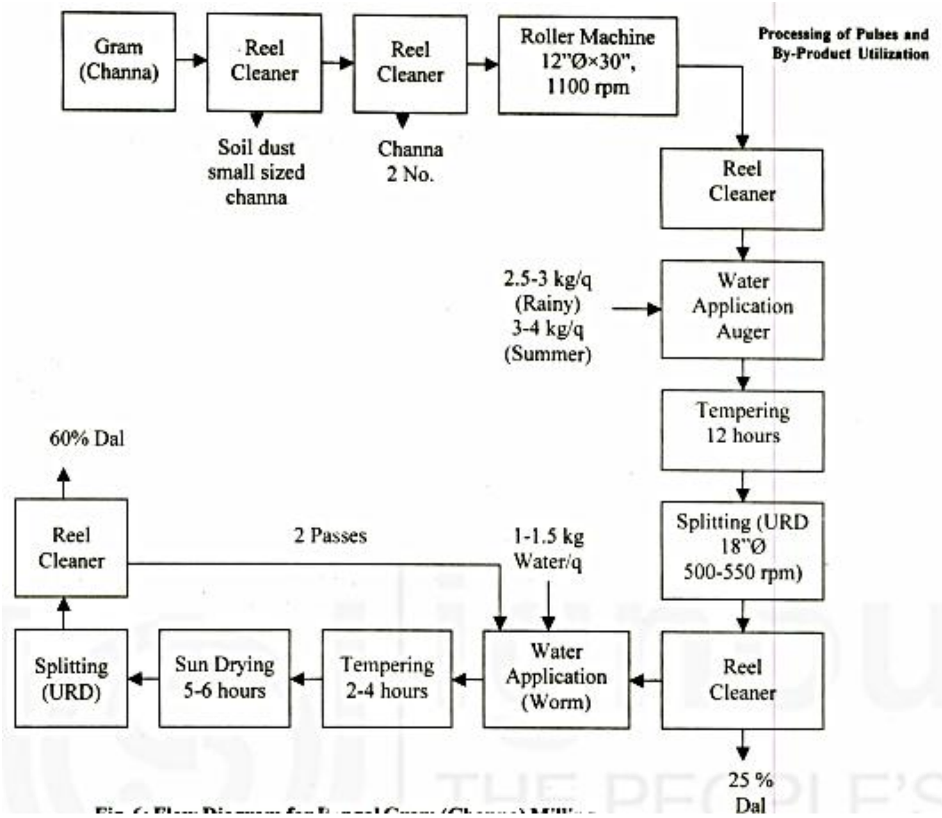


Fig 2.10 Processing of Bengal gram

2.5PREPARATION OF SALTED, DEHYDRATED, PRESERVES (TRADITIONAL INDIAN VARIETIES OF CHIPS, PAPADS, KHAKHARAS ETC, AND MASALA POWDERS, ONION, GARLIC, GINGER POWDER ETC).

Dried foods are preserved as a result of the lower moisture content. It is conveniently portable. Indian delicacies like **chips, Papads, Khakharas,** onion, garlic, ginger, and curry powders are preserved by sun drying. **Preparation of such salted and dehydrated, preserves are as below-**

Chips: Potato Chips is one of such value-added products which has a great potential as this is considered as one of the traditional foods of India. Only two potato-based snack foods—

chips/wafers and French-fried potatoes—represent more than 42% of all processed potato-based products worldwide as the primary value-added products of potatoes**.**

Manufacturing Process: The potatoes are carefully cleaned under running water before being peeled using an abrasive potato peeler. Water jets are used to remove the peelings. After trimming, they are submerged in water to stop browning. After that, slices (1.7-1.85 mm thick) are created using a cutting machine. If the successive steps of blanching take a long time, the slices are once more submerged in cold water. To prevent oxidation, slices are then stored in water containing 0.05% potassium metabisulphite. Slices are spread out on trays at a rate of 4.88 kg to 7.30 kg per square metre of tray area and blanched for 3 to 5 minutes in boiling water.After being blanched, the chips are D-Watered to remove excess water before being cooked in edible oil for 3–4 minutes at 180–240°C. The fried potato wafers are then placed on a sieve to drain excess oil, allowed to cool, and other ingredients such salts and a spicy mixture are sprayed on using a batch flavouring machine to the desired taste. After cooling, potato chips are packaged in plastic bags.

Papads: Papad is just the name for the thin Indian wafer, often known as a cracker or flatbread. Typically made from dried pulses, papad can be roasted or fried. To improve both organoleptic and nutritional qualities, the papad's fundamental ingredients can include grain flour, pulse flour, soy flour, spice mixtures, chemical mixtures, and various vegetable juices. North Indian and South Indian papad are the two original varieties of papad. They are available in a variety of shapes and sizes, including tiny, large, roasted, khakra, and many others.

Manufacturing Process: Any papad must first have its dough prepared. To make the unique regional papad, the dough also has flavours like salt and peanut oil. Another essential element for a tasty papad is baking soda. The dough is formed into a circular, thin flatbread and typically dried in the sun. Papads can be roasted over an open flame, deep-fried, toasted, or microwaved.

Some of benefits are as follows

- Papad is a tasty appetiser and a healthy source of fibre.
- Papad that has been roasted or grilled aids in absorbing the fatty substances from the mouth and throat.
- Papad should be consumed in moderation to avoid becoming the cause of acidity.
- Papad has an extremely high salt content, making it unwise for those with hypertension.
- Lentils are used to make papads, which makes them gluten-free, high in protein, and low in fat.

Khakharas

Khakhara is a thin cracker popular in western Indian cuisines such as Gujarati and Rajasthani, particularly among Jains. Mat bean, wheat flour, and oil are used to make it. Typically, it is offered during breakfast. Khakhara is prepared with a number of different ingredients, including methi (fenugreek), jeera (cumin), bajri, pudina, garlic, and ajwain, among others. A sweet kind of khakhra is mungdi.

Manufacturing Process: The dough is rolled out into thin sheets to form Khakhara. Round shapes are cut out of the sheets. To completely remove the moisture level, they are first cooked on the Hot Plate and then roasted in the roasting apparatus. Khakhra that has been properly packed has a longer shelf life. Khakhara is made with the following machines:

1. Dough Making Machine: To mix flour, salt, and water to make the dough for Khakhara.

2. A Khakhara extruder is used to extrude the dough into tiny dough balls that are then rolled into thin sheets.

3. Sheet Making & Cutting Machine: To create the necessary thickness of very thin dough sheets and cut them into rounds.

4. Hot Plate: To bake and cook the khakhara till it is golden.

5. Roasting Device: To roast the baked Khakhara in order to lower its moisture level and get it ready for packaging.

6. Vacuum Packaging Equipment the Khakhra into appropriate printed vacuum-sealed packs.

Masala Powders

Blends of various Spices are called masalas.A spice can be any vegetable substance that is primarily used to flavour, colour, or preserve food. It can also be a seed, fruit, root, bark, berry, or bud.By geography and taste preference, a masala's precise ingredients might vary greatly. For instance, masala can be whole or ground spices, powerful or weak, bland or harsh, and dry or moist. Indian chefs have perfected the art of timing the roasting of spices, unleashing different aromas from the same spices depending on how long they are roasted. The manner in which a spice is made can also influence it.

Dry Masala: In Northern India, a masala is made of dry spices that have been ground into a powder that is resistant to spoilage and is claimed to improve with age.

Wet Masala: In Southern India, a masala is made with fresh or green spices that are blended with liquids like water, lime juice, coconut milk, or vinegar to create a paste that is only briefly edible.

There are various types of masala powder available in Indian market such as Chaat Masala, Sambar Masala, Pav Bhaji Masala, Garam Masala, Goda Masala, Pani Puri Masala, Kitchen King Masala, Thandai Masala Powder, Meat Masala, Rasam Powder, Kesari Milk Masala, Punjabi Chole Masala, Shahi Biryani Masala, Tea Masala Powder, Jaljeera Masala, Tandoori Masala, Fish Curry Masala, Chicken Masala, Pickle Masala, Curry Powder

Manufacturing Process: 1. Cleaning-It is a very primitive process of producing spices, involving the physical cleaning of unground spices to remove contaminants like stone, dust, and filth.

1. Drying- The quality of the spice powder can rely on how well-dried the spice was, therefore after cleaning and laundry, expose them to light so they can dry. Lack of proper laundry and cleaning will encourage the growth of bacteria that can contaminate food.
2. Roasting- After being dried, spices are put through the roasting process, which is crucial because it helps produce spice powder with a pleasing scent, colour, and flavour.
3. Grinding- The spices are pulverised using a grinding machine to create powder.
4. Grading- The grading process may be based on the inclusion and proportion of spices in relation to the raw materials used. It may also be influenced by the type of spices (flavour), as well as their size, shape, density, and colour.
5. Sieving- Make sure the mesh size of the spice powder is constant.
6. Spice packaging- Your favourite foods benefit greatly from the flavour that seasoning and spices bring. However, for them to work their magic, they must be fresh, so proper packing is essential.

Ginger powder: Ginger is first scrapped to remove skin and then washed so as to remove dirt. Then it is cut to small pieces so that it can be ground easily into a paste in a mixer and then dried/dehydrated to remove moisture and packed in airtight container

Garlic powder: peeled garlic in a grinder along with some water so as to get smooth texture as paste and then dried to remove moisture and packed in airtight sealed container

Curry Powder: The most popular of all spice blends or mixes is curry powder, which occasionally contains 20 or more spices and is made to influence the distinctive flavour of an Indian curry, which is loved by people all over the world. A clear trend today is towards employing spices primarily in powdered form in many combinations of curry powders, even if freshly ground masalas (mixed curry spices are preferred to powdered masalas) are favoured due to the lack of domestic labour. For the preparation of a range of veggie and non-vegetarian food products, curry powder, chilli powder, turmeric powder, spices powder, etc. are heavily used.

Hands-on experience:Drying of vegetables- peas, potato, carrot, French beans, Reconstitution of dried vegetables, Drying & preparation of powders- garlic, ginger, spices mix, etc.

KNOW YOUR PROGRESS

Check Your Progress Exercise

Note: Use the spaces given below for your answers.

1) What do you mean by pulse milling?

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2) how do khakhras manufacture?

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3) Discuss briefly the methods of drying.

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4) What is LSU drier?

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LET'S SUM UP

In this unit, we have learnt about the methods of drying and dehydration. Different types of driers used for cereals and pulse processing are discussed briefly. Pulses milling viz. wet and dry method. In dry method, it is the oil that loosens husk while in the wet method, it is water that dilutes gum in between the husk and kernel which makes it easy to dehusk pulses. In wet method, the cooking quality of dal is affected. Due to this, the dry method of milling is mostly practiced in country.

REFERENCES BOOK

Handbook on Manufacture of Indian Kitchen Spices (Masala Powder) with Formulations, Processes and Machinery Details (4th Revised Edition)

BLOCK-II PRESERVATION BY USING SUGAR, CHEMICALS, SALTS, AND ADVANCED PRESERVATION

UNIT III PRESERVATION BY USING SUGAR:

Role of Pectin in Preserved foods Stages in Sugar Cookery Sugar Concentrates – Principles of Gel Formation Hands on Experience: Preparation of Jam, Jelly, Marmalades, Sauce and Squash Preserves, Candied, Glazed, Crystallized Fruits, Toffee Evaluation of pH, Acidity and pectin quality Visit to Fruits and Vegetable processing industry.

UNIT IV PRESERVATION BY USING CHEMICALS AND SALTS AND FERMENTATION:

Preparation and Preservation of Fruit Juices, RTS Pickling – Principles Involved and Types of Pickles Chemical Preservatives – Definition, Role of Preservation Permitted Preservatives, FSSAI guidelines Foods fermented by Yeasts Foods fermented by Bacteria Common Fermented Foods, Wine and Cheese Making Hands on experience: Pickle making Visit to Commercial Pickle Manufacturing Food Industry and Wine industry

UNIT V PRESERVATION BY ADVANCED PRESERVATION TECHNOLOGY:

Meaning and needs of freezing foods Types of Freezing and managing freezers Guidelines for types of frozen foods-Fruits, Vegetables, fish, meat and poultry Smoking foods Pasteurization and Sterilization Food Irradiation Vacuum Packing Canning and Bottling Food Packaging Materials for preserved food products

Hands on experience: Blanching of fruits & Vegetables Visit to Food Industries

BLOCK-II PRESERVATION BY USING SUGAR, CHEMICALS, SALTS, AND ADVANCED PRESERVATION

UNIT-III PRESERVATION BY USING SUGAR

Structure

3.0 OBJECTIVES

After reading this unit you should be able to:

- To study sugar and salt preservation
- To know the role of pectin during jam, jelly and marmalade making
- Study the principle of gel formation
- To know about various food preserve

3.1 INTRODUCTION

The use of sugar syrup is one of the earliest techniques for reducing oxidation. It was used for this purpose for a very long time before the causes of the reactions were identified, and it is still widely used today.

By coating the fruit and shielding it from ambient oxygen, sugar syrup reduces oxidation. Additionally, sugar syrup lends a sweet flavour to fruits that might otherwise be acidic while providing some protection against the loss of volatile fruit esters.

3.2ROLE OF PECTIN IN PRESERVED FOODS STAGES IN SUGAR COOKERY SUGAR CONCENTRATES

Fruit contains protopectin, pectin, and pectic acid, which are all pectic compounds. Gel formation is prevented by the protopectin found in underripe fruits. When combined with water, the pectin found in properly ripened fruits forms a solution. Because some of the fruit's pectic compounds are still present in the solid portion, heating the fruit with a tiny amount of water is necessary to extract the pectin. Fruit sugars and acids cause the pectin to gel into a jelly when they are present.

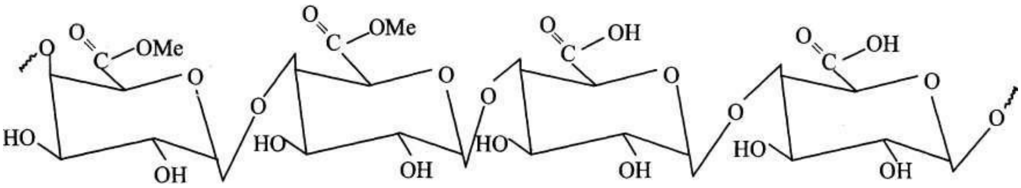

Fig 3.1 pectin chemical structure

Protopectin is the water-insoluble parent pectic chemical found in plants. During fruit ripening, this diminishes and soluble pectin increases. Pectinic acid and pectin are produced via the limited hydrolysis of protopectin. Pectinic acid has a higher than negligible amount of methylester groups and forms a colloidal solution. It can combine acid and sugar to make gels. Pectin is a kind of pectinic acid that is water soluble and has different levels of methyl ester neutralisation. When the right circumstances are present, pectin gels with acid and sugar. Galacturonic acid makes up the majority of pectic acid, which is largely free of methyl ester groups.

Citrus peels (or apple pomace) are extracted with diluted acid to yield commercial pectin. Jams and jellies are made using a product in which at least 50% of the carboxyl groups of galacturonic acids have been methylated. The level of methylation should be high (about 60) for jellies to set quickly. Sugar (65–70%), acid (pH 2.3–3.2), water, and pectin are all necessary for gel formation. The capacity of pectin to remain in a dispersed state is diminished by the acid's rise in unionised carboxyl groups, which lessen the attraction between pectin and water molecules. Sugar competes with water, which further reduces pectin's hydration. When chilled, the unstable dispersion of the less hydrated pectin turns into a gel. By creating cross-linkages between free carboxyl groups and divalent cations like calcium, pectin with a low methoxyl forms concentration gels. In these circumstances, the presence of sugar is not necessary for gel formation.

Only when pectin, acid, sugar, and water are present in specific ratios does a hard jelly develop. The pectin-water equilibrium is disrupted when sugar is introduced to the pectin solution because it works as a drying agent. As a result, the pectin combines and forms a network of insoluble fibres. This mesh-like structure has the capacity to hold large volumes of sugar solution. The structure, continuity, and rigidity of the fibres determine the jelly's strength. The amount of pectin in the system determines the network's continuity, whereas sugar content and acidity determine how firm the network is. The jelly's hardness grows as sugar concentration does. The amount of sugar can be reduced to create a soft jelly. However, acidity affects how quickly things set. When an acid is present, the pectin fibrils toughen and can hold the sugar solution in the interfibrillar gaps. If the acid concentration is high, the fibrils become less elastic and the jelly turns viscous.

3.3 PRINCIPLES OF GEL FORMATION

Pectin does not swell; instead, it precipitates, leading to the production of jelly. The precipitation of pectin only occurs when the balance between the pectin, acid, sugar, and water is exact. The concentration of pectin in solution, the makeup of pectin, the pH of the pectin solution, and the concentration of sugar in solution all affect how quickly precipitation occurs.

Fibrilar theory: According to Cruess, when sugar is added to a pectin solution, the pectin water equilibrium is upset, and the network of fibrils formed by the pectin conglomerates holds the sugar solution in the interfibrillar spaces. The rigidity, continuity, and strength of the fibrils determine the jelly's strength. The more pectin present, the more fibrils develop, and the more extensive and denser the network will be. Acidity and sugar content affect how solid a network is. A reduced amount of sugar can be made up for by using more pectin, as increasing the amount of sugar reduces the amount of water that needs to be supported by pectin fibres. When there is acid present, the pectin's fibrils become tough and may hold sugar. Due to the hydroxylation of pectin with a higher concentration of acid, fibrils become less elastic and the jelly becomes viscous. A weak fibril that is unable to maintain the sugar solution forms when acid is present in lesser amounts. More pectin can be added to make up for it. The degree of pectin breakdown ultimately determines the maximum amount of acid that can be added to the pectin solution without producing any unfavourable effects.

Spencer’s theory: Negatively charged pectin particles are present. At a pH of 7, a pectin solution is the most stable. The stability of the pectin solution thus diminishes with an increase in acidity or alkanity. Acid helps sugar serve as a precipitating agent during the creation of jelly. According to their potential to improve or decrease the stability, some salts aid in the precipitation of pectin while others impede it. Therefore, the less sugar is needed, the more acid is present.

Olsen's theory: The following can be anticipated if pectin is thought of as a negatively charged hydrophilic colloid.

- Sugar works as a dewatering agent, upsetting the balance between pectin and water.
- Sugar does not immediately dehydrate the pectin micelles; rather, it needs time to reach equilibrium.
- Pectin precipitates and forms a network of insoluble fibres if the negative charge on it is reduced with the help of an increase in the concentration of hydrogen ions (H+), provided that the concentration of sugar is high enough.
- In direct proportion to the concentration of H+, the rate of pectin hydration and precipitation rises with the addition of acid up to an optimal pH of about 2.0.
- The jelly strength increases to its maximum as the system reaches equilibrium.

- The effects of salt and other components on the system's final jelly strength may be due to changes in the rate of gelation, changes in the final jelly structure, or a combination of both.

Hinton's theory: It is predicated on the idea that pectins are intricate compositions of different factors. It claims that pectin gelations are a type of coagulation in which the coagulated particles create an ongoing network. Only non-ionized pectin, not ionised pectin, contributes to the formation of jelly. Therefore, in order for a mixture to produce jelly, the concentration of non-ionized pectin must surpass a specific saturation limit, which varies depending on the amount of total solids present.

Strength of Pectin Jellies

Pectin Content: Pectin content directly correlates with jelly strength.

Acidity: The pH will be lower and the jelly's strength will increase as acidity increases.

Salt content: Jelly strength is influenced by salt content, gelation temperature, and the amount of time that passes between adding sugar and evenly pouring into containers.

Sugar content: the jelly's potency increases with its sugar concentration

Temperature of gelation: When sugar and pectin are heated to between 21 and 100 °C, more jelly strength is obtained.

Hands on Experience:

A significant group of preserved fruits include jams, jellies, and marmalades, and methods for making them have been around for a while. Despite more advanced techniques like canning and freezing, this approach is still widely used to preserve fruit since it is convenient and affordable. The technique is based on the pectin found in fruit, when cooked in the presence of the right amount of sugar and acid, forming a gel.

The gel in a **jam** holds the fruit tissues in place. The transparent fruit juice is turned to a gel in a **jelly**. Fruit peels or slices are suspended in a fruit jelly called **marmalade**. **Conserve** is a type of jam prepared from a combination of fruits, almonds, and raisins; **fruit butters** are made from fruit pulp. A **preserve** is made of entire fruit or large pieces of it that have been simmered in a thick syrup until they are soft but still have some structure to them.

3.4PREPARATION OF JAM, JELLY AND MARMALADE

Jam

Making jam is a popular practise being done by homes all around the world on a small scale to preserve fruit. The production procedures employed in factories are substantially the same as those used in homes, despite the fact that they now include rigorous quality control techniques to ensure a uniform output. Manufacturing jam in factories is now a highly sophisticated process. A cane or beetroot sugar solution is boiled with fresh or already cooked fruit until enough water has been removed to make a mixture that will gel when cooled and has 32–34% water. When the pH of the fruit is between 3.2 and 3.4 and there is a lot of sugar present in the fruit, the presence of the carbohydrate pectin is required for gel formation. All of the microorganisms in jam are eliminated during the boiling process; therefore, if the jam is put hot into clean containers that are subsequently sealed, and the containers are turned over so that the hot jam contacts the lid surface, microorganism spoiling won't happen during storage. Jam is created by cooking fruit pulp with enough sugar until it is sufficiently thick and hard to hold the fruit tissues in place. Jams are made with apples, pears, sapota (chiku), apricots, loquats, peaches, papayas, karondas, carrots, plums, strawberries, raspberries, tomatoes, grapes, and muskmelon.

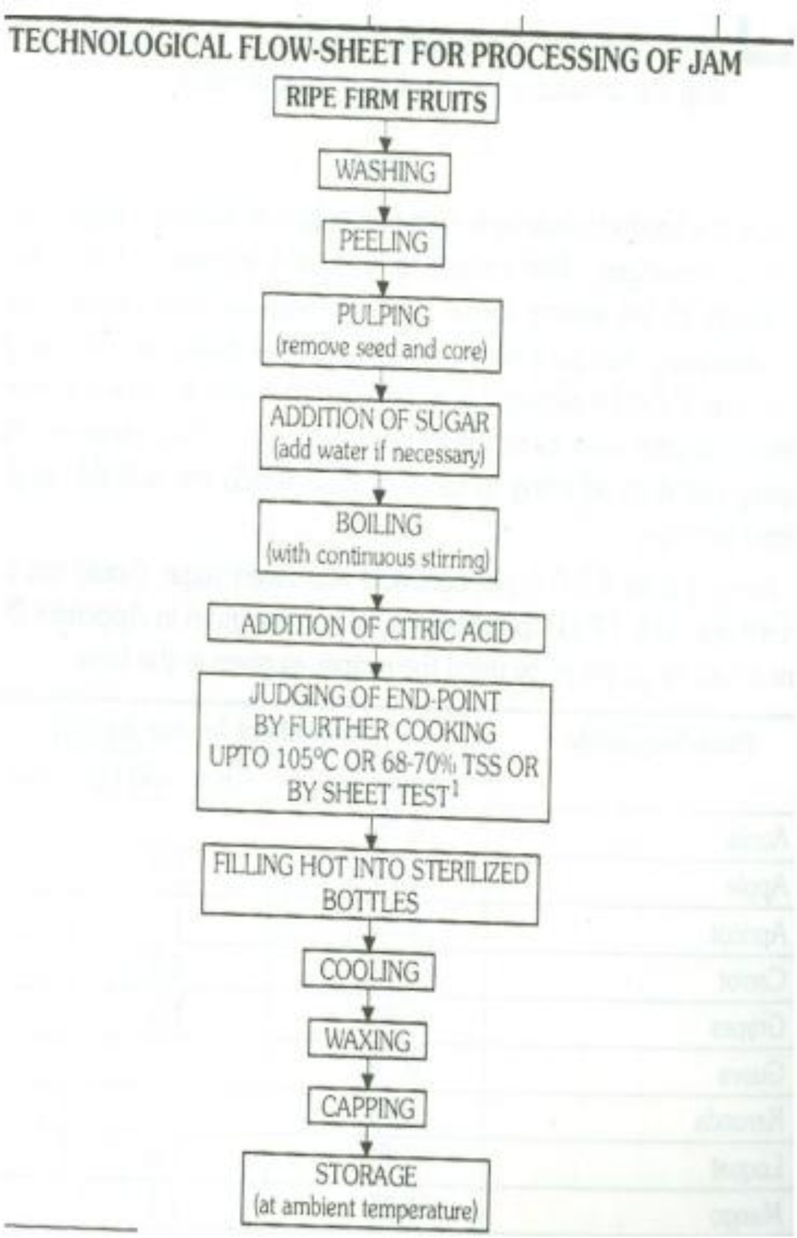

Fig 3.2 processing of jam

Jelly

Jelly is typically made using a mix of slightly overripe and underripe fruits. Since jellies are made from aqueous fruit extracts, peeling fruit is often not required before producing them. Fruits are washed in water. Only a small amount of water should be added to the fruit in order to quickly extract the pectin. Of course, how much water is added will depend on the sort of fruit utilised. Really juicy fruits don't have any water added to them. The pectin extract is filtered by passing it through folded cheese cloth or a bag made of linen, flannel, or felt. The component that is most important for creating jelly is pectin. If the fruit's pectin level is low, commercial pectin should be applied. Similar to this, it is necessary to add fruits with a high acid content or an acid if the fruit's acid content is low, like citric, tartaric, or malic acid. The mixture is then heated until it reaches the jelly stage by bringing it to a boil. It is then put into glass jars or cans, much like jam.

A good jelly should be translucent, well-set but not overly rigid, and retain the flavour of the fruit it was made from. When taken from the moulds, it should maintain its shape and have a pleasing colouring. It should maintain its shape after being cut and have a smooth surface. It need to be soft enough to tremble but not flow.

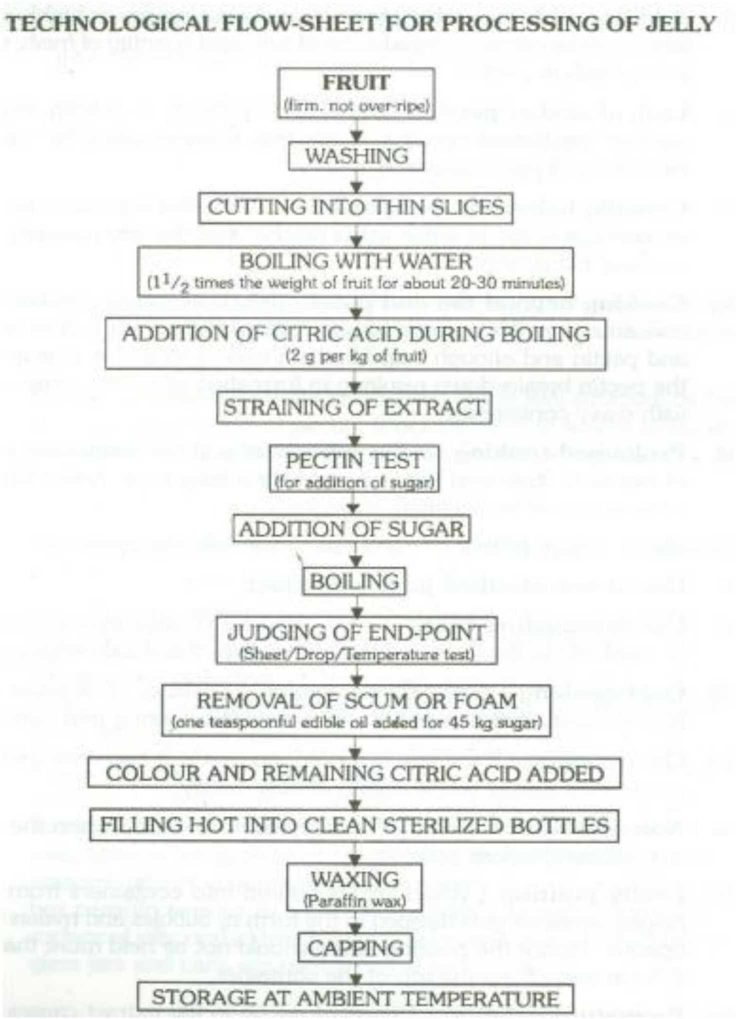

Fig 3.3 Processing of jelly

Marmalades

The product created from citrus fruits, such as oranges, grapefruit, and lemons, in which the shredded peel is included as the suspending material, is known as marmalade. The same processes used to prepare jelly are also employed to make marmalade. The marmalade's pectin and acid level should be a little bit more than what is needed to make jellies. Citrus fruits' outer skin is removed from the actual fruit. To extract pectin, the peeled fruit is cooked in water that is 2-3 times its weight for 45–60 minutes after being sliced into slices or crushed. In certain circumstances, the fruit's aqueous solution is strained (to make jelly marmalade) or run through a coarse sieve to remove gritty debris (to make jam marmalade). Shredded peels that have been cooked in water for 10–15 minutes are added to the fruit extract. After adding the proper amount of sugar, the liquid is cooked until it reaches the jellying stage. When the marmalade is finished, it is packaged similarly to how jams and jellies are.

Marmalades are classified into (i) jelly marmalade, and (ii) jam marmalade.

(1) Jelly marmalade: The following mixtures produce jelly marmalade of high quality: (i) A 2:1 weight ratio of sweet oranges (Malta) and khatta or sour oranges (Citrus aurantium). Peel from a Malta orange is used in shreds. (ii) A 2:1 weight ratio of mandarin oranges to khatta. Peel from a Malta orange is used in shreds. (iii) Galgal (Citrus iimonia) and sweet orange (Malta) in a weight-to-volume ratio of 2:1. Peel from a Malta orange is used in shreds.

(2) Jam marmalade : Practically the same preparation process as for jelly marmalade. In this instance, the entire pulp is used rather than clarifying the fruit pectin extract. According to the weight of the fruit, sugar is often added in a ratio of 1: 1. TSS concentration in the pulp-sugar mixture is heated until it reaches 65%.

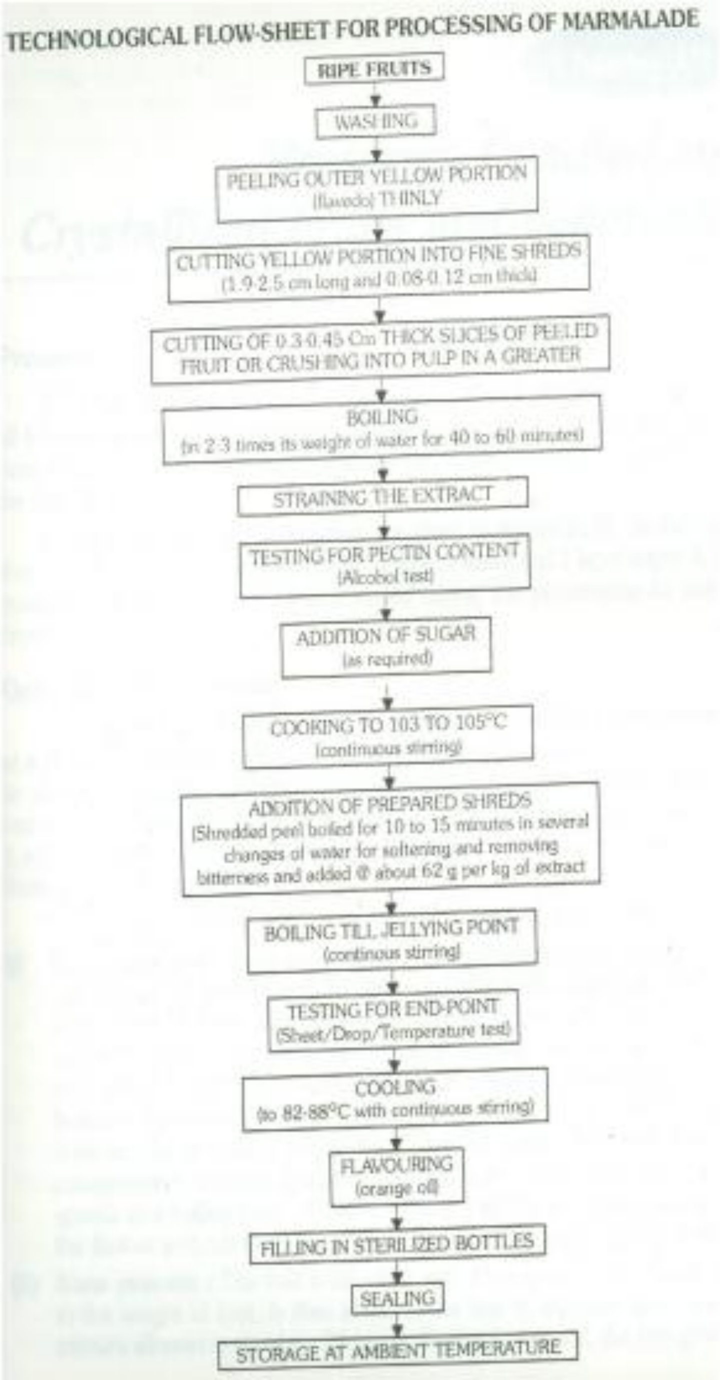

Fig. 3.4 Processing of Marmalade

3.5SAUCE AND SQUASH

Sauce and ketchup are not fundamentally different from one another. However, compared to ketchups (minimum 28%), sauces are typically thinner and have a higher percentage of total solids (minimum 30%). Sauces can be made from tomato, apple, papaya, walnut, soybean, mushroom, etc. There are two types of sauces: (i) thin sauces with low viscosity made primarily of vinegar extract and flavourings such as herbs and spices, and (ii) thick sauces with high viscosities. By macerating spices, herbs, fruits, and vegetables in cold vinegar or by boiling them in vinegar, high-quality sauces can be made. The standard commercial procedure is to prepare cold or hot vinegar extracts of each type of spice and fruit separately, blend these extracts appropriately to create sauces, and then allow these sauces to mature. To avoid solid particles settling to the bottom of the sauce, thickening agents are often used. In India, apple pulp is frequently used for this purpose, but potato, maize, arrowroot (cassava), and sago starches are also employed. Fruit tissues shouldn't separate out in the bottle when a fruit sauce is heated to the point where it may be freely dispensed. The sauce should be a vibrant colour. On cooling, sauces typically become slightly thicker. Hot ketchup is poured into bottles with a funnel, leaving a 2 cm headspace at the top, and the bottles are immediately corked or sealed. The bottles' necks are sealed airtight by being dipped in paraffin wax when they are cold. Since there is always a risk of fermentation, especially in tomato- and mushroom-based sauces, it is advised to pasteurize sauces after bottling. Even though other sauces are more acidic and less likely to ferment, they still need to be pasteurized for 30 minutes in a pot of boiling water.

The ingredients for tomato sauce/ketchup include strained tomato juice or pulp, spices, salt, sugar, and vinegar. It can be made with or without onion and garlic, and it must have at least 12% tomato solids and 25% total solids.

Squash

Squashes are commercially manufactured from various fruits such as mango, orange and pineapple, lemon, lime, bael, guava, litchi, pear, apricot, pummelo, musk melon, papaya, etc., with addition of potassium metabisulphite (KMS) as preservative, or from jamun, passion-fruit, peach, phalsa, plum, mulberry, raspberry, strawberry, grapefruit, etc., with sodium benzoate as preservative (Table 3.1).Squashes, are sometimes fortified with vitamins to enhance their nutritive value, to improve taste, texture or colour and to substitute nutrients lost in processing.

Table 3.1 Represents the concentration of sugar, water, citric acid and preservative for processing of squash from different fruit

S. No.	Fruit	Ingredient for one litre pulp/juice			
		Sugar (kg)	Water (litre)	Citric acid (g)	Preservative (g)
1	Orange*	1.75	1.0	20	2.5 KMS
2	Mango	1.75	1.0	20	2.5 KMS
3	lime, Lemon	2.0	1.0	-	2.5 KMS
4	Bael	1.80	1.0	25	2.5 KMS
5	litchi	1.80	1.0	25	2.25 KMS
6	Pineapple	1.75	1.0	20	1.9 KMS
7	Guava	1.80	1.0	20	2.0 KMS
8	Papaya	1.80	1.0	25	2.5 KMS
9	Karonda	1.80	1.0	5	4.0SB
10	Phalsa	1.80	1.0	5	4.0SB
11	Jamun	1.80	1.0	15	3.0SB
12	Plum	1.90	1.0	10	4.0SB
13	Water melon	0.50	0.25	10	1.5 SB

KMS= Potassium metabisulphite
SB= Sodium

3.6PRESERVES, CANDIED, GLAZED, CRYSTALLIZED FRUITS, TOFFEE

Preserves

A ripe fruit or vegetable, or one of its components, that has been highly sweetened till it is tender and translucent, is referred to as a preserve. Fruits like apple, pear, mango, cherry, karonda, strawberry, pineapple, papaya, etc. can be used to make preserves. You may prepare these at home using 1 kg of fruit, 1 liter of water, and 1 kg of sugar. To prevent the syrup from crystallizing, a small amount of acid (citric or tartaric) is added during preparation.

Candy

Crystalline and non-crystalline (amorphous) sweets are made from boiled sugar solution. The nature of the finished product depends on the boiling sugar solution temperature, the components employed, and the handling procedures for the supercooled sugar solution. Crystalline sweets can be cut with a knife and are easily chewed. Fondant and fudge are the main crystalline candies. When making crystalline candy with a smooth and velvety texture, much attention must be taken. In contrast, amorphous candies (such as toffee and brittles) have a heterogeneous structure and break into pieces rather than being cut with a knife into the appropriate forms. However, caramels—the softest of the amorphous candies—can be cut.

Table 3.2 Temperature test for syrups and cadies

Product	Temp 0°C	Test	Description of test
Syrup	110-112	Thread	When syrup is dropped from a spoon, syrup spins a 5 cm thread
Barfi, Fondant, Fudge	112-115	Softball	Forms a soft ball when syrup is dropped into cold water; flattens on removal from water
Caramel	118-120	Firm ball	Forms a firm ball when syrup is dropped into cold water; does not flatten on removal from water
Divinity, *Ladu (Laddoo)*, Marshmallow	120-130	Hard ball	Forms a ball hard enough t Md its shape when syrup is dropped into cold water
Butterscotch, Toffee	132-143	Soft crack	Forms threads which are hard but not brittle when syrup is dropped into cold water
Brittle, Glace	150-154	Hard crack	Forms thread which are brittle when syrup is dropped
Barley Sugar	160	Clear liquid	Sugar melts
Caramel	170	Brown liquid	Sugar melts and browns

Source: *Indian Journal of Home Science*. Vol.7, p. 152.

Preserve

Glazed,fruits and vegetables with glaze

Giving candied fruits and vegetables a thin, transparent sugar coating to give them a shining appearance is known as glazing. The guidelines supplied by Cruess for glazing fruits are as follows: Cane sugar and water are combined in a steam pan and heated to 113–114°C. As the scum rises, it is scraped off. The syrup is then cooled to 93°C and scraped over the pan's surface with a wooden spoon to make granular sugar. Before being put on trays and kept in a warm, dry atmosphere, dried candied fruits are individually pushed through this granular section of the sugar solution using a fork. They can also be dried in a dryer for a few hours at 49°C. They are set inside airtight jars.

Crystallized Fruits Fudge and fondant are crystalline sweets. The amount of sugar used must be completely dissolved by adding enough water as the first stage in making sugar-boiled sweets. A smooth-textured, soft-yet-firm result is desired in crystalline or cream candies. This is made feasible by adding components to the sugar solution that promote the growth of tiny crystals. In order to make fondant, substances including acid (cream of tartar), inverted sugar, and glucose or corn syrup are added. The solution of the candy combination is then concentrated by boiling it until it reaches the proper doneness. Slow heating causes excessive acid hydrolysis and could result in an overly pliable product. The creation of the sugar moulds utilized in this nation for special occasions likewise follows this approach. The temperature of the boiling solution is used to gauge the candy mixture's readiness. The ideal temperature for fondant is between 113°C and 114°C. Dropping a little amount of boiling syrup into ice-cold water, letting it cool, and then judging the consistency of the syrup is another way to determine when candy is done. It is the softball form in the case of fondant. Table 26.3 lists the consistency of syrup at various temperatures.

Toffee

Amorphous candies are a little simpler to produce than crystalline ones. Sugar crystallisation can be avoided by heating the solution to a high temperature so that the final product hardens quickly before crystals have a chance to form, by adding a lot of compounds that interfere with crystal formation, or by doing both at once. Different confections require different temperatures to be created. The final syrup temperature for caramels is between 118° and 120°C. When milk is one of the ingredients, caramelization of sugar as well as interactions between the amino groups of milk proteins and reducing sugars cause a brown colour to appear during cooking. Corn syrup, lipids and concentrated milk products are used as components while making caramels, Brittles are simply produced by melting and caramelising sugar. Simple sucrose syrup is the base for toffee, which is then flavoured with cream of tartar, vinegar, or lemon juice. When the solution has cooled enough, flavourings are added. Gelatin is used to make spongy candy like marshmallow and gum drops.

3.7EVALUATION OF PH, ACIDITY AND PECTIN QUALITY

Measurement of grades of pectin

Initially pectin was graded as per SAG value but now a days it is being estimated as breaking strength and as internal strength as being measured by pektionometer and Stevens- LFRA Texture Analyser respectively.

Pectin and gel formation

When the proportion of soluble solids is less than 25%, pectin is easily soluble in water. Pectin will dehydrate as the amount of sugar or total solids [TS%] grows through processing and the free moisture is taken away. Because pectin molecules in solution are negatively charged, they will oppose one another when the precipitated macromolecule forms a lattice across the gel. Reduced repulsion will result from reducing pH [raising hydrogen ion concentration], and gel.

Pectin content assessment:

One of the two approaches listed below is typically used to assess the pectin content of the strained extract.

(i) Alcohol test: The steps for this technique, which involves precipitating pectin with alcohol, are listed below:

Three teaspoonfuls of methylated spirit are carefully poured down the side of a beaker that has been filled with one teaspoon of strained extract, cooled, and turned for mixing. The beaker is then left to stand for a few minutes.

(a) A single, clear lump or clot will form in pectin-rich extracts. The extract must be combined with an equal amount of sugar to make jelly.

(b) The clot will be less rigid and fractured if the extract contains a considerable/moderate amount of pectin.

(c) If the pectin content of the extract is low, many tiny granular clots will be present. Add half as much sugar has been added.

(ii) The jelmeter test: The thumb and forefinger of the left hand are used to hold the jelmeter. With the little finger, the jelmeter tube's bottom is sealed. With a spoon held in the right hand and the strained extract being poured into the jelmeter until it is completely full. The little finger is taken off the bottomend of the jelmeter while it is still being held, and the extract is allowed to drip or flow for exactly one minute before being reinstalled. The extract level in the jelmeter is noted in the reading.

Acid

The amount of acid and pectin in the fruit determines how jelly-like the extract will be. Tartaric acid performs best among the three acids found in fruits—citric, malic, and tartaric. The finished jelly should have at least 0.5% (ideally 0.75%) of total acids, but no more than 1%, as too much acid may result in syneresis.

Extract's pH: Until the pH is optimal, jelly strength increases as pH rises. The jelly's strength is decreased with more acid addition. For a jelly with 1% pectin, the ideal pH is roughly 3.0, 3.2, and 3.4 for 60%, 65, and 70% TSS, respectively.

Visit to Fruits and Vegetable processing industry.

KNOW YOUR PROGRESS

Check Your Progress Exercise

Note: Use the spaces given below for your answers.

1) What is the principle of gel formation?

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2) What are the processing steps involved in jam manufacturing?

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3) Discuss briefly the pectin test during jelly-making.

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4) Enlist different types of fruit preserves.

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LET'S SUM UP

In this unit, we have learnt about what is fruit preservation.fruits have high water activity and hence are more prone to spoilage. They can be preserved through the sugar concentration process.Fruit preservation is mainly done by using high concentrations of sugar or salt leading to the osmosis process which results in reducing the water activity of the fruit. In this unit, some of the fruit preserves and their manufacturing process are discussed.

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UNIT-IV Preservation by Using Chemicals and Salts and Fermentation:

Structure

4.0 Objectives

4.1 Introduction

4.2 Preparation and Preservation of Fruit Juices, RTS

4.3 Pickling – Principles Involved and Types of Pickles

4.4 Chemical Preservatives – Definition, Role of Preservation Permitted Preservatives, FSSAI guidelines Foods fermented by Yeasts Foods fermented by Bacteria

4.5 Common Fermented Foods, Wine and Cheese Making

Hands on experience: Pickle making Visit to Commercial Pickle Manufacturing Food Industry and Wine industry

4.0 OBJECTIVES

After reading this unit you should be able to:

• know about the methods of preserving fruit juice and RTS;

• learn various methods of pickling as a preservation method;

• know about types of fermented food and beverage;

• study FSSAI guidelines for fermented foods

4.1 INTRODUCTION

Osmotic dehydration, which is achieved by soaking the solid food, whole or in part, in aqueous solutions of sugars or salts that have a high osmotic pressure, is a useful technique for concentrating fruit and vegetables. A considerable water flow from the meal into the solution and a solute transfer from the solution into the food both happen concurrently as a result, creating at least two significant counter-current flows.

The goal of all currently known food preservation techniques, including application of heat, cold, removal of water, and other techniques, is to either reduce the quantity of microorganisms in food or to prevent them from proliferating further. Contrarily, the proliferation of microorganisms and their metabolic processes are promoted during the fermentation process of food preservation. However, only a few types of organisms are promoted to proliferate and grow because their metabolic byproducts aid in food preservation.The term "fermentation" refers to the anaerobic breakdown of carbohydrate material by microorganisms (or enzymes). The breakdown of carbohydrates and carbohydrate-like substances occurs both anaerobically and aerobically, and is referred to as "fermentation" in common usage. Therefore, the processes of Streptococcus lactis converting lactose to lactic acid under anaerobic conditions and Acetobacter aceti converting ethyl alcohol to acetic acid under aerobic conditions are both referred to as fermentation.

Since ancient times, natural fermentations have been essential for the preservation of food. Fruit juices that were exposed to the air naturally fermented and took on an alcoholic flavour. Standing milk had a mild acidic flavour. Therefore, these modifications were used to preserve foods that would otherwise spoil quickly. At the same time, some found the altered flavour and texture of fermented meals to be appealing. These are the main justifications for fermentation's continuous usage in food processing and preservation. Cheese, curd, butter, all alcoholic beverages, pickles, sauerkraut, vinegar, bread, idli, soy sauce, coffee, tea, and chocolate are just a few of the numerous items that can be made through fermentation.

4.2PREPARATION AND PRESERVATION OF FRUIT JUICES, RTS

Fruit Juices

Juices come in two varieties:

(a) Natural juice: it is also known as pure juice, is the juice that has been extracted from ripe fruits and solely includes natural sugars.

(b) Sweetened juice: This liquid product has a minimum juice content of 85% and a maximum total soluble solids content of 10%. Pure fruit juices, including apple juice and orange juice, are produced for sale in a number of nations. While other juices are typically canned, apple juice is typically bottled. The following are the methods for making different fruit juices:

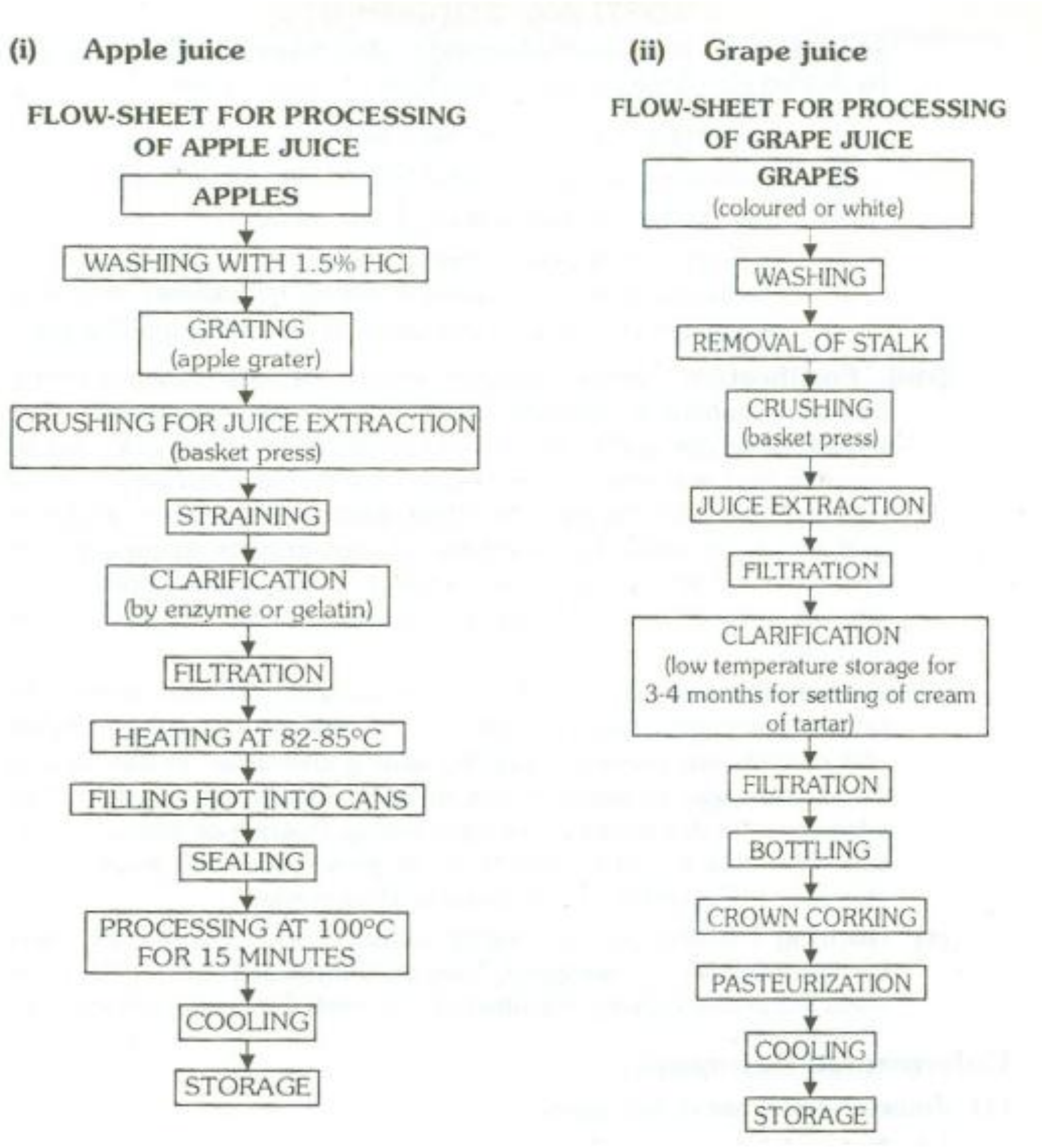

Fig 4.1 processing of apple and grape juice

Pasteurization is used to preserve fruit juices, RTS, and nectars, but chemical preservatives are occasionally used. The only way to preserve squashes, crushes, and cordials is by adding chemicals. Syrup has a high enough concentration of sugar to keep it from spoiling. Fruit juice concentrates are preserved through the use of heat, freezing, or chemical additions.

RTS (Ready-to-Serve)

In addition to roughly 0.3% acid, this type of fruit beverage comprises at least 10% fruit juice and 10% total soluble solids. It is called ready-to-serve (RTS) since it hasn't been diluted before consumption. Knowing how to remove the pulp and juice from different fruits used to make RTS, nectar, squash, syrup, etc. is important before beginning the beverage production process. Some fruits' extraction methods have already been mentioned, while others are as follows. Before adding the necessary amounts of sugar and citric acid dissolved in water for TSS and acidity adjustment, the total soluble solids (TSS) in the pulp/juice and its acidity are first determined for the preparation of the beverages.

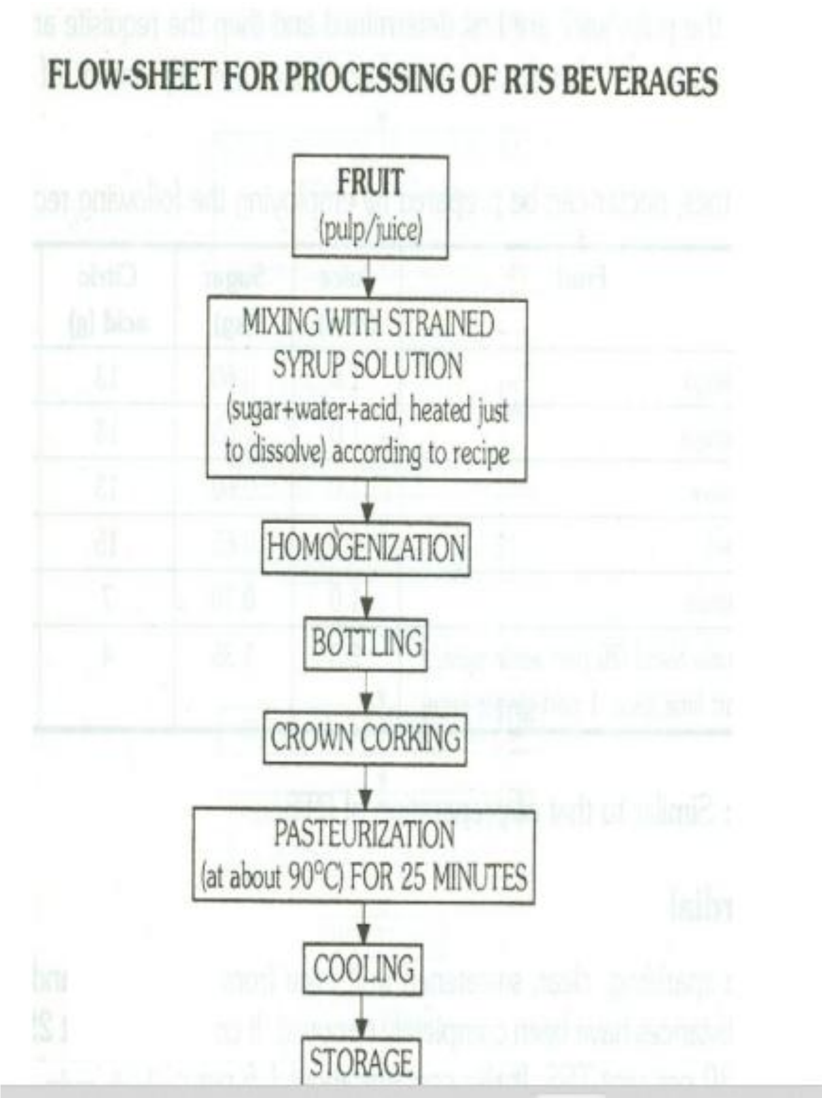

Fig 4.2 processing of RTS

4.3PICKLING – PRINCIPLES INVOLVED AND TYPES OF PICKLES

Pickles

Pickling is the process of preserving food in vinegar or table salt. One of the oldest techniques for preserving fruits and vegetables. Pickles make a meal more palatable and make for tasty appetizers. They aid in digestion by promoting the flow of gastric juice. The Indian market offers a variety of pickles. Cauliflower, onion, turnip, and lime pickles come in second place, after mango pickles. These are frequently produced both commercially and at home, and they are also exported. Vegetables are typically pre-served in salt, and fruits are typically kept in sweetened and flavoured vinegar.

Principle of pickling: Lactic acid-forming bacteria, which are often abundant on the surface of fresh vegetables and fruits, ferment foods to produce pickling. These bacteria may thrive in an acidic environment and in the presence of an 8–10% salt solution, whereas the majority of harmful organisms have their growth suppressed. In the early stages of preparing pickles, the temperature must be kept as close to 30°C as possible since lactic acid bacteria are most active at this temperature. When vegetables are submerged in brine, it seeps into their tissues and soluble substances disperse through osmosis into the brine. Minerals and fermentable carbohydrates are included in the soluble material. Lactic acid bacteria feed on the sugars, converting them into lactic and other acids as a result. The resulting acidic brine reacts with the vegetable tissues to give pickles their distinctive flavour and scent. In the dry salting method, a vessel covered with a cloth and a wooden board and let to stand for about 24 hours is filled with multiple alternating layers of vegetables and salt (20- 30 g of dry salt per kg of vegetables). Osmosis causes enough juice from the veggies to escape during this time, forming brine. Vegetables are covered with brine (steeping in a concentrated salt solution is known as brining) if they don't have enough juice (like cucumber, for example) to dissolve the salt that has been added.

Pickles are currently made and preserve with salt, vinegar, oil, or a combination of salt, vinegar, oil, and spices. The following methods are covered:

(1) Salt preservation

Salt enhances flavour, increases vegetable tissue hardness, and inhibits fermentation. A 15% salt concentration or more prevents microbiological deterioration. This method of preservation is typically only utilised for vegetables that have a very low sugar content because this limits the amount of lactic acid that can be produced during fermentation to serve as a preservative. However, salt is also used to preserve some fruits, including lime, mango, and others. The following is a description of how various pickles are made:

(i) Lime pickle: 1 kg of limes, 200 g of salt, 15 g of red chilli powder, huge cinnamon, cumin, and cardamom pods, and powdered black pepper.

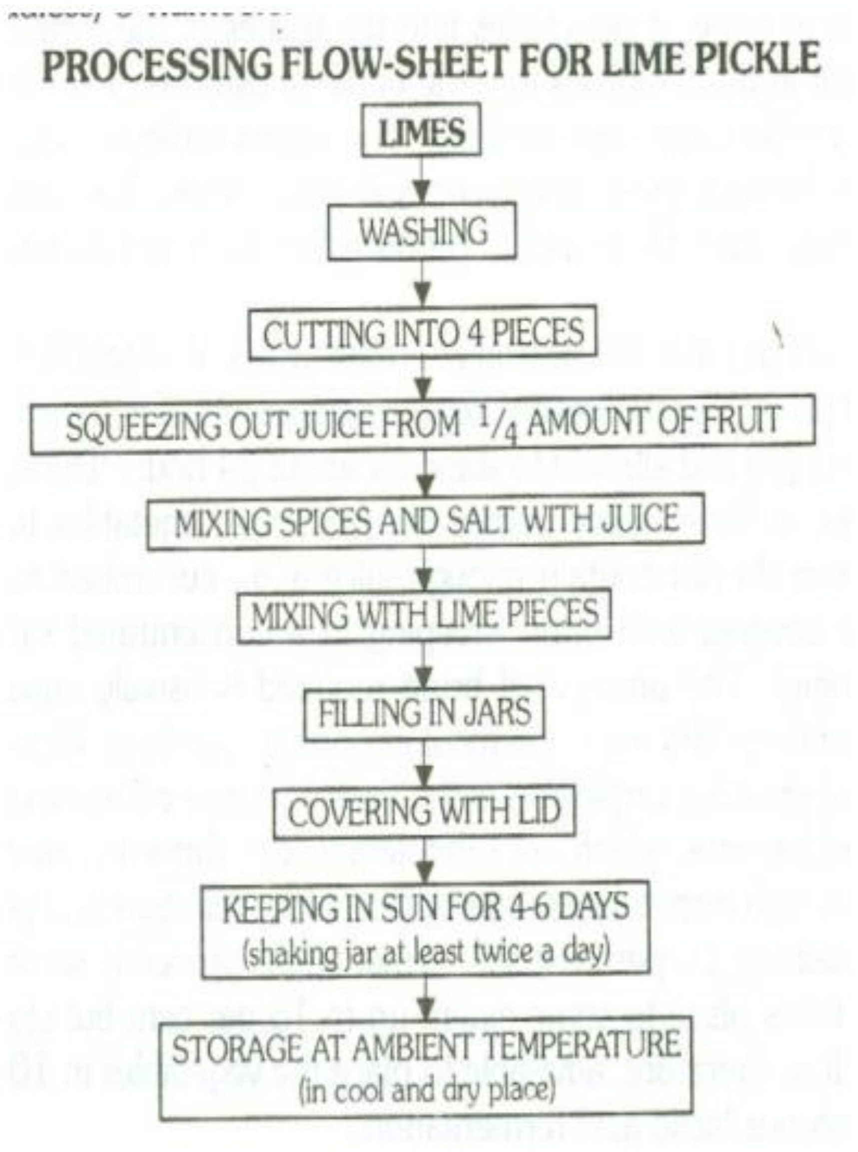

Fig 4.3 processing of lime pickle

(2) Vinegar preservation

A variety of fruits and vegetables are preserved in vinegar, which should have a final acetic acid concentration in the finished pickle that is no less than 2%. The vegetables or fruits are typically placed in strong vinegar of about 10% strength for several days before pickling, which helps to expel the gases present in intercellular spaces of vegetable tissue and prevents vinegar below this strength from being diluted by the water released from the tissues. The most significant pickles eaten abroad are vinegar pickles. In vinegar, items such as mangoes, garlic, chilies, etc. are preserved. ex(i) Papaya pickle: 1 kilograms of peeled papaya chunks, 100 g of salt, 10 g of red chilli powder, 1 cup of cumin, powdered black pepper 10 g, vinegar 750 ml.

(3) Oil-based preservation

The edible oil needs to cover the fruits or vegetables entirely. The most significant oil pickles are turnip, lime, mango, and cauliflower. approaches to below is how some oil pickles are made:

Pickled mango: Mango pieces 1 kg, salt 150 g, fenugreek (powdered) 25 g, turmeric (powdered) 15 g, nigella seeds 15 g, red chilli powder 10 g, clove (headless) 8 numbers, black pepper, cumin, cardamom (large), aniseed (powdered) each 15 g, asafoetida 2 g, mustard oil 350 ml Gust adequate to cover pieces).

(4) Preserving with a salt, oil, spice, and vinegar mixture

Cauliflower pickle ingredients include 1 kg of chopped cauliflower, 150 g of salt, 25 g of chopped ginger, 50 g of chopped onion, 10 g of chopped garlic, 15 g each of powdered cardamom, cumin, and aniseed, 6 g each of headless cloves, and 50 g each of ground mustard and tamarind pulp.

4.4CHEMICAL PRESERVATIVES – DEFINITION, ROLE OF PRESERVATION PERMITTED PRESERVATIVES,

To inhibit microbial degradation of food products, chemical preservatives are utilised that solely contain microbial antagonists as opposed to salt, sugar, acetic acid, oils, or alcohols. Preservatives interfere with the mechanisms of cell division, cell membrane permeability, and enzyme activity, which results in their inhibitory actions. Pasteurized squashes, cordials, and crushes have a cooked flavour. After the container is opened, they quickly begin to ferment and spoil, especially in a tropical climate. To stop this, chemical preservatives are necessary. Chemically preserved squashes and crushes can be kept for a while even after the seal on the bottle has been broken. Chemical use must be carefully regulated, nevertheless, as their indiscriminate use is likely to be detrimental. The preservative utilized shouldn't be unhealthy or irritant to the skin. It should be straightforward to calculate and identify.

The British Food and Drug Act of 1928 defines a "preservative" as any substance that has the ability to prevent food from fermenting, becoming acidic, or otherwise decomposing. Common salt (sodium chloride), saltpetre (sodium or potassium nitrate), sugar, acetic acid or vinegar, alcohol or potable spirits, spices, essential oils, or any other substance added to the food during the smoking process are not considered to be "preservatives." Sulphur dioxide (including sulphites) and benzoic acid (including benzoates) are the two significant chemical preservatives that are approved in many nations. According to the Fruit Product Order (F.P.O.) of 1955, these two are also permitted in India. first, sulphur dioxide It is commonly used all over the world to preserve items like juice, pulp, nectar, squash, crush, and cordial. It effectively prevents the growth of germs and mould, inhibits enzymes, etc. It also functions as a bleaching and antioxidant agent. These characteristics aid in the retention of oxidizable substances such as carotene, ascorbic acid, and others. Additionally, it prevents the product from developing nonenzymatic browning or discoloration after the enzyme has been destroyed. Typically, its salts, such as sulphite, bisulphite, and metabisulphite, are used.

Alcoholic acid Its salt, sodium benzoate, is employed since it is only slightly soluble in water. At room temperature, one part of sodium benzoate dissolves in 1.8 parts of water, but one part of benzoic acid dissolves in just 0.34 parts of water. Therefore, sodium benzoate is almost 1170 times more soluble than benzoic acid. Pure sodium benzoate has neither flavour or aroma. Bacillus subtilis cannot survive in a solution of benzoic acid in the presence of carbon dioxide, demonstrating the enhanced antibacterial effect of benzoic acid in the presence of both carbon dioxide and acid. Benzoic acid works better against yeast than it does against mould. Lactic acid and acetic acid fermentation are not stopped. The amount of benzoic acid needed will vary depending on the product's composition, notably how acidic it is. The addition of 0.06 to 0.10 percent of sodium benzoate has been found to be sufficient for juices with a pH of 3.5 to 4.0, which is the range of most fruit juices. A minimum of 0.3% is required for less acidic liquids like grape juice. At pH 5.0, benzoic acid's effect is significantly diminished. Over 0.1% sodium benzoate may result in an unpleasant burning taste. The permissible level in RTS and nectar is 100 ppm, while in squash, crush, and cordial it is 600 ppm, according to the F.P.O. Several substances that were once used as preservatives, including hydrogen peroxide, formaldehyde, halogenated acetic acid, salicylic acid, etc., have now been outlawed in many nations. Tylosin, sorbic acid, and other substances have all been tested recently.

FSSAI guidelines Foods fermented by Yeasts Foods fermented by Bacteria

Up until the date of minimal durability, the starter microorganisms must be present in the product in a viable, active, and plentiful state. The beginning culture described in sub-item (a) of item 1 must contain a total of 107 cfu/g of microorganisms. When particular microorganisms other than those listed in sub-item (a) of item 1 are introduced and a content claim is stated on the label, the labelled microorganisms must not be fewer than 106 cfu/g. These requirements for live microorganisms do not apply if the product is heated after fermentation;

A statement to this effect must be made on the label or in another manner if the product is not pre-packaged when cultures of *Bifidobacterium bifidum*, *Lactobacillus acidophilus*, and other compatible lactic acid generating harmless bacteria are added.

4.5 Common Fermented Foods

The phrase "fermented foods" designates a particular class of food items that occasionally show different patterns of carbohydrate breakdown. Most fermented meals are composed of a complex mixture of proteins, lipids, carbohydrates, and other substances that are being changed simultaneously or in some sequence by a variety of bacteria and enzymes. Therefore, additional terminology is needed to distinguish between the various important types of change. Reactions involving carbohydrates and compounds that resemble carbohydrates are referred to as "fermentative" reactions (actual fermentations). Proteolytic or putrefactive transformations occur in proteinaceous materials. Lipolytic refers to the breakdown of fatty compounds. When complex foods are "fermented" naturally, they always go through varying degrees of each of these types of changes. It will either be fermentative, proteolytic, or lipolytic end products that predominate, depending on the nature of the meal, the types of bacteria present, and environmental conditions effecting their development and metabolic inclinations. Acetic, lactic, and alcoholic fermentation are the three main types utilized to preserve fruits and vegetables.

Additionally helpful in preserving the healthy microbiota composition of celiac disease, fermented food products can support physiological homeostasis and play a critical role in disease prevention. We can also refer to fermented food products as naturally energizing edibles. According on which food product has been fermented, there are numerous sorts of fermented goods still available on the market. They fit into the following categories. (i) cereal-based (with/without pulses) fermented foods, (ii) cereal/pulse and buttermilk-based fermented food: those made with cereal/pulse and buttermilk, (iii) cereal-based fermented sweets and snacks, (iv) milk-based fermented foods, (v) vegetable, bamboo shoot (BS) and unripe fruits-based fermented foods, (vi) meatbased fermented foods and (vii) pulse (legume)-based fermented food

Wine

Wine Different nations' legal systems define wine differently; for instance, in China, wine is regarded as an alcoholic beverage and is referred to as appetite wine. It is referred to as the fermented juice of several fruits in California. However, wine generally refers to the end result of the fermentation of grape juice. The most apt description appears to be "wine is a beverage resulting from the fermentation by yeasts of the grape juice with proper processing and addition." In other words, wine strictly refers to the alcoholic beverage made from grape juice that has undergone fermentation but not distillation. Historically, grapes have been used to make wine for the following reasons: (i) Juice has a tremendous amount of natural sugar. (ii) The berries' organic connection with fermenting yeasts. (iii) A high amount of nitrogenous substances helps fermentation by boosting yeast development. (iv) Juice's high acidity favours yeast growth and guards against the fermentation of other microorganisms.

(v) The fermented wine is stable and safe for long-term preservation because of its high alcohol and acid levels. Wines come in countless variations and have so many unique qualities that it is challenging to categorise them. There are two sorts, red and white, based on colour. There are two types of grape wines: dry and sweet. Wines that can't be detected as having any sugar are said to be dry. The sugar concentration in sweet wines is significant enough to taste. These two types of wines have an alcohol percentage that ranges from 7 to 20%. "Light" wines are those that have 7 to 9 percent alcohol by volume, "medium" wines have 9 to 16 percent, and "strong" wines have 16 to 21 percent. CO_2 is present in sparkling wine. They undergo secondary fermentation in tightly sealed containers, usually the bottle itself, to become fizzy. Wines classified as "still" don't have any carbon dioxide in them. Brandy, an additional form of alcohol, is added to fortified wines. Wines that contain more than 12% alcohol are typically fortified with fruit brandy, which is alcohol made by distilling grape wine.

Diverse types of marketable wines are listed below: **Champagne**: it is a foaming wine which contains dissolved carbon dixoide. **Sparkling wine**: it is produced by carbonation by injecting carbon dixoide into the wine. **Liqueur Wine:** it is sweet with a higher content of alcohol. **Sherry**: it is a fortified wine with two distinct styles, the first being dry wine (without any sweet taste) consumed as an appetizer before meals and the other being olorosos sweetened wine taken after meals. • **Port**: it is a type in which wine is stored in a wooden cask or Hintage ports. During maturation the type of barrel used for aging contributes to quality of wine. **Vermouth**: it is a flavoured wine in which different varieties of herbs and spices are added. **Brandy:** It is a distilled wine stored mostly in wooden cooperage or casks.

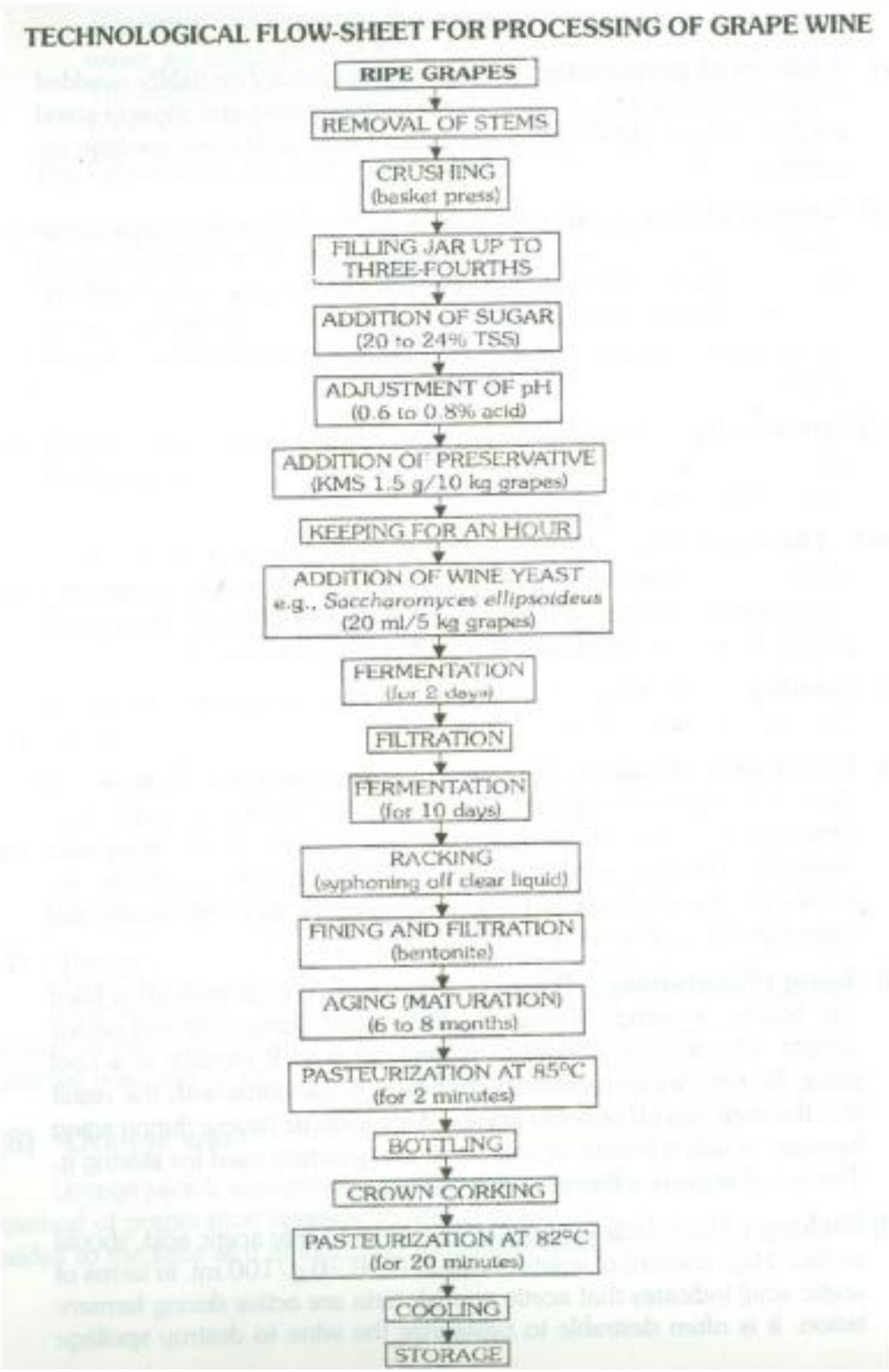

Fig 4.4 Processing of wine

Cheese Making

Cheese is made from around one-third of the milk produced annually in the United States. The production of natural and processed cheeses was 9.7 billion pounds in 1998. Cheese, which was made by adding rennet (an enzyme found in a calf's stomach) to sour milk, which is only possible by exposing milk to microbes, can undoubtedly be considered as one of the first direct products (or by-products) of biotechnology, even though this understanding was not present at the time. All cheeses are made from milk, however the variety of cheeses that are currently on the market is produced using various manufacturing and ageing techniques. Milk from cows, goats, and buffaloes can all be used to make cheese. Making cheese involves coagulating or curdling milk, boiling the curd, stirring it, removing the whey (the liquid portion of the milk), collecting and pressing the curd, and occasionally ripening it. Whole milk, 2% low-fat milk, 1% low-fat milk, fat-free milk, or a combination of these milks can all be used to make cheese. There are more than 400 different kinds of cheese to choose from. There are various classifications for cheeses, including natural versus processed, unripened versus matured, and soft versus hard. Many cheeses bear the name of the town or region where they were first produced, such as the English cheese known as Cheddar.

Natural cheeses are frequently divided into groups based on their moisture content or level of softness or hardness.

• Casein, a milk protein, is coagulated with acid to produce unripened cheeses.

• For instance, ripened cheeses are produced by coagulating milk proteins with enzymes (rennet) and culture acids. Soft cheeses like cream cheese, cottage cheese, and Neufchatel are examples of this type of cheese. Then, bacteria or mould ripen (age) the cheeses. Cheeses that have been matured by bacteria include Cheddar, Swiss, Colby, brick, and Parmesan.

• Mold Mold-ripened cheeses include ripened cheeses like.

Natural cheeses include:

Soft Cheeses: Brie, Camembert, ricotta, cottage

Semi-Soft Cheeses: Blue, brick, feta, Havarti, Monterey Jack, mozzarella, Meunster, provolone

Hard Cheeses: Cheddar, Colby, Edam, Gouda, Swiss

Very Hard Cheese: Parmesan, Romano

Process Cheeses. These cheeses are made by blending one or more natural cheeses, heating and adding emulsifying salts. Process cheeses contain more moisture than natural cheeses.

- **Pasteurized process cheeses** include American cheese, cheese spreads and cheese foods.
- Cold-pack cheese is a blend of natural cheeses processed without heat.

Hands on experience: Pickle making Visit to Commercial Pickle Manufacturing Food Industry and Wine industry.

KNOW YOUR PROGRESS

Check Your Progress Exercise

Note: Use the spaces given below for your answers.

1) What is the principle of pickling?

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2) What are the processing steps involved in wine manufacturing?

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3) Discuss the manufacturing process of cheese.

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4) Enlist different types of fermented food with their health benefits.

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LET'S SUM UP

In this unit, we have learnt about what is fermentation. Pickling is also one of the oldest known methods of preservation. Fermented food is easily digestible, having more nutrients with increased bioavailability. In this unit, some of the fermented foods like cheese, wine etc. and their manufacturing process are discussed.

REFERENCES BOOK

Wood, B.J.R. (Editor) (1985) Microbiology of Fermented Foods, Volumes 1, 371 pp & Volume 2, 292 pp. Elsevier Applied Science Publishers. London and New York. [This two-volume book discusses the microbiology of fermented foods from around the world].

Okafor, N (1987) Industrial Microbiology. Ife (Nigeria): University of Ife Press [This volume containsinformation on various fermented foods]

UNIT-V PRESERVATION BY ADVANCED PRESERVATION TECHNOLOGY:

Structure

5.0 Objectives

5.1 Introduction

5.2 Meaning and needs of freezing foods

5.3 Types of Freezing and managing freezers

5.4 Guidelines for types of frozen foods-Fruits, Vegetables, fish, meat and poultry

5.5Pasteurization and Sterilization Food Irradiation Vacuum Packing Canning and Bottling

5.6 Food Packaging Materials for preserved food products

Hands on experience: Blanching of fruits & Vegetables Visit to Food Industries

5.0 OBJECTIVES

After reading this unit you should be able to:

• know about the methods of low temperature preservation;

• learn various methods of freezing and types of freezers;

• know about types of food irradiation;

• study different types of food preservation such as aseptic canning and bottling, pasteurization, sterilization, etc.

5.1 INTRODUCTION

Through the ages, modern techniques for food preservation have evolved based on earlier techniques. The 19th century saw the modest beginnings of industrial food processing, but this century has seen enormous advancements. The fundamental goal of all food preservation methods, whether they are used at home or in industrial settings, is to prevent food from spoiling so that it can be utilized later on without risk and in a delectable state. Methods of preservation are intended to prevent the spread of organisms as well as their removal and eradication. The biochemical degradation of tissues and the change of their cell contents should also be halted by food preservation. Heat, cold, drying, fermentation, radiation, and chemicals are used to accomplish this**.**

Freezing

Many foods can be successfully frozen to extend their shelf life and preserve them for a very long time. The technique, according to Fennema et al. (1973), involves lowering the product's temperature to -18 °C or lower. The physical state of food is changed when energy is removed from it by chilling it below the freezing point. Only chemical changes that affect food quality or cause it to decay, as well as the development of microbes, are slowed by extremely cold temperatures (George, 1993).

5.2 MEANING AND NEEDS OF FREEZING FOODS

As was already said, ancient humans were aware of the benefits of freezing and cold storage for food preservation. Tribes and countries in temperate and cooler climates preserved their crop by freezing them, thawing them as needed, and eating it. Even short distances to consumption centers were covered by the transportation of frozen meals. The advent of mechanical refrigeration systems has led to a rise in the use of cold storage, processing, and delivery of food. Agriculture practices have also been impacted by refrigeration. Perishable foods can now be transported over great distances from the point of production to the point of consumption, and seasonal foods can now be found all year round.

Storage that keeps food in a frozen state is referred to as frozen storage. Normal requirements for good frozen storage are -18°C or lower. Since fresh foods contain so much water, freezing them takes a lot of energy, which is why the frozen fruit and vegetable industry uses so much of it. The refrigeration burden is lessened when a material is frozen due to its moisture content.

Fruits and vegetables can be partially concentrated before freezing to minimize packing and delivery costs and to increase product quality because there is a significantly lower danger of structural collapse and leaking when the food is thawed.

The final goods are referred to as "dehydro-frozen" products, and the concentration step is frequently finished by conventional air drying, with an additional expense to take into account. Osmotic dehydration may be employed in place of air drying to save energy consumption or enhance product quality, especially for produce that is air-sensitive.

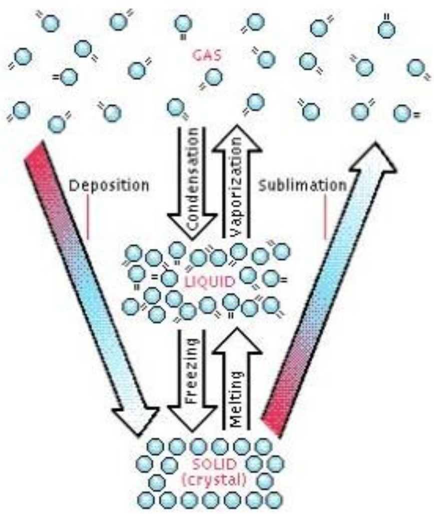

Fig 5.1 Schematic representation of freezing processSource:https://www.fao.org/3/y5979e/y5979e03.htm

5.2 TYPES OF FREEZING AND MANAGING FREEZERS

Freezing of Foods,The rate of freezing of foods depends on a number of factors, such as the method employed, the temperature, circulation of air or refrigerant, size and shape of package, and kind of food. Sharp freezing usually refers to freezing in air with only natural air circulation or at best with electric fans. The temperature is usually −23.3 C or lower but may vary from −15 to −29 C, and freezing may take from 3 to 72 hr. This sometimes is termed **slow freezing** to contrast it to quick freezing, in which the food is frozen in a relatively short time. **Quick freezing** is variously defined but in general implies a freezing time of 30 min or less and usually the freezing of small packages or units of food.

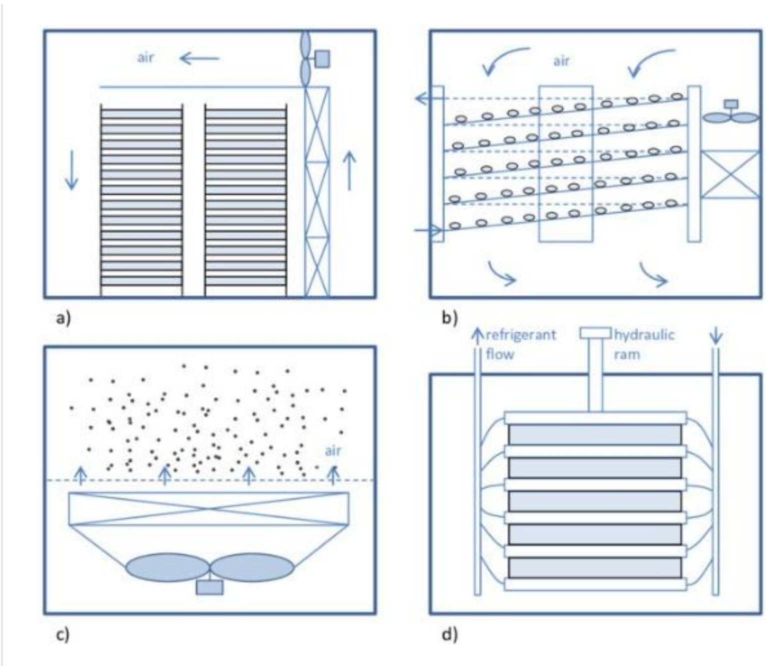

Fig 5.2 Different types of freezing equipment a) blast freezer, b) spiral belt freezer, c) fluidized bed freezer d) plate freezer

Source: Valentas et al., 1997, chap. 3

Quick freezing is accomplished by one of three general methods**:**

(1) direct immersion of the food or the packaged food in a refrigerant, as in the freezing of fish in brine or of berries in special sirups,

(2) indirect contact with the refrigerant, where the food or package is in contact with the passage through which the refrigerant at −17.8 to −45.6 C flows, or (3) air-blast freezing, where frigid air at −17.8 to −34.4 C is blown across the materials being frozen. A method for the overseas shipment of frozen, packaged foods involves nitrogen freezing of the cartoned foods in a special aluminum case and ordinary storage on the ship. The original low temperature and the insulation guarantee that the food will remain in the frozen condition for the desired period. Certain fruits and vegetables, fish, shrimp, and mushrooms now are being frozen by means of liquid nitrogen. For **dehydrofreezing**, fruits and vegetables have about half their moisture removed before freezing.

The advantages claimed for quick freezing over slow freezing are that

(1) smaller ice crystals are formed, hence there is less mechanical destruction of intact cells of the food,

(2) there is a shorter period of solidification and therefore less time for diffusion of soluble materials and separation of ice,

(3) there is more prompt prevention of microbial growth, and

(4) there is more rapid slowing of enzyme action. Quick-frozen foods, therefore, are supposed to thaw to a condition more like that of the original food than slow-frozen foods. This seems to be true for some foods, e.g., vegetables, but not necessarily for all foods. Research on fish, for example, has indicated little advantage for quick freezing over slow freezing.

5.3 GUIDELINES FOR TYPES OF FROZEN FOODS-FRUITS, VEGETABLES, FISH, MEAT AND POULTRY

In order to reduce the environmental impact of our consumption, packaging serves to protect and confine our products. It is a technology for enclosing or safeguarding goods for usage, sale, distribution, and storage. All food packaging materials must receive FDA approval before being used. Any material created with the goal of being used in food packaging needs to be formulated in accordance with FDA specifications. If a novel material is not currently regulated for the intended purpose, the maker must submit a petition to the FDA and present data demonstrating the material is safe to use.

Requirements for Packaging Depending on their physical, anatomical, physiology (primarily transpiration, respiration, and ethylene production rate), and susceptibility to microbial decay, various horticultural products require various types of packaging. The post-harvest life of fresh produce also depends significantly on temperature, relative humidity, and ventilation. Thus, the guidelines for packaging fresh produce can be summed up as follows: • Provide air for breathing and gas exchange • Protect against bruising and physical harm • Protect against microbiological contamination and deterioration • Prevent moisture loss and weight loss • Reduce the rate of respiration, postpone ripening, and lengthen storage time • Regulate ethylene concentrations in the package

Accidentally frozen cans, such as those left in a car or cellar in below-freezing temperatures, can cause health issues. The food might still be useable if the cans are very slightly swelled and you are certain that the swelling was brought on by freezing. Throw the cans away right away if any of the seams have rusted or burst. Throw away frozen cans that have thawed to temperatures exceeding 40 °F (4.4 °C). Before opening, let the unopened can defrost in the fridge. Throw away a product if it doesn't appear or smell as it should. Taste it not! If the product appears and/or smells normal, immediately boil the contents for 10 to 20 minutes to fully cook them. The products can then be stored or refrigerated for later use.

Food contact has been authorised by the FDA for packaging that is available for purchase or usage in grocery stores (such as produce or meat bags). These consist of: Polyethylene (PE), polyvinylidene chloride (PVDC), and polyvinyl chloride (PVC) are the three main types of plastics used to make consumer plastic wraps and storage bags. Petroleum derivatives are used in the plastic resins. It is possible to add plasticizers, colourants, or anti-fog substances.

In-store Produce bags are used to package fruits and vegetables for sale to consumers in-store. They are often constructed of polyethlene or another type of plastic film. Useless for cooking since the thin plastic could burn or melt.

Oven cooking bags - The bags' closure ties and material are both composed of heat-resistant nylon. They are suitable for use in normal ovens and microwaves with a maximum temperature of 400 °F (204.4 °C). Foil made of aluminium contains 98.5% of the material, with the remaining silicon and iron serving mostly as reinforcement and puncture resistance. Between big, water-cooled chill rollers, the molten alloy is rolled thin and solidified. Two layers of foil are run through the mill simultaneously during the final rolling. The side that comes into contact with the smooth steel rollers shines, while the opposite side becomes dull. Whichever side of the foil touches the food has no bearing.

Freezer paper is white paper that has had a plastic coating applied to one side to assist prevent freezer burn and moisture loss by keeping air out of frozen meals.

Parchment paper is a flavourless, odourless paper created from pure chemical wood pulps and/or cotton fibre. It is either greaseproof or grease resistant and can be coated or waxed. In baking, parchment paper is mostly used as a pan liner or to wrap food before cooking.

Wax paper A food-safe paraffin wax is pressed into the paper's pores and applied as a coating to the outside of wax paper, a triple-waxed tissue.

The FDA must approve packaging materials for irradiation in accordance with the Federal Food, Drug, and Cosmetic Act (FFDCA). It is impossible for the packaging to contain materials that could migrate into the food as a result of the irradiation process because it comes into direct contact with the food. Furthermore, after being exposed to radiation, these packaging materials cannot exhibit any discernible radioactivity. FDA guidelines outline a maximum absorbed dose level of radioactivity to which packing materials can be exposed without endangering food.

Poultry must be irradiated according to USDA/FSIS irradiation requirements in the package in which it will be marketed to consumers. There are only a few places in the United States where you can get irradiated poultry. Regulations for the irradiation of pork by the USDA/FSIS permit the irradiation of unpackaged pork because the radiation treatment kills the parasite trichinae, which is not airborne. Trichinae larvae would not likely contaminate the irradiated pork post-process. Currently, irradiated pork is not offered in the United States. In addition to the words "Treated with Radiation" or "Treated by Irradiation," the international symbol for irradiation, "Radura," can be found on the package of irradiated foods.

Fig 5.1 symbol for irradiation

The FDA has the authority to approve packaging materials that come into contact with food under the Federal Food, Drug, and Cosmetic Act (FFDCA). Go to "Packaging Materials for Irradiated Foods" in the Code of Federal Regulations, Title 21, Volume 3, Section 179.45 (referred to as: 21CFR179.45), updated as of April 1, 2013, for a comprehensive list of the packaging materials authorised for use in irradiation. www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm

5.5 PASTEURIZATION AND STERILIZATION FOOD IRRADIATION VACUUM PACKING CANNING AND BOTTLING

Pasteurization and Sterilization

Pasteurization is a process of heating a food, which is usually a liquid(milk), to a specific temperature for a predefined length of time and then immediately cooling it after it is removed from the heat. This process slows spoilage caused by microbial growth in the food. The French scientist Louis Pasteur invented pasteurization. To remedy the frequent acidity of the local wines he found out experimentally that it is sufficient to heat a young wine to only about 50–60 °C (122–140 °F) for a brief time to kill the microbes. Pasteurization of milk was suggested by Franz von Soxhlet in 1886. Pasteurization was originally used as a way of preventing wine and beer from souring, and it would be many years before milk was pasteurized. This procedure accomplishes two goals at once: it eliminates harmful organisms connected to the food and increases the shelf-life of the product by reducing the microbial population and inactivating certain enzymes. The goal of the process, as well as the chemical and physical makeup of the food, will be taken into account when choosing the temperature and duration of pasteurization. Therefore, whole eggs (mixture of yolk and white) are pasteurized at 64.4°C for 2–5 minutes to prevent the spread of *Salmonella* spp., and milk is pasteurized at 62.8°C for 30 minutes to inactivate pathogens. - Inactivation of bacterial pathogens (target organisms *Coxiella burnettii*)

- Assurance of longer shelf life (inactivation of most spoilage organisms and of many enzymes)

– Does not kill all vegetative bacterial cells or spores (*Bacillus* spp. and *Clostridium* spp.)

– Pasteurization temperature is continuously recorded

-Pasteurised goods lack sterility. They include spores and vegetative creatures that can still grow. Many pasteurised foods require refrigeration to be stored.

Sterilization is a term referring to any process that eliminates or kills all forms of microbial life, including transmissible agents (such as fungi, bacteria, viruses, spore forms, etc.) present on a surface, contained in a fluid, in medication, or in a compound such as biological culture media.

Food Irradiation

Ionizing radiation used for food preservation is a recently invented technique; however, it hasn't yet found widespread popularity. It is common knowledge that electromagnetic radiations inhibit the growth of the majority of microorganisms. Since World War II, there has been a lot of research done on the potential applications of nuclear radiation in food sterilization. Many individuals have doubts regarding the safety of using irradiated foods due to the negative effects of radiation from nuclear explosions on the human body. There has been a lot of research on the wholesomeness and safety of irradiated foodstuffs, but more thorough studies are needed before irradiated food can be used on a large scale.

There are several kinds of radiant energy emitted from different sources, which differ in wavelength, frequency, penetrating power, and in the various effects they have upon biological systems. Irradiation of foods is carried out by exposing them to high-energy radiations which penetrate them and bring about changes within them. The principal radiations used in food irradiation are gamma rays (wavelengths<2A), emitted from excited radioactive elements(60CO), and accelerated negatively charged particles, electrons (P-particles), which are emitted from a hot cathode. Gamma rays are very similar to X-rays, except that they have much greater penetrating power. An electron beam can be accelerated to very high speeds and increased energies so that it can penetrate foods, by passing it through electronic devices.

Ultraviolet radiations are also employed in preservation; but they have a very low degree of penetration and are employed to inactivate micro-organisms on the surface of food and to treat air, water, and the surface of food processing equipment to reduce the number of micro-organisms.

Originally, the common reference for a specific radiation dose was the term "rad," which stands for radiation absorbed dose. A rad is defined as the amount of radiation that results in absorption of 100 ergs of energy per gram of irradiated material (1 joule=107 ergs).

The radiation effects are related to dose by the relation:

n = *no* exp (-D / *Do)*

where *n* = the number of live organisms following irradiation; *n0* = initial number of organisms; D = dose radiation received (rads), and Do = a constant depending on type of organism and environmental factors.

However, this term "rad," has fallen out of use and has been replaced with the term "Gray" (Gy). A Gy is defined as 100 rads. So, when 1 kilogram (kg) of material absorbs 1 joule of energy, it is said to have received a radiation dose of 1 Gy. Doses are usually measured in the kiloGray, or kGy. which is equal to 1,000 Gy

Different organisms are sensitive to irradiation to different extent as indicated below: 103^ — 107 rads— micro-organisms are killed. 103 — 105 rads — insects are killed.

103 — IO4 rads — sprouting of potatoes, onions, carrots, etc., is inhibited. 102 — 103 rads — dose is lethal for humans.

The approximate sterilising dose for microorganisms is 3.0 x 106 rads for bacterial endospores and -5.0 x 104 rads for yeasts and fungi. But some microbes have exceptional resistance to radiation; for instance, *Micrococcus radiodurans* can withstand radiation doses up to 55 times higher than gram-negative organisms like *Escherichia coli*.

Ion pairs and free radicals are created when gamma rays and electron beams collide with food particles at the atomic and molecular levels. This happens when these ionizing radiations travel through foods. These products' interactions with one another and with other molecules produce physical and chemical events that render food-borne microorganisms inactive. This means that "cold sterilization" of food can be accomplished by irradiating food.

Types of Radiation Treatment

There are distinct radiation treatments that are utilized in the food industry today, even though the term "irradiation" refers to all methods of subjecting food products to ionising radiation.

Radurization: Radiation-based pasteurization is known as radularization. It is mostly used to treat foods with high pH levels and high-water activity levels. Typically, grain-negative psychrotrophs, which are primarily spoilage microbes, are the organisms that are targeted. The major food types for which this method is employed are meat and fish. Additionally, it can be used to combat mould and yeast in foods with low pH and water activity. About 1 kGy is the treatment dose for radurization.

Radicidation: The process of radicidation treats the food product to destroy pathogenic organisms on the product. This process only kills vegetative cells. This means that it will not kill spores that have been produced. The dose for radicidation ranges from 2.5 -5.0 kGy. Most vegetative cells are killed by this dose. However, some cells can survive. This includes some strains of the bacterium *Salmonella typhimurium.* These strains are said to be radiation-resistant. After the dosage has been administered, the product should be stored at or below 4°C to prevent any growth of spores from the *Clostridium botulinum organism.*

Radappertization: Radappertization is a process that is not recommended for most foods. It involves treating the product to levels of radiation of approximately 30 kGy. This high level of radiation kills all vegetative cells and also destroys spores from organisms, such as *Clostridium botulinum.*

Vacuum packaging and modified atmosphere packaging

The air's oxygen speeds up the chemical and microbiological deterioration of many foods. Scientists have created techniques to assist counteract the effects of oxygen in order to help keep meals longer. For instance, vacuum packaging creates a vacuum inside of containers by taking the air out of them. By substituting other gases, such as carbon dioxide or nitrogen, for some or all of the oxygen in the air inside the package, modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) aid to preserve foods.

Rigid or flexible containers that have had the majority of their air evacuated before being sealed. Nitrogen or carbon dioxide can be added to the container. This procedure delays bacterial development, protects flavours, and extends shelf life. The air's oxygen speeds up the chemical and microbiological deterioration of many foods. Scientists have created techniques to assist in counteracting the effects of oxygen in order to help keep meals longer. For instance, vacuum packaging creates a vacuum inside of containers by taking the air out of them. By substituting other gases, such as carbon dioxide or nitrogen, for some or all of the oxygen in the air inside the package, modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) aid in the preservation of foods.

Canning andBottling

Placement of food in a sealable container, closure, heating, and cooling constitute the fundamental steps of canning. Although it was not until much later that the process was fully understood, this method of food preservation has been in use since the early 1800s. For preservation, large quantities of food are canned. Cans of food make up a sizable portion of the diet in developed nations. All canned foods include the majority of fruits and vegetables, a large range of meats and meat products, fish products, soups, and many other foods.

The following steps make up a standard canning process: Receiving, cleaning, sorting, and checking raw materials. 2. Blanching to render enzymes inactive. 3. Placing the product in the container with additional syrup or brine and deaerating it. 4. Heating in a retort with pressurized water for glass containers or steam for metal cans under a pressure of 1.05 kg/cm2. 5. Pressure-induced partial cooling in the retort. 6. Additional cooling in a cooling tank or using water jets. 7. Distribution, racking, and labelling.

Before canning, the raw product must first be evaluated for any necessary treatments. A lot of them need specific handling, including washing, trimming, shelling, size grading, and other processes. The majority of these processes are automated during commercial canning. The food can then be blanched to kill any enzymes and reduce surface contamination. The containers are filled with blanched food. In the case of vegetables, meat, and fish, brine (1.1 to 1.6 percent salt content) is added; in the case of fruits, syrup. Only water is added in some circumstances. Products made from fish frequently have oils added. Tin cans are often preferred for the majority of heat-processed foods.Glass jars are transparent, corrosion-free, and simple to clean, but they have the drawback of taking longer to process than cans of the same size. Additionally, there is the issue of breakage. Food canned in larger containers will be of inferior quality than food canned in smaller containers since heating time is roughly related to container volume and must be heated for a longer period of time. Instead, then using a container or jar to heat the food, try using a flexible, relatively thin pouch. Foods treated in this way have been shown to have a similar quality as frozen foods.The damage during distribution would be substantially less with pouches than with cans or glass jars because they can be heated for serving by simply submerging them in hot water. The importance of pouch canning is growing over time. The food container needs to be prepared for deaeration. This can be accomplished by heating the filled cans in steam or hot water or by using a vacuum closing machine, which removes the air with a pump and then seals the lid while maintaining vacuum.To avoid the can bulging owing to internal pressure, oxidation of the contents, and internal tin plate corrosion, air and gas must be removed. i.e. The sealed containers are heated in a retort, a room used for processing canned goods. Retorts come in a variety of forms. The most basic response is a still.Osmotic dehydration and canning/appertization have both been suggested as ways to enhance canned fruit preserves. On a small scale, the viability of an approach dubbed osmo-appertisation to achieve good quality fruit in syrup has been evaluated.

Aseptic canning: In normal canning, heat transfer from the outside of the container to the inside will require many minutes or even hours depending upon the container size to reach the sterilization temperature. The time of sterilization can be shortened to seconds or even a fraction of a second in aseptic canning. The basic principle of this method is that food is pumped continuously through a plate-type or tubular heat exchanger, which heats it very quickly to a high temperature, holding it at that temperature for the time required and then cooling. Food temperature employed may be as high as 150°C and sterilization takes place in 1 or 2 sees. Such a rapid sterilization at high temperature is referred to as ultra-high-temperature sterilization. The sterile food is quickly cooled, placed in aseptic containers, and the lids are sealed, while in a sterile environment. The food canned aseptically retains the nutrients and the sensory attributes will be good.

With acid foods, foods sterilized as in aseptic canning, while still hot, can be filled into clean but not necessarily aseptic containers. The heat of the food and some holding time before cooling the closed container renders the containers commercially sterile. This type of canning is known as "hot pack" or "hot fill."

With low-acid food (above pH 4.6), the conventional hot pack processing is not possible. In such cases, the *"flash 18 "* process (pressure canning) is employed. Low-acid foods are heated above 100°C under pressure for sterilty. If food at that temperature is poured into containers for sealing at atmospheric pressure, there will be violent boiling. This is eliminated by carrying out the canning process in a chamber under a pressure of 1.05 to 1.40 kg/cm2. Thus, low-acid foods can be pre-sterilized by high temperature for a short time. They are then transferred to cans in a pressurized room and heated for an appropriate number of minutes so that commercial sterility of non-sterile cans is obtained, and finally the cans are sealed and cooled.

5.6 FOOD PACKAGING MATERIALS FOR PRESERVED FOOD PRODUCTS

Glass bottles or cans with an open top should be used for packaging. Tomato juice should be hermetically sealed in glass or tinplate containers. The containers may be lacquered or plain, but should be of an acid-resistant variety if lacquered.It is generally ideal to leave some headroom so that the packaging can be opened and the contents can be poured without spilling. When the contents need to be shaken (like with flavoured milk drinks and pulpy fruit juices), a headspace is crucial. For items like fruit juices, it is preferable to fill the space between the product and the top of the packaging with steam or an inert gas like N2.

A thin, rolled sheet of alloyed aluminium with a thickness range of 4 to 150 m is called aluminium foil. It was used to wrap chewing gum and Life Savers candy bars when it was first commercially made in the United States in 1913**.**

W.M. Martin invented the technology for cans in the late 1940s, and the James Dole Corporation in California ordered the first commercial aseptic filling equipment for soups in 1950. The cans and can ends are sterilised by this method using superheated steam at temperatures up to 225°C for up to 40 sec. This technique is compatible with the three common types of metal cans: tinplate, electrolytically chromium-coated steel (ECCS), and aluminium.

Hands on experience: Blanching of fruits & Vegetables Visit to Food Industries

KNOW YOUR PROGRESS

Check Your Progress Exercise

Note: Use the spaces given below for your answers.

1)Discuss briefly the methods of Freezing types of freezers.
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2) What is aseptic canning?

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3) What is the difference between pasteurization and sterilization?

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4) What arethe methods and safety regulations of food irradiation?

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LET'S SUM UP

In this unit, we have learnt about what is low-temperature preservation along with various methods of freezing. Freezing is mainly important to inactivate or suppress the growth of microbesin the food. Different types of freezers with their functioning are discussed briefly. Many other preservationssuch aspasteurization and sterilization food irradiation vacuum packing canning and bottling are discussed briefly in this unit.

REFERENCES BOOK

Norman N. Potter and Joseph H. Hotchkiss, 1995 Food Science, Fifth Edition, Springer

Some abbreviation

ICAR: Indian Council of Agricultural Research.

ICMR: Indian Council of Medical Research.

CFTRI: Central Food Technological Research Institute, Mysore.

CSIR: Council of Scientific and Industrial research.

NDDB: National Dairy Development Board, Anand, Gujarat.

CIPHET: Central Institute of Post Harvest Engineering and Technology, Ludhiana, Punjab.

CIAE: Central Institute of Agricultural Engineering.

APEDA: Agricultural Processed Food Products Export Development Authority.

MPEDA: Marine Product Export Development Authority.

NADC: National Cooperative Development Committee.

IIHR: Indian Institute of Horticultural Research. (Kassargud, Bangalore).

IISR: Indian Institute of Species Research.

IVRI: Indian Veterinary Research Institute.

NDRI: National Dairy Research Institute. (Karnal, Haryana).

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CPRI: Central Potato Research Institute.

CTRI: Central Tobacco Research Institute.

NRDC: National Research Development Cooperation.

CIFT: Central Institute of Fishery Technology.

FAO: Food and Agricultural Organization.

IRRI: International Rice Research Institute.

AICRP: All India Crop Research Products.

PHT: Post Harvest Technology, ANGRAU, Bapatla.

APFE: Agricultural Processing and Food Engineering.

UAS: University of Agricultural Sciences, Bangalore.

CPCRI: Central Plantations Crop Research Institute, Trivandrum.

NHB: National Horticultural Board.

MOFPI: Ministry of Food Processing Industries.

FPO: Fruit Product Order.

HACCP: Hazard Analysis Critical Control Point.

BIS: Bureau of Indian Standards.

PFA: Prevention of Food Adulteration Act.

Ag mark: Agricultural Marketing Inspection.

GDP: Gross Domestic Product.

WHO: World Health Organization.

FDA: Food and Drug Administration.

GMP: Good Manufacturing Practices.

TQM: Total Quality Management.

DOFPI: Department of Food Processing Industries.

PCB: Pollution Control Board.

PRRC: Paddy Processing Research Center.

CIDA: Canadian International Development Agency.

NABARD: National Bank for Rural Development.

SSCA: State Seed Certification Agency.

MMPO: Milk and Milk Product Order.