

FRUITS AND VEGETABLES PROCESSING

NSQF LEVEL - 3

TRADE THEORY

SECTOR: FOOD INDUSTRY

(As per revised syllabus July 2022 - 1200Hrs)



Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

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National Instructional Media Institute

Post Box No.3142

Guindy, Chennai - 600032

INDIA

Email: chennai-nimi@nic.in

Website: www.nimi.gov.in

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Fruits and Vegetables Processing - Theory** in **Food Industry Sector** under **Yearly Pattern**. The NSQF Level - 3 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Director General, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ATUL KUMAR TIWARI, I.A.S

Secretary

Ministry of Skill Development & Entrepreneurship,
Government of India.

March 2024
New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material (**Trade Theory**) for the trade of **Fruits and Vegetables Processing NSQF Level - 3 (Revised 2022)** under **Food Industry** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. Raminder Kumar	-	Training Officer NSTI (W), Panipat, Haryana.
Smt. Samita	-	Assistant Professor (Chemistry) G.G.S Khalasa college, Mahipur, Punjab
Shri. Dr. Amandeep Kaur		Research Scholar (Chemical) P.U, Chandigarh

NIMI CO-ORDINATORS

Shri. Nirmalya nath	-	Deputy Director of Training, NIMI, Chennai - 32.
Shri. V.Veera Kumar	-	Assistant Manager NIMI, Chennai - 32.

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course of **Fruits and Vegetables Processing** under **Food Industry** Sector. The trade supplemented and supported by instructions/informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 3 (Revised 2022) syllabus are covered.

The manual is divided into Eight modules

Module 1	Trade Introduction
Module 2	Identification of Fruits, Vegetables, Spices & Food additives
Module 3	Preparation of Common Juices and Beverages
Module 4	Drying, Preparation and Packaging
Module 5	Preparation of Beverages, Synthetic Vinegar & Candies
Module 6	Canning and Preservation of Fruits and Vegetables
Module 7	Pickles
Module 8	Study of food safety standard

The skill training in the shop floor is planned through a series of practical exercises centered around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual, a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Fruits and Vegetables Processing NSQF Level - 3 (Revised 2022)** in **Food Industry**. The contents are sequenced according to the practical exercise contained in NSQF Level - 3 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptual capabilities for performing the skills.

The trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not for the purpose of self-learning and should be considered as supplementary to class room instruction.

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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No	Learning Outcome	Ref. Ex.No.
1	Identify the spoilage in fruits and vegetables and state the reason for the spoilage following safety precautions. (Mapped NOS:FIC/N0103)	1.1.01 - 1.1.02
2	Identify and select fresh fruits and vegetables with the help of checklist. (Mapped NOS:FIC/N0203)	1.2.03
3	Identify spices and food additives by visual inspection. (NOS:FIC/N9406)	1.2.04
4	Prepare and pack perishables for storage and then store under refrigerated conditions with safety precautions. (Mapped NOS:FIC/N0203)	1.2.05 - 1.2.06
5	Prepare fruit juices with juice extracting machines with safety precautions and preserve fruit juices with addition of preservatives and determine the acidity and TSS content. (Mapped NOS:FIC/N0103)	1.3.07 - 1.3.08
6	Prepare and package fruit beverages such as Squashes, RTS, Nectar, Cordial, Crush and Syrup by using appropriate machines such as pulper, juice extractor, autoclave, and corking machine with safety precautions, determine the acidity and TSS content. (Mapped NOS:FIC/N0103)	1.3.09 - 1.3.10
7	Prepare and preserve Tomato products by using appropriate machines such as pulper, autoclave, and corking machine with safety precautions, determine acidity and TSS content. (Mapped NOS:FIC/N0111, FIC/N0204)	1.3.11
8	Prepare, dry and storage fruits and vegetables with appropriate methods such as drying, cabinet drying and solar drying with safety precautions and determine the moisture. (Mapped NOS:FIC/N0118)	1.4.12
9	Prepare, preserve and store jam, jelly and marmalades by using appropriate machines such as pulper, autoclave & sealer with safety precautions, determine acidity and TSS content, pectin test. (Mapped NOS:FIC/N0111)	1.4.13
10	Examine the tetra pack w.r.t to the materials of construction & dimension and its type. (NOS:FIC/N9407)	1.4.14 - 1.4.15
11	Explain and understand the process of wine preparation and canning process of fruits and vegetables and Identify defects by physical observation & its causes in canned foods and explain food safety standards. (Mapped NOS:FIC/N0204)	1.5.16
12	Prepare synthetic vinegar by using appropriate tools and check the quality and explain other methods of vinegar production and its types. (NOS:FIC/N9408)	1.5.17
13	Prepare preserve (murabba), candy, crystallized and fruit bar by using appropriate machines/Tools such as solar drier, cabinet drier, weighing balance and refractometer with safety precautions and determine the TSS contents. (Mapped NOS:FIC/N0202, NOS:FIC/N0122)	1.5.18 - 1.6.21
14	Prepare fruits/ vegetables pickles with oil/ salt/ vinegar/ spices, determine acidity content. (Mapped NOS:FIC/N0204)	1.7.22
15	Check physical quality parameters in frozen market samples of frozen fruits and vegetables. (NOS:FIC/N9409)	1.8.23 - 1.8.25

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Identify the spoilage in fruits and vegetables and state the reason for the spoilage following safety precautions. (Mapped NOS:FIC/N0103)	1. Spoilage of fruits and vegetables. (20 hrs.) 2. Industrial visit in fruits and vegetables processing industry. (20hrs.)	Introduction - Definition and scope of preservation. History and development of food preservation industry with special reference to India. Different types of spoilages in fresh fruits and vegetables. General principles and methods of food preservation. (12 hrs.)
Professional Skill 20Hrs; Professional Knowledge 06Hrs	Identify and select fresh fruits and vegetables with the help of checklist. (Mapped NOS:FIC/N0203)	3. Identifications of Fruits and vegetables. (20 hrs.)	Definition of Fruits and vegetables, Difference in between fruits and vegetable, Fruits and vegetables as available in different parts of the country, their preservation, season of maturity. Constituents of food, importance of fruits & Vegetables in the diet. (06 hrs.)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Identify spices and food additives by visual inspection. (NOS:FIC/N9406)	4. Identification of spices and food additives used in fruits and vegetable processing. (40 hrs.)	Selection of raw materials including fruits and vegetables for Preparation of various products. Spices and other constituents, their properties, condiments and other additives and ingredients and their flavouring and preservative properties. (12 hrs.)
Professional Skill 45Hrs; Professional Knowledge 12Hrs	Prepare and pack perishables for storage and then store under refrigerated conditions with safety precautions. (Mapped NOS:FIC/N0203)	5. Study of common food processing equipment such as pulper, sealers, juice extracting machines, autoclaves, corking machines etc. (25hrs.)	Study of various equipment: usage, care/maintenance and precautions. (06 hrs.)
		6. Refrigeration and other methods for storing perishables. (20hrs.)	Storage of fresh fruits and vegetable. Methods and containers used in fresh fruits and vegetable preservation. (06 hrs.)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Prepare fruit juices with juice extracting machines with safety precautions and preserve fruit juices with addition of preservatives and determine the acidity and TSS content. (Mapped NOS:FIC/N0103)	7. Preparation of Fruit Juice. (20hrs.) 8. Preservation of fruits juices with addition of preservative. (20hrs.)	Technology of extraction of juices from different types of fruits. Definition of Preservatives- types of preservatives commonly used in food industry limits of usage of preservatives. (12 hrs.)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Prepare and package fruit beverages such as Squashes, RTS, Nectar, Cordial, Crush and Syrup by using appropriate machines such as pulper, juice extractor, autoclave,	9. Preparation of common fruit beverages. (20hrs.) 10. Determination of Acids in fruits and vegetable products. (20hrs.)	Fruit beverages: Squashes, syrups, nectars, RTS, crushes, cordial etc. (12 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
	and corking machine with safety precautions, determine the acidity and TSS content. (Mapped NOS:FIC/N0103)		
Professional Skill 45Hrs; Professional Knowledge 12Hrs	Prepare and preserve Tomato products by using appropriate machines such as pulper, autoclave, and corking machine with safety precautions, determine acidity and TSS content. (Mapped NOS:FIC/N0111, FIC/N0204)	11. Preparation of tomato juices, puree, sauces, ketchups, soup, paste, chutney etc. (45hrs.)	Tomato products: Technology of manufacture of tomato products. (12 hrs.)
Professional Skill 45Hrs; Professional Knowledge 12Hrs	Prepare, dry and storage fruits and vegetables with appropriate methods such as drying, cabinet drying and solar drying with safety precautions and determine the moisture. (Mapped NOS:FIC/N0118)	12. Various methods of drying: sun drying, cabinet drying and solar drying. (45hrs.)	Sun drying & dehydration and its merits and demerits. Principles involved preservation by drying method. Treatment prior to drying. (12 hrs.)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Prepare, preserve and store jam, jelly and marmalades by using appropriate machines such as pulper, autoclave & sealer with safety precautions, determine acidity and TSS content, pectin test. (Mapped NOS:FIC/N0111)	13. Preparation of Jam, jelly and marmalades. (40hrs.)	Jams, nellyies and marmalades: selection, preparation, production and preservation. Difference in between jam and jelly. (12 hrs.)
Professional Skill 40Hrs; Professional Knowledge 12Hrs	Examine the tetra pack w.r.t to the materials of construction & dimension and its type. (NOS:FIC/N9407)	14. Practical demonstration of sealing pouching machine. (20hrs.) 15. Examination of the tetra pack. (20hrs.)	Study of various types of containers like Glass, Tin-merits and demerits of each-scope for new types of containers/ packaging materials, such as plastic pouches, tetra pack, PET bottle and cartons. Understanding the label its importance, and labeling requirements. (12 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 120 Hrs; Professional Knowledge 30Hrs	Explain and understand the process of wine preparation and canning process of fruits and vegetables and Identify defects by physical observation & its causes in canned foods and explain food safety standards. (Mapped NOS:FIC/N0204)	16. Demonstration of wine/ Beverages preparation process in wine/Beverage industry and Visit to wine/Beverage industry. (120 hrs)	Fermented beverages-wines. (30 hrs.)
Professional Skill 30Hrs; Professional Knowledge 12Hrs	Prepare synthetic vinegar by using appropriate tools and check the quality and explain other methods of vinegar production and its types. (NOS:FIC/N9408)	17. Preparation of synthetic vinegars. (30hrs.)	Different type of vinegar, methods of Vinegar Production. (12 hrs.)
Professional Skill 200 Hrs; Professional Knowledge 60Hrs	Prepare preserve (murabba), candy, crystallized and fruit bar by using appropriate machines/ Tools such as solar drier, cabinet drier, weighing balance and refractometer with safety precautions and determine the TSS contents. (Mapped NOS:FIC/N0202, NOS:FIC/N0122)	18. Preparation of preserves, candies, crystallized and glazed and fruit bars. (40hrs.)	Definition of preserves, candied fruits, glazed fruits, crystallized fruits- methods of preparation of these. (12 hrs.)
		19. Demonstration of Canning process in fruits and vegetables canning industry. Visit to canning industry. (70hrs.)	Canning and bottling- Canning of fruits and vegetables- principles, procedure and steps involved- care in handling of common available fruits and vegetables in the region. (24 hrs.)
		20. Identification of defective cans, Precautions while consuming the canned foods. (45hrs.)	Scheme and layout of canning industry. Study about the various defects in canned products, lacquers. (12 hrs.)
		21. Freezing demonstration on market sample of frozen fruits and vegetables. (45hrs.)	Study of Frozen Fruits and Vegetables, Blanching and Freezing. (12 hrs.)
Professional Skill 50Hrs; Professional Knowledge 12Hrs	Prepare fruits/ vegetables pickles with oil/ salt/ vinegar/ spices, determine acidity content. (Mapped NOS:FIC/N0204)	22. Preparations of different types of pickles from fruits and vegetables. (50hrs.)	Pickles, chutneys and sauces, Different types of pickles. Methods of preparation curing techniques, defects and remedies. (12 hrs.)
Professional Skill 45Hrs; Professional Knowledge 12Hrs	Check physical quality parameters in frozen market samples of frozen fruits and vegetables. (NOS:FIC/N9409)	23. Examination of processed products. (15hrs.) 24. Cleaning and maintenance of the equipments. (20hrs.) 25. Detection of benzoic acid, Sulphur dioxide and KMS in fruits and vegetable products. (10hrs.)	Study of Food safety Standards: HACCP, ISO22000, GMP, and FSSAI. Importance of personal Hygiene, Cleaning & Sanitary standards in Fruits and Vegetable preservation. Good Handling Processes (GHP), Traceability aspects of processed product. (12 hrs.)

Introduction of fruits and vegetable preservation

Objectives: At the end of this lesson you shall be able to

- state the history and development of food preservation industry
 - state the definition and scope of preservation
 - state the principle and methods of food preservation.
-

History and development of food preservation

The technique of food preservation has been known since ancient times, still in use being drying in the sunlight, salting and smoking food preservation in the process of treating and handling of food with the method of prevention of decay or spoilage. Maintaining or creating nutritional value, texture and flavour of the food.

Firstly in 1749 Needham was explain the cause in spoilage of stored products. He observed that boiled mutton gravy, even if kept in a tightly corked bottle, became spoiled after some time as compared to the unboiled gravy. In 1765 this theory was disputed by spallanzeni gave view the organism presented in untreated air and inside vessel are responsible for the spoilage which can be prevented by heating and food kept in an airtight container. This is the basic principles of canning. During the war canning industry to be actually born in France. During the war the French government faced difficulty to supplying food to its fighting forces at the front. In 1795 the government announced a reward of French investor who called develop of satisfactory method of preserving food.

The M.Nicholas Appert was first who told preservation of food in glass container in 1804. The principles of appert are followed in every canning industry.

The role of microorganism in food spoilage demonstrated by Louis Pasteur in 1864. He told heat treatment of food at specified high temperature to kill the majority of the microorganism not all the microorganism such as bacteria, yeast and mould present in food. This process of preservation is sterilization. The food preventing by packed in the container by sealing latter hermetically.

Introduction and Definition of Food Preservation

Food preservation is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro- organisms. Some methods, like use of benign bacteria, yeasts or fungi to add specific qualities and to preserve food (e.g., cheese, wine). Maintaining or creating nutritional value, texture and flavour is important in preserving its value as food.

Preservation usually involves preventing the growth of bacteria, fungi, and other micro-organisms, as well as retarding the oxidation of fats which cause rancidity. It also includes processes to inhibit natural ageing and discolouration that can occur during food preparation such as the enzymatic browning reaction in apples after

they are cut. Some preservation methods require the food to be sealed after treatment to prevent recontamination with microbes; others, such as drying, allow food to be stored without any special containment for long periods.

Scope of Food Preservation

The main aim of food preservation is to minimize the growth of microorganisms during the storage period, thus promoting longer shelf life and reduced hazard from eating the food. Fruit and vegetables are an important supplement to the human diet as they provide the essential minerals and vitamins and fibre required for maintaining health. For various reasons, this abundance of production is not fully utilized and about 25-30% of it is wasted due to spoilage.

Two approaches of preserving fruits and vegetables One is the creation/expansion of cold storage facilities in the fruit and vegetable producing regions themselves, as also in the major urban consumption centres, to ensure supply of fresh fruits and vegetables throughout the year. Another approach is to process the fruits and vegetables into various products that could be preserved for a long time, and add to the value of the product.

Principles of Food Preservation

Food spoilage may be caused due to chemical and biological factors. Inherent enzymes present in food may cause spoilage under certain conditions. Growth of bacteria, moulds or yeast already present are inoculated. Foods while processing causes more serious spoilage than enzymes. To prevent spoilage of food, various methods of preservation are available which are based on certain principles. The principles of food preservations are,

- 1 Prevention or delay of microbial decomposition
- 2 Prevention or delay of self decomposition of the food.
- 3 Prevention of damage from insects, animals and mechanical causes

Prevention or delay of microbial decomposition

Prevention or delay of microbial decomposition can be achieved by

- 1 Keeping out micro organisms
- 2 Removing micro organisms Eg: by Filtration
- 3 Retarding the growth and activity of micro organisms Eg: by the low temperature, drying, anaerobic conditions or antibiotics

4 Killing the micro organisms Eg: by heat or radiation

Prevention or Delay of self decomposition of the food

Prevention or Delay of self decomposition of the food can be achieved by,

- 1 Destruction or inactivation of food enzymes Eg: by blanching
- 2 Prevention or delay of purely chemical reaction Eg: Prevention of oxidation by the use of anti oxidant.

Prevention of damage from insects, animals and mechanical causes

Food if not packed and stored properly may be attacked by insects, worms etc which damage the products and make them unfit for human consumption. This can be prevented by the use of chemicals. So keeping quality of products can also be retained by using proper packing materials.

Methods of Food preservation

Common methods of applying these processes include drying, spray drying, freeze drying, freezing, vacuum- packing, canning preserving in syrup, sugar crystallisation, food irradiation, and adding preservatives or inert gases such as carbon dioxide. Other methods that not only help to preserve food, but also add flavour, include pickling, salting, smoking preserving in syrup or alcohol, sugar crystallisation and curing.

Drying

This is one of the oldest methods of food preservation. This process acts by reducing the moisture content in the food which in turn arrests bacterial growth. Drying is largely used for preserving meat. However, fruits and vegetables can also be preserved by this method. The additional advantage of drying is that it reduces the size and weight of the food product, therefore making it more portable. Sun drying, oven drying, and drying with the help of a dehydrator are the various ways used to reduce the water content of food.

Freezing

Micro-organisms require a certain level of temperature for their survival. Freezing foods lowers the temperature to levels that make the environment unsuitable for microbial growth. This is the principle on which home refrigerators work. Cold stores are used to preserve large amounts of food stuff for a longer period of time, so that they can be used during a natural calamity or national emergency. The only drawback of this food preserving technique is its dependence on electricity.

Canning

In this process, the food is first processed and then sealed in airtight containers. While the micro-organisms are killed by processing the food, their entry and proliferation is restricted by canning it in an airtight environment. The various methods used to process the food before it is canned are pasteurization, boiling, freezing or vacuum treatment.

Vacuum Treatment

In this method food is stored in airtight containers that strips bacteria of the oxygen that helps it carry on with its metabolism. Hence, the growth of these micro-organisms is arrested and food is preserved. Nuts are usually preserved by this method.

Sugaring

Sugaring is used to preserve fruits like apples, apricots and plums in sugary syrup that dehydrates the foods. The skin of certain fruits are cooked in sugar till they crystallize and then they are stored in a dry environment. One drawback of this method is that sugar itself draws moisture. Once the amount of moisture in sugared foods rise, it might reach the level congenial for microbial growth.

Salting

Salt is a natural food preservative that draws out moisture from the food as well as from the cells of the micro-organisms that may be present in it. Lack of moisture kills these organisms and hence prevents food spoilage. Salt is commonly used as a preservative in meat products and fruits & vegetables products.

Pickling

Cucumber, beef, peppers and some vegetables may be preserved by pickling. This technique involves dipping the food in some liquid chemical that prevents the growth of micro-organisms but still maintains edibility of the food. The preserving liquids used are vinegar, brine, alcohol and some other oils. This process is known as chemical pickling. The other way of pickling is by fermentation. In fermentation pickling, the preservation agent is produced by the food itself during the process of fermentation.

These are a few of the healthy ways to preserve food. Most of these can be domestically used to delay food spoilage. In other methods, ionizing radiation, high pressure and even controlled growth of certain bacteria are used to fight the decaying action of micro-organisms.

Refrigeration

Refrigeration preserves food by slowing down the growth and reproduction of micro-organisms and the action of enzymes which cause food to spoil.

Vacuum packing

Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival, slowing spoiling. Vacuum-packing is commonly used for storing nuts to reduce loss of flavor from oxidation.

Smoking

Smoking is used to lengthen the shelf life of perishable food items. This effect is achieved by exposing the food to smoke from burning plant materials such as wood. Most commonly subjected to this method of food preservation are meats and fish that have undergone curing. Fruits and vegetables like paprika, cheeses, spices, and ingredients

for making drinks such as malt and tea leaves are also smoked, but mainly for cooking or flavoring them. It is one of the oldest food preservation methods, which probably arose after the development of cooking with fire.

Artificial food additives

Preservative food additives can be antimicrobial; which inhibit the growth of bacteria or fungi, including mould, or antioxidant; such as oxygen absorbers, which inhibit the oxidation of food constituents. Common antimicrobial preservatives include calcium propionate, sodium nitrate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA. Antioxidants include BHA and BHT. Other preservatives include formaldehyde (usually in solution), glutaraldehyde (kills insects), ethanol and methyl-chloro-isothiazolinone.

Lye

Sodium hydroxide (lye) makes food too alkaline for bacterial growth. Lye will saponify fats in the food, which will change its flavor and texture. Lutefisk uses lye in its preparation, as do some olive recipes. Modern recipes for century eggs also call for lye. Masa harina and hominy use agricultural lime in their preparation and this is often misheard as 'lye'.

Jellifying

Food may be preserved by cooking in a material that solidifies to form a gel. Such materials include gelatine, agar, maize flour and arrowroot flour. Some foods naturally form a protein gel when cooked such as eels and elvers, and sipunculid worms which are a delicacy in Xiamen in Fujian province of the People's Republic of China. Jellied eels are a delicacy in the East End of London where they are eaten with mashed potatoes. Potted meats in aspic, (a gel made from gelatine and clarified meat broth) were a common way of serving meat off-cuts in the UK until the 1950s. Many jugged meats are also jellied.

Preservation of fruits and vegetables

1 Sugar as a Preservative - Fruits may be preserved by many of the methods employed for preserving foods of animal origin. Sugar is commonly used to preserve many fruits. The minimum concentration of sugar that will effectively serve as a preservative is 25 percent. The heat treatment, the fruit is subjected to and the acidity of the product will both have a direct bearing on the amount of sugar required. In the case of jams, jellies, and preserves, 45 percent sugar and an acidity of 0.8 percent will not be adequate as a preservative. With the combination of 45 percent sugar and 1.2 percent acidity, jam, jellies, and preserves will be adequately preserved.

2 Drying of Fruits - Drying has been used for many centuries to preserve fruits. Bacteria, yeasts, and molds are commonly found on dried fruits. It is uncommon to find sterile dried fruits. Souring in dried fruits results from the growth of yeasts. Dried fruits will generally have microbial counts much lower than the count in dried vegetables.

3 Pasteurization - Preservation by pasteurization is a relatively new process and is used more on dates than on any other kind of fruit.

4 Sulfur Dioxide - Sulfur dioxide has been used for many years in the preservation of dried and fresh fruits. Sulfur dioxide is of definite value in preserving the color of dried fruits. Sulfur dioxide has a minor bacteriostatic action against bacteria, yeasts, and molds. Yeasts are more sensitive to sulfur dioxide than bacteria and molds.

Sulfur dioxide will delay the rate of deterioration in storage grapes by as much as 50 percent.

5 Salting - The precise mechanism by which salting preserves food is not entirely understood. It is known that salt binds with water molecules and thus acts as a dehydrating agent in foods. A high level of salinity may also impair the conditions under which pathogens can survive. Sugar appears to have effects similar to those of salt in preventing spoilage of food. The use of either compound (and of certain other natural materials) is known as curing.

Food scientists have now learned that a number of factors relating to the food product and to the preservative conditions affect the efficiency of curing. Curing is used with certain fruits and vegetables, such as cabbage (in the making of sauerkraut), cucumbers (in the making of pickles), and olives.

6 Freezing - Freezing is an effective form of food preservation because the pathogens that cause food spoilage are killed or do not grow rapidly at low temperatures. The process is less effective in food preservation than are thermal techniques such as blanching because pathogens are more likely to be able to survive cold temperatures than hot temperatures.

7 Fermentation - Fermentation is a naturally occurring chemical reaction by which a natural food is converted into another form by pathogens. It is a process in which food "goes bad," but results in the formation of an edible product, for eg: spoilage of milk can be controlled in such a way as to produce a new product, cheese.

Food spoilage

Objectives: At the end of this lesson you shall be able to

- state the types of spoilage
- explain the cause of food spoilage
- explain about the causes food spoilage.

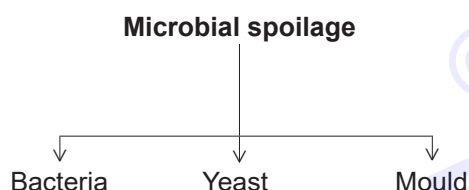
Food spoilage

Unless foods are preserved they deteriorate; therefore, to keep them in edible condition it is necessary to know what causes of food spoilage. In the air there are certain micro-organisms called moulds, yeasts and bacteria which cause foods to be spoiled.

Different types of spoilage in fresh fruits and vegetable

The fresh fruits and vegetables are spoiled by the various factors given below :

- 1 Micro organism
- 2 Enzymes
- 3 Insects, parasites and rodents
- 4 Mechanical damage
- 5 Characteristic and storage condition of foods



The microorganism is smallest living organism which we cannot be seen by naked eyes.

The main microorganism which are responsible for the spoilage of fruits and vegetables :-

- 1 Moulds
- 2 Yeasts
- 3 Bacteria

Moulds

These are simple plants which appear like whiskers on foods, particularly sweet food, meat and cheese. To grow, they require warm air, moisture, darkness and food; they are killed by heat and sunlight. Moulds can grow where there is little moisture then yeasts and bacteria requires to grow. Mould spoil the jam, jellies and preserve and other sugar-based products.

Moulds are multicellular, filamentous fungi belonging to the division Thallophyta but are devoid of chlorophyll. Mould are larger than yeast. Mould are strict aerobes and require oxygen for growth and multiplication and to grow more slowly than bacteria. Mould are web like structure

known as mycelium. The mycelium is often white and cottony and penetrates into the attacked food stuff.

Correct storage in a dry cold store prevents the growth of mould in food.

Not all moulds are destructive. Some are used to flavour cheese (Stilton, icquefort) or to produce antibiotics (penicillin, streptomycin)

Yeasts

These are single-cell plants or organisms larger than bacteria, which grow on foods containing moisture and sugar. Foods containing only a small percentage of sugar and a large percentage of liquid, such as fruit juices and syrups, are liable to ferment because of yeasts. They seldom cause disease. Foodstuffs should be kept under refrigeration or else they may be spoiled by yeasts. Yeasts are also destroyed by heat. The ability to yeast to feed on sugar and produce alcohol is the basis of the beer and wine-making industry.

Bacteria

Bacteria are minute plants, or organism, which require moist, warm conditions and a suitable food to multiply. They spoil food by attacking it, leaving waste products, or by producing poisons in the food.

Their growth is checked by refrigeration and they are killed by heat. Certain bacterial form (spores) are more resistant to heat than others and require higher temperatures to kill them.

Pressure cooking destroys heat - resistant bacterial spores provided the food is cooked for a sufficient length of time, because increased pressure increases the temperature; therefore heat - resistant bacterial spores do not affect canned foods as the foods are cooked under pressure in the cans. Acids are generally capable of destroying bacteria, such as vinegar in pickles.

Dehydrated foods and dry foods do not contain much moisture and, provided they are kept dry, spoilage from bacteria will not occur. If they become moist then bacterial can multiply; if dried peas are soaked and not cooked then the bacterial present can begin to multiply.

Enzymatic spoilage

The enzyme are also responsible for the spoilage of food. Like phenolase, peroxidase and polyphenol oxidase. In plant and animal tissues many reactions are activated by enzymes. During storage changes in foods can be

produced both by enzymes present in the food or by enzymes from microorganisms that contaminate the food. For example the ripening of Banana due to the enzymes present which hasten the ripening process, after some times the fruit became too soft and unfit to eat. If bruised spot on the fruit, yeast can grow and produce enzymes which spoil the fruit. Some fruits and vegetable turn into brown when cut surface and damaged fruits are exposed to air due to the presence of the enzymes peroxidase, phenolase, and polyphenol oxidase.

Enzymes act between 0°C to 60°C. The optimum temperature of reaction is mainly 37°C. The rate of reaction varying directly with temperature. The enzymes are inactivated at 80°C.

Enzymes convert starch of food into sugars, protein of food into amino acids, and pectin of food into pectic acid and thus change the constituents of food.

Spoilage by insects pesticides and rodents

The insects cause greater damage by the bruises and cuts they make in foods thus exposing them to microbial attack resulting in total decay and the direct loss through consumption of the food.

Insect infestation are in grain dry fruits and spieces are generally controlled by fumigation with methyl /bromide, ethylene oxide and propylene oxide.

The loss of food due to insect is 5 to 50 percent its varies depend upon the care taken in the field during storage. Insects are particularly destructive of fruits and vegetable.

Some parasites can spoil the foods. The parasitic infection in food is due Entamoeba Histolytica which is responsible for amoebic dysentery. This organism contaminate foods when raw human excrement is used as fertilizes for crops. The infected water and poor hygiene condition are responsible for spreads the parasites.

These parasites are mostly killed by cooking.

Rats are responsible for the destruction of food where they are not controlled. A part from the fact they consume large quantities of food, they contaminates the food with their urine and droppings which produce diseases producing bacteria. Rats are responsible for various human diseases such as plague, typhoid and typhus etc.

Spoilage by characteristic of food

The characteristic of food are responsible for the type of microorganisms that can grow in it and thus determine the changes in its appearance, flavour and other qualities.

Composition: Protein containing food are degraded by proteolytic organism.

- 1 Protein containing food + proteolytic micro organis → amino acid + amines + ammonia + hydrogen sulphide
- 2 Fat containing food + lipolytic micro organism → fatty acids + glycerols

Food containing	Spoiled by
Protein	Bacteria, moulds
Fat	Moulds, a few bacteria
Carbohydrates	Moulds, yeasts

Acidity: The pH of all foods nearly below 7.0 food are divided into acidic and non-acidic its depending on whether the pH is below or above 4.5. Mostly fruits are acid foods which are spoiled by yeast and mould. The non acid food like nearly all vegetables are spoiled by bacterial and also support growth of moulds under favourable conditions.

Moisture: The moisture is required for the microbial growth and chemical reactions. Food which contain high percentage of water spoiled fast.

Microorganism require for their growth at least 13% free water in foods. The bacterial required more free water for their growth as compared to mould. The foods containing high sugar and salt concentration do not support the growth of mostly microorganisms. The salt concentration upto 5 to 15% inhibited the growth of bacteria. The mould and some yeasts can tolerate more than 15%. The sugar concentration upto 65 to 70% required to inhibit the growth of moulds but 50% inhibits the growth of bacterial and most yeasts. The food with high sugar and high salt content are mostly spoiled by moulds.

Spoilage by storage condition of food

The most important factors like temperature, oxygen, light and duration of storage that influence the type of microbial growth and spoilage of food during storage

Temperature: Heat and cold playing a important role in food preservation. Its contribute the spoilage of food if not controlled. The rate of chemical reaction is double itself for every 10°C rise in temperature.

The high heat brings about protein denaturation, destruction of vitamins breaking of emulsions and desiccation of food by removing moisture. Some fruits and vegetables are spoiled on keeping even at the temperature of refrigeration 4°C. The deterioration includes off colour, development and surface biting like tomato, banana, lemon should be stored at about 10°C for retaining their quality. At low temperature retards spoilage. Refrigerated food are mostly spoiled by mould, yeast, and bacteria food stored at -18°C remain free from microbial growth and may even show a gradual decrease in the population of microorganisms. The food and food products which are stored at room temperature or in worm condition are mainly spoiled by mesophilic and thermophilic organisms.

Oxygen: Atmospheric oxygen are responsible for undesirable changes in food such as destruction of food colour, vitamins A and flavour. Mould are generally growth in the presence of oxygen that way vaccum packing is done and container are filled by the nitrogen and carbondioxide gas. Some cases oxygen absorbing chemicals are filled into the container.

Light: Light destroys vitamins A, B2 and C and also many food colours. Food may be protected from light by keeping them in containers.

Duration: All the above food deteriorating changes are time dependent like changes in colour and flavour of foods its mainly depends upon the time duration of storage. Except foods like cheese, wine and other fermented food which improves upto a point with aging.

Type of foods	Spoilage	Spoilage responsible microorganisms
Fresh fruits and vegetable	Black mould rot	Aspergillus Niger
	Blue mould rot	Penicillium italicum
	Gray, mould rot	Botrytic Cinerea
	Rhizopus soft rot	Rhizopus nigricans
	Sliminess	Saprophytic bacteria
Pickles	Black pickles	Bacillus nigricans
	Soft pickles	Bacillus spp.
Sugar based product	Ropy syrup	Aerobacter aerogenes
	Yeasty	Saccharomyces sp. Taurula sp.
	Pink syrup	Micrococcus roseus
	Green syrup	Pseudomonas flurescens
	Mouldy	Aspergillus sp., Penicillium Sp.

Mechanical damage: Picking of fruits from trees without some injury its not possible. The fruits separating from its stalk itself causing injury. Some time fruits are scratched during harvesting and handling. If proper precautions are not taken the injured spots become the points of entrance of microorganism which causes spoilage. The mechanical damage in fruits are highly reduced by removal of diseased, damaged and scratched fruits during grading and post harvest treatment of the fruits with fungicides like benomyl, sodium ortho-phenylphenate, thiabendazole

Example of spoilage

Fruits	Spoilage
Banana	Crown rot
Pineapple	Pedicle rot
Mango	Stem-end rot
Citrus fruit	Green mould
Apple	Blue mould

Fruits and Vegetables Processing - Identification of fruits,vegetables,spices& food additives

Fruits and Vegetables

Objectives: At the end of this lesson you shall be able to

- classify fruits and vegetables
- list out the different fruits and vegetables
- differentiate in between fruits and vegetables
- state the availability of fruits and vegetables in different parts of the country and its preservation.

Fruits : A fruit is the edible, and more or less juicy, product of a tree or plant and consists of the matured ovary including its seeds and adjacent parts. Usually fruits are sweet, with a wide range of flavour, colour and textures.

Vegetables : Vegetables are plants or parts of plants served with the main course of a meal. Apart from their nutritive value of vegetables is probably more than any other group of foods to add appetizing colour, texture and flavour to our daily food.

Difference in between fruits and vegetables water range

Vegetables	Fruits
Vegetables plants are non woody in nature	Fruits plants are generally woody in nature
Its generally consumed after cooking	Its mostly consumed freshly
All part of vegetables are edible	Only the fruits part is edible
Vegetables are mostly sexually propagated	Fruits a sexual mostly propagated
Mostly vegetable plant are annuals	Fruit plant are perennial seedless fruits
Cultivation is seasonal and special techniques like pruning and training are generally not required	Special, practices like training and pruning are required seasonally

Some time a fruit is called vegetable and vegetable is called fruit eg. Tomato

Fruits available in different part of the country

S. No.	Name of fruits	State
1	Mango	Punjab, Haryana, Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Karnataka, Tamilnadu, Andra Pradesh, Orissa, Assam
2	Banana	Rajasthan, Gujarat, Maharashtra, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Orissa, Bihar, Arunachal Pradesh
3	Malta	Punjab, Rajasthan, Uttar Pradesh
4	Papaya	Rajasthan, Gujarat, M.P, U.P, Maharashtra, Karnataka, Tamilnadu, Andhra Pradesh, Bihar
5	Guava	Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, Andra Pradesh, Karnataka, Orissa, Bihar, Assam
6	Grapes	Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh
7	Pine Apple	Maharashtra, Andhra Pradesh, Karnataka, Orissa, Assam, Uttar Pradesh, Sikkim
8	Litchi	Punjab, Uttar Pradesh, Gujarat, Bihar, Andra Pradesh, Orissa, Assam, Arunachal Pradesh
9	Apple	Jammu Kashmir, Himachal Pradesh, Uttar Pradesh, Haryana, Maharashtra, Karnataka, Andhra Pradesh
10	Chiku	Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Kerala, Arunachal Pradesh, Assam, Goa
11	Citrus Fruit	Rajasthan, Maharashtra, Bihar, Assam

Seasons

The chief citrus fruits (oranges, lemons and grape fruit) are available around the year. Mandarins, Clementines, satsumas and tangerines are available in the winter.

Rhubarb is in season in the spring, and the soft and stone fruits become available from June in the following order: gooseberries, strawberries, raspberries, cherries, currants, plums.

Different Fruits and their seasons

Fruit	Season
Apple	around the year
Apricot	May to Sept
Avocado pear	around the year
Banana	around the year
Blackberry	Sept to October
Blackcurrants	July to Sept
Cherry	June to August
Clementine	Winter
Cranberries	Nov to January
Damson	Sept to October
Date	Winter
Fig	July to Sept
Gooseberry	July to Sept
Grapefruit	around the year
Grapes	around the year

Because of modern storage methods and air transport the majority of these fruits may be available through out the year

Constituents in Fruits and Vegetable

Constituent	Fruits	Vegetables
Vitamin C (Ascorbic acid)	Citrus fruits, Amla, Guava, Kiwifruit, Pineapple, Strawberry, Watermelon, Papaya	Broccoli, Cabbage, Leafy greens, Tomato, Potato, Peppers (Yellow bell), Peas
Vitamin A (Carotenoids)	Orange, Orange-flesh fruits (such as Apricot, Mango, Orange, Papaya, Peach and Pineapple)	Dark-green vegetables (such as Spinach, and Turnip greens), vegetables (such as Carrots, Pumpkin and Sweet potato), Tomato
Vitamin K	Blueberry, Mulberries, Raspberries, Figs, Pear	Green onions, Cabbage, Broccoli, Leafy greens
Vitamin E (Tocopherols)	Nuts (such as Almonds, Cashew nuts, Pistachios, Peanuts, and Walnuts), Avocados, Papaya, Dried Apricots, Kiwi, Mango	Dark-green leafy vegetables, corn, dry beans, lentils and chickpeas, turnip green, tomato
Fiber	Most fresh fruits, Apple, Pear	vegetables, nuts, cooked dry beans and peas, carrot, spinach, amaranth, broccoli,

Imported apples and pears are available around the year, home-grown mainly from August to April. Many varieties of fruits are imported from all over the world and speedy air transport cargo services enable some fruits (e.g strawberries) to be in seasons virtually around the year.

Constituent	Fruits	Vegetables
Folate (Folic acid)	Citrus fruits, Amla, Avocados	Dark-green leafy vegetables (such as spinach, mustard greens, broccoli), legumes (cooked dry beans, lentils, chickpeas and green peas), asparagus, legumes (cooked dry beans, lentils, chickpeas and green peas), broccoli,tomato,okra, cabbage,cauliflower
Calcium	Papaya, Raisins, Orange, Dried figs	cooked vegetables (such as beans, tomatoes), pumpkin, peas, cauliflower,green leafy vegetables
Magnesium	Banana, Nuts, Cashews, Avocados, Dried figs	spinach, lentils, potato, corn,dark leafy greens,bean
Potassium	Banana, Dried fruits (such as Apricots and Prunes)	Baked potato or sweet potato, cooked dry beans, cooked greens,dark leafy greens

Importance of fruits and vegetables in diet

Fruit and vegetables contained a number of essential vitamins and minerals that cannot be found in other types of foods or they may contain higher levels of these nutrients than other foods.

Fruits and vegetables are made up of water, melons contain water up to 94%, which is also essential for the body and their skin and seeds contain plenty of fibre, which our body needs to help cleanse and rid itself of waste and toxins. Fibre is needed to keep bowel movements regular, lower cholesterol, bowel cancer and other illnesses of the bowel and intestine.

Different coloured fruits and vegetables contain different minerals, nutrients and antioxidants and therefore it is recommended that we consume a wide variety of fruit and vegetables in order to receive the benefits from the various types.

For example, dark green leafy vegetables such as cabbage or spinach contain certain carotenoids that

protect, delay and may prevent the onset of degenerative age-related eye diseases such as cataracts or macular degeneration.

They are also rich in vitamins C and E, which are both very powerful antioxidants. This means that eating dark green vegetables daily could help to protect the body from developing cancerous cells and from suffering heart disease.

Red, orange and yellow coloured fruits and vegetables such as melon, tomatoes, carrots and apricots contain lots of vitamins A, C and E, which all help to fight certain types of cancer and act by neutralising free radicals in the body.

As well as containing large amounts of vitamins A, C and E, fruits and vegetables are also rich in vitamins B and K plus minerals such as potassium, calcium, phosphorous, manganese and iron.

Selection of raw materials including fruit and vegetables

Objectives: At the end of this lesson you shall be able to

- select the fruits for various products
- select the vegetables for different products
- select the spices and additives for various products.

Selection of fruits and vegetables

- 1 For processing of fruits and vegetables based products we must use fresh fruits and vegetables.
- 2 For best quality of product few point we should remember that over ripe fruits must avoid, the fruits should be ripe and uniformly mature.
- 3 For pickles, chutney and other fruits and vegetables based products we choose the tender vegetables.
- 4 In case of tomato based products like - sauce, ketchup, puree and paste we must choose tomato fully ripe, firm and of deep red colour.
- 5 Any type of soil, dirt, sand may contaminate the product it should be free from the dirt particles.
- 6 The fruits and vegetables should be free from spoilage e.g: enzymatic, Insect, Mechanical damage and Microbial

List of various fruits and vegetables based products

Sl. No.	Name of fruit	Fruit based product
1	Pineapple	Canned pineapple, Juice, Squash, Syrup, Jam
2	Litchi	Juice, Syrup, Canned litchi
3	Mango	Juice, RTS, Nectar, Squash, Jam, Preserve, Toffee, Amchur, Pickle, Chutney, Canned mango, Mango powder, Mango concentrate
4	Guava	Jelly, Cheese Toffe, Nectar, Canned guava, Squash, Vinegar
5	Papaya	Jam, Candy, Nectar, Pickle, Sauce, Canned papaya, Papain
6	Grape	Wine, Juice, Raisin, Munakka
7	Pomegranate	Juice, Squash, Syrup, Anardana (dried product)
8	Aonla	Preserve, Jam, Candy, Syrup, Pickle, Chutney, Dried shreds, Triphla, Chyawanprash
9	Karonda	Pickle, Juice, Raisn, Munakka
10	Banana	Canned banana, Dried banana, Toffee
11	Fig	Dried fig
12	Loquat	Jam, Jelly, Canned loquat
13	Ber	Candy, Preserve, Canned ber, Jam
14	Bael	Preserve, Nectar, Squash, Canned bael, Cider
15	Phalsa	Juice, Squash, Syrup
16	Jackfruit	Pickle
17	Citrus fruits	Juice, Pickle, Marmalade, Squash, Cordial, Barley water, Candy
18	Jamun	Jelly, Syrup, Vinegar

Sl. No.	Name of vegetable	Vegetable based product
1	Cauliflower	Pickle, Dried and Canned cauliflower
2	Bitter Gourd (Karela)	Pickle, Dried bitter gourd
3	Garlic	Pickle, Powder
4	Carrot	Jam, Preserve, Pickle, Candy, Canned carrot
5	Ginger	Pickel, Preserve, Candy, Dried ginger, RTS, Syrup
6	Peas	Canned peas, Dried peas, Pickle
7	Cabbage	Sauerkraut, Dried cabbage
8	Brinjal	Pickle
9	Cucumber	Pickle
10	Green chilli	Pickle
11	Water melon	Juice, squash
12	Onion	Pickle, Dried onion
13	Mushroom	Pickle, sauce, Canned mushroom, Dried mushroom
14	Beetroot	Pickle, Canned beetroot
15	Potato	Chips, Papad, Starch, Canned potato
16	Radish	Pickle
17	Mush melon	Juice, Squash
18	Turnip	Pickle, Canned beetroot
19	Beans	Canned and Dried beans
20	Pointed gourd (Parwal)	Canned and Dried parwal
21	Spinach	Canned spinach
22	Ash gourd (Petha)	Candy
23	Tomato	Sauce, Chutney, Pickle, Puree, Paste, Canned tomato, Juice, Soup, Jam

Spices and additives used in fruits and vegetable processing

Ajwain: It contains essential oil as thymol, we can recognize this spice with its characteristic aromatic smell, it is used in pickles, beverages, etc.

Aniseed: It is known as “Saunf” in India. It is used as a mouth freshener the flavour compound in the “saunf” is anethole it is used in pickle, Bread, Biscuit etc.

Bay Leaf: It is a dry leaf of laurel tree it is used in pickle flavor meat etc.

Black Peppers: Black pepper or kali mirch is the king of spice, huge amount of this spice is consumed by the domestic and industrial sector they are the dried, mature small round berry of a perennial climbing vine with small white flower.

Caraway: It is a flavor enhancer of canned food, the Chief flavor constituents of caraway is D- Carvone and D limonene.

Cardamom: The spice is having characteristic pleasant odour and its fruits contains - Brownish black seeds, it

is mainly used for flavouring sweet preparation, cookies, breads, pickles etc.

Cassia: Also called Chinese cinnamon spice consisting of the aromatic bark of the cinnamonum cassia plant of the family lauraceae it is thicker than cinnamon bark is used as a flavouring in cooking and particularly in liquor and chocolate.

Chillis: Chillis are the common spice used in Indian food. This fruit of genus capsicum.

Cinnamon: Cinnamon or Dalchini is used as a flavouring spices in different food it is a thin inner bark of the cinnamon tree.

Cloves: Cloves or laung is the dried flower bud of a clove tree. The chief constituent of clove is eugenol which is act as an antioxidant which prevents rancidity.

Coriander: We can use its fresh leaf and also dried roasted seed for various types of food, mostly fresh leaf is used for sprinkling on prepared food.

Cumin: Cumin or Jeera is a caraway type seed usually medium brown. The flavor compound of Jeera is

aldehyde cumino. It is used in pickles pulav, mix with curry powder etc.

Dill seeds: It is ripe, brown seeds of apiaceae it is used both whole and ground as condiment in soups, salads, pickle etc. The leaves have pleasant aromatic odour and warm taste both seeds and leaves are valued in spice.

Fennel: Is a flavouring plant spices in the celery family Apiaceae or umbelliferae herb with yellow flower and leaves it is used in pickles sugar coated or not coated as a mouth freshener.

Fenugreek: It is also known by methi it is bitter in taste, it is used in pickles it improves flavor and keeping quality.

Garlic: It is also known by lissan the structure of Garlic is like a bulb contains several cloves. It is used in Tomato ketchup, pickle and several other products.

Ginger: Ginger or adrak is the root of the plant zingiber officinale roscoe is used in beverages like, Tea, Lime Juice the whole root is used for curries, pickles, chutney, preserve etc.

Hing /Asafoetida: Asafoetida or hing, contains resins, gum and essential oil in varying proportions which are responsible for the strong flavor, it is used in sauces, pickles, etc.

Large cardamom: This is bigger form of cardamom, contains brownish black seeds it is mainly used for flavouring meat curry, pickles etc.

Mace: Mace is the orange, red fleshy. Covering spice, it is used in small amount to flavor puddings and fruit, pie.

Nutmeg: Nutmeg is the dry hard seed of the Nutmeg fruits, it is having antimicrobial property used in pickles, preserves, fish sauces etc.

Pimento: Pimento is the unripe, rough surfaced globular berries of reddish brown colour. The berries possess the characteristic flavor and aroma of cloves, nutmeg cinnamon and black pepper. And used as a flavouring ingredients in ketchup, soups, sauces, pickles etc.

Saffron: It is mainly the stigma of saffron flower, it is used in mainly for yellow colour and distinctive flavor. And it is used in soups, sauces, pudding etc.

Turmeric: Turmeric or haldi is root of turmeric plant, used domestically as a spice and a colouring material due to its natural aroma and colour we use it mostly in pickles, kadi etc.

Vanillin: Vanilla is a spice contains the flavouring compound "Vanillin" in today's scenario the use of synthetic vanilla is very high than the natural it is used in ice cream, pudding, cakes etc.

Food Additives

A food additive is defined as a substance or mixture of substance.

An expert committee on Food Additives made up of representatives of FAO and WHO has defined food additives as non nutritive substances added intentionally

to food, generally in small quantities, to improve its appearance, flavor, texture or storage properties. This definition excludes substances added primarily for their nutritive value, such as vitamins and minerals.

A broad definition of food additive is any substance the intended use of which results, directly or indirectly, in its becoming a component of or otherwise affecting the characteristics of any food and which is safe under the condition of its use. Any substance present in food, either, by intentional addition or an unintentional contaminant, has its effects on the safety of food.

Need for Food additives

A number of factors have led to the demand for foods with built-in "convenience" foods. A can of vegetable soup is a convenient food. Since various vegetables have been cut, blended, supplemented with spices and so on. It just requires warming up before use. There is a great demand nowadays for "instant", heat and serve, and "ready-to-cook" convenient foods. These foods make up about 60 percent of the food that Americans buy. Such foods result in saving considerable amounts of time and effort in food preparation at home, restaurants, etc. The convenience food revolution would not have been possible without food additives.

Additives permit the variety of foods that we deem desirable and which certainly are objectively important in maintaining good nutrition. Vitamins and minerals are important, among other things, for good health. Many of these chemical additives can be manufactured so that foods can be "fortified" or "enriched". Potassium iodide, for instance, added to common salt can eliminate goiter, enriched rice or bread with B-complex vitamins can eliminate pellagra and adding vitamin D to cow milk prevents rickets.

Many foods, particularly those with high moisture contents, do not keep well. All foods are subject to microbial attack. Fats or oily foods become rancid, particularly when exposed to humid air. The conservation of the quality of foods against agents causing such deterioration of foods requires the addition of preservatives. Additives are also used to colour foods, add flavor, impart firmness and retard or hasten chemical reaction in food.

There is then the need for the use of food additives to maintain the nutritional quality of food, to enhance stability with resulting reduction in waste, to make food more attractive and to provide efficient aids in processing, packing and transport. The amount of additives used should be kept to a minimum; it should conform to a standard of purity and be safe. On the other hand, food additives must not be used to disguise faulty processing and handling techniques, to deceive the customers, or if it reduces the food's nutritive value, or when the desired effect can be achieved by good manufacturing practices that are economically feasible.

Food additives can be divided into 12 categories, and except for purely 'natural' substances, their use is subject to certain legislation.

- 1 **Preservatives:** Natural ones include salt, sugar, alcohol and vinegar; synthetic ones are also widely used.
- 2 **Colouring agents:** natural, including cochineal, caramel and saffron, and many synthetic ones.
- 3 **Flavouring agents:** synthetic chemicals to mimic natural flavor (monosodium glutamate to give a meaty flavor to foods)
- 4 **Sweetening:** saccharin, sorbitol and aspartame.
- 5 **Emulsifying agents:** (to stop separation of salad creams, ice-cream, etc); examples are lecithin and glyceryl monostearate (GMS)
- 6 **Antioxidants:** to delay the onset of rancidity in fats due to exposure to air, such as vitamin E and BHT.
- 7 **Flour improvers:** to strengthen the gluten in flour, such as vitamin C
- 8 **Thickeners:** animal (gelatin); marine (agar-agar); vegetable (gum tragacanth used for pastillage), pectin; synthetic products.
- 9 **Humectants:** to prevent food drying out, such as glycerine (used in some icings)
- 10 **Polyphosphate:** injected into poultry before rigor mortis develops; it binds water to the muscle and thus prevents 'drip', giving a firmer structure to the meat
- 11 **Nutrients:** vitamins and minerals added to breakfast cereals, vitamins A and D added to margarine.
- 12 **Miscellaneous:** anticaking agents added to icing sugar and salt; firming agents (calcium chloride) added to tinned fruit and vegetables to prevent too much softening in the processing; mineral oils added to dried fruit to prevent stickiness.

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Juice pulper

Objectives: At the end of this lesson you shall be able to

- define a pulper.
-

Pulper can be used to extract pulps from most fruits and vegetables. The working of the machines depends upon type, size and quality of the product to be pulped. The following are few types of pulper:

- Coarse Pulper
- Fine Pulper
- Mini Pulper

Pulp extraction equipment ranges from hand operated crushers to tonnes/hour mechanical extractors. With soft or comminuted fruit a cone screw expresser or paddle pulper fitted with appropriate screens serves to separate the juice from particulate matter. Where skin or seed shattering is a problem, Brush paddles can replace metal bars. Two pulpers in series with screens of 0.1 to 0.2 mm can effectively clean up many juices and often yield a usable thick pulp by-product



Food Industry

Related Theory for Exercise 1.2.06

Fruits and Vegetables Processing - Identification of Fruits, Vegetables, Spices & Food Additives

Refrigeration of fruits and vegetables

Objectives: At the end of this lesson you shall be able to

- explain refrigeration
- explain the table & tips for the storage of fruits under refrigerated condition.

Refrigeration

The house hold and commercial refrigerators usually run at 4.4°C - 7.2°C. Commercial refrigeration may use a slightly lower temperature, depending upon the nature

of food refrigerated. The refrigerated storage will preserve perishable food for days or weeks depends upon the good. Mostly spoilage organism grow above 10°C.

Refrigeration storage Table for fruits

Fruits	Refrigerated Storage (4°C)	Special Tips
Grapes	Store for 5 days	Grapes is not store with green onion because it absorb smell.
Lemons and Lime	Store for 1 month openly or in perforated plastic bags	Do not store with egg, meat, and product prepared from milk it absorb smell
Orange	Store for 1 month openly or in perforated plastic bags	Do not store with egg, meat, and product prepared from milk it absorb smell.
Papaya	Ripened papaya store for 1 week	It ethylene gas produces
Mango	Ripened Mango store for 3 days	It ethylene gas produces
Melon	Store for 3 days without covering	* Ethylene gas producer * Cutted melon consume within 2 day.
Peach	Store for 1 week without covering	It ethylene gas produces
Lichee	Store for 1 to 2 weeks	Dont have cracks on the surface of lichee.

Refrigeration storage Table for Vegetables

Vegetable	Refrigerated Storage (4°C)	Special Tips
Broccoli	Store for 5 days in perforated plastic bag	It is ethylene sensitive due to develop yellow buds on broccoli.
Cabbage	Store for 2-3 weeks	It is ethylene sensitive. Don't store with apple and pear because it absorb smell. In the presence of ethylene gas its leaves become separate and colour become change.
Cucumber	Store for 1 week	It is ethylene sensitive. In the presence of ethylene gas its colour become yellow.
Green other Varieties	Store for 2 to 4 days without washing	It is ethylene sensitive. In the presence of ethylene gas develop spots on it.
Mushroom	Store for 5 days in paper Bag	It absorb the smell of onion so it store separated.
New Potato	Store for 1 week	It absorb the smell of pear
Radish	Store for 2 week	Before storing remove the upper portion of radish
Onion Sweet	Store for 1 month without covering	It is ethylene producer

Storage of fruits and vegetables

Objectives: At the end of this lesson you shall be able to

- define perishable fruits and vegetable
- select fresh fruits and vegetables for refrigeration.

Perishables:- Fruits and Vegetables Containing high moisture contents are called perishable fruits and vegetables. Most fruits and vegetables should be stored between 5° and 9°C. Tropical fruit such as banana and pineapples should be stored at 18°C, root vegetable such as carrots, potatoes, pumpkins and onions are classed as semi perishable and do not require refrigeration. Frozen vegetables and fruits are stored in a deep freezer where the temperature is set at -18°C or less.

Semi perishable vegetables kept on shelves in the store room, where they get plenty of air circulation around them, potatoes need to be kept away from light as they will start sprouting.

Store room temperature : 10°C - 20°C

Humidity : 50% and 60%

Cool room temperature : 2°C - 4°C (for all perishable and semi perishable)

Vegetables stored in cool room

Root	: Carrot, Potatoes, Onions
Leaves	: Cabbage
Flower	: Cauliflower
Fruits	: Tomatoes, Pumpkin
Freezer	: All the frozen perishable goods.

Fruits stored in cool room:-

Fruits are grouped into the following categories:

Soft fruits	: Strawberries
Hard fruits	: Apples
Stone fruits	: Cherries, Apricots
Citrus fruits	: Oranges, Lemons, Grapes
Tropical fruits	: Melon, Banana, Pineapple and Guava

Selection of fruits

Appearance: The fruits should be the correct shape for the variety. The colour should be correct for the degree of ripeness required.

Blemishes: Fruits should be free of blemishes, scarring.

Ripeness: Fruits should be firm to touch sweet smell and look soft.

Vegetables stored in cool room

Vegetables are grouped into the following categories:

Stem Vegetable: It should be firm and crisp.

Leaf Vegetable: It should be bright, crisp with no discoloured, cabbage should be compact.

Flower vegetable: It should be firm and compact with tightly closed buds.

Bulbs and tubers: It should show no signs of sprouting they should be firm and free any spade marks or discoloration.

Tomatoes & cucumber should be firm but not hard and no any dark discoloration.

Quality : Fresh vegetable should have the correct shape, be free of blemishes and look fresh.

Methods used for storing vegetables

Raw vegetables such as carrot, cauliflower, pea etc., We can preserve in a solution of salt, water and acetic acid in a ratio of 17:80:3 for longer time.

Methods:- Perishable vegetables are store in store room by preserving of salt, water and acetic acid in a ratio of 17:80:3 for longer time.

Selection of vegetable



Cutting



Washing



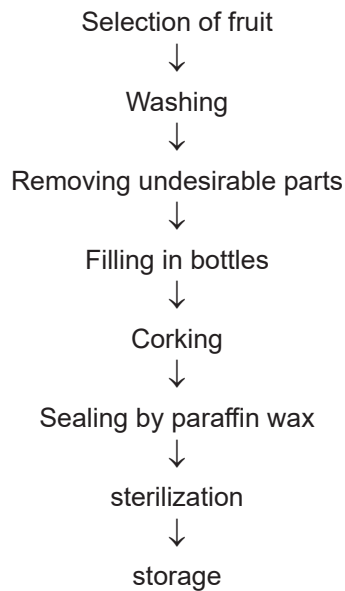
Dip in a solution of salt, water and acetic acid in a plastic drum



Store at room temperature

Storing of perishable in air tight Jar

Perishable fruits are store in store room by air tight packaging. Such as strawberry, cherry, blackberry, amla, mango.



Preparation method: Slightly under ripe fruit has firmer than ripe fruit so it can be preserved for long time. Washing and removing of undesirable portion from fruits. Put it in wide mouthed bottle and fill them. Seal the cork by melting paraffin wax. Cork bottles dipping into boiling water for sterilization. Bottles of the heat and stored until the bottles are cool, store the bottles in a cool place.

- Vegetables can be stored in brine solution (at least 15%)
- Vegetables can be stored for long time by dehydrate it.
- Fruits and vegetable can be stored for long period by canning.

Juice extraction and preservatives

Objectives: At the end of this lesson you shall be able to

- explain the aware of technology of extraction of juices.

Technology of extraction of juice

There are many methods of juice extraction, from squeezing fruit by hand to wide-scale extraction with industrial equipment. Juicing is generally the preferred method of consuming large amounts of produce quickly and is often completed with a household appliance called a juicer/ pulper, which may be as simple as a cone upon which fruit is mashed or as sophisticated as a variable-speed, motor-driven device. It may also refer to the act of extracting and then drinking juice or those who extract the juice. Juicing is different from buying juice in the supermarket because it focuses on fresh pressed fruits and vegetables.

Juicing tools have been used throughout history. Manual devices include barrel-shaped presses, hand-operated grinders, and inverted cones upon which fruit is mashed and twisted. Modern juicers are powered by electric motors generating from 200 to 1000 or more watts. There are several types of electric juicers: masticating, centrifugal, and triturating juicers. These variations are defined by the means of extracting the juice.

Masticating - utilizes a single gear driven by a motor; slower operation; kneads and grinds items placed in a chute

Centrifugal - utilizes a spinning blade that resembles a grated basket; faster operation; quickly grinds items and discards pulp in a receptacle

Triturating - utilizes twin gears; slower operation; often has multiple uses

Mastication or chewing is the process by which food is crushed and ground. It is the first step of juice extraction and it increases the surface area of foods to allow more efficient break down by enzymes. During the mastication process, the food is positioned between the brush and sieves for grinding.

Centrifugal It uses the rotation of the rotor inside a centrifuge to mix two immiscible liquids outside the rotor and to separate the liquids in the field of gravity inside the rotor. This way, a centrifugal extractor generates a continuous extraction from one liquid phase (fermentation broth) into another liquid phase (organic solvent)

Trituration is the name of several different methods used to process materials. Trituration is also the name of the process for reducing the particle size of a substance by grinding, as by grinding of powders in a mortar with a pestle. Trituration additionally refers to the production of a homogeneous material through mixing.

Definition of preservatives

A preservative is a naturally occurring or synthetically produced substance that is added to products such as foods, pharmaceuticals, paints, biological samples, wood, etc. to prevent decomposition by microbial growth or by undesirable chemical changes. Preservatives can be divided into two types, depending on their origin. Class I preservatives refers to those preservatives which are naturally occurring, everyday substances. Examples include salt, honey and wood smoke. Class II preservatives refer to preservatives which are synthetically manufactured.

These two are also allowed in India according to the Fruit Product Order (F.P.O.) of 1955.

(i) Sulphur dioxide

It is widely used throughout the world in the preservation of juice, pulp, nectar, squash, crush, cordial and other products. It has good preserving action against bacteria and moulds and inhibits enzymes, etc. In addition, it acts as an antioxidant and bleaching agent. These properties help in the retention of ascorbic acid, carotene and other oxidizable compounds. It also retards the development of nonenzymatic browning or discolouration (after killing the enzyme) of the product. It is generally used in the form of its salts such as sulphite, bisulphite and metabisulphite.

Potassium Meta-bi-sulphite is commonly used as a stable source of sulphur dioxide. Being a solid, it is easier to use than liquid or gaseous sulphur dioxide.

It is fairly stable in neutral or alkaline media but decomposed by weak acids like carbonic, citric, tartaric and malic acids. When added to fruit juice or squash it reacts with the acid in the juice forming the potassium salt and sulphur dioxide, which is liberated and forms sulphurous acid with the water of the juice.

Sulphur dioxide has a better preservative action than sodium benzoate against bacteria and moulds. It also retards the development of yeasts in juice, but cannot arrest their multiplication, once their number has reached a high value. It is well known that fruit juices with high acidity do not undergo fermentation readily. The preservative action of the fruit acid is due to its hydrogen ion concentration. The pH for the growth of moulds ranges from 1.5 to 8.5, that of yeasts from 2.5 to 8.0 and of bacteria from 4.0 to 7.5. As fruit beverage like citrus squashes and cordials have generally a pH of 2.5 to 3.5, the growth of moulds and yeasts in them cannot be prevented by acidity alone. Bacteria, however, cannot grow. The pH is, therefore, of great importance

in the preservation of food product and by regulating it, one or more kinds of microorganism in the beverage can be eliminated. The concentration of Sulphur dioxide required to prevent the growth of microorganism at different pH levels is given in Table 2. The toxicity of sulphur dioxide increases at high temperature. Hence its effectiveness depends on the acidity, pH, temperature and substances present in fruit juice. According to Indian Fruit Product Order, the maximum amount of sulphur dioxide allowed in fruit juice is 700 ppm, in squash, crush and cordial 350 ppm and in RTS and nectar 100 ppm.

The advantages of using sulphur dioxide are : (a) it has a better preserving action than sodium benzoate against bacterial fermentation, (b) it helps to retain the colour of the beverage for a longer time than sodium benzoate, (c) being a gas, it helps in preserving the surface layer of juices also, (d) being highly soluble in juices and squashes, it ensures better mixing and hence their preservation, and (e) any excess of sulphur dioxide present can be removed either by heating the juice to about 71°C or by passing air through it or by subjecting the juice to vacuum. This causes some loss of the flavouring materials due to volatilization, which can be compensated by adding flavours.

The major limitations of sulphur dioxide are : (a) it cannot be used in the case of some naturally coloured juices like those of phalsa, jamun, pomegranate, straw-berry, coloured grapes, plum, etc., on account of its bleaching action, (b) it cannot also be used for juices which are to be packed in tin containers, because it not only corrodes the tin causing pinholes, but also forms hydrogen sulphide which has a disagreeable smell and reacts with the iron of the tin container to form a black compound, both of which are highly undesirable, and (c) sulphur dioxide gives a slight taste and odour to freshly prepared beverages but these are not serious defects if the beverage is diluted before drinking.

(ii) Benzoic acid

It is only partially soluble in water hence its salt, sodium benzoate, is used. One part of sodium benzoate is soluble

in 1.8 parts of water at ordinary temperature, whereas only 0.34 part of benzoic acid is soluble in 100 parts of water.

Sodium benzoate is thus nearly 170 times as soluble as benzoic acid. Pure sodium benzoate is tasteless and odourless. The antibacterial action of benzoic acid is increased in the presence of carbon dioxide and acid, e.g., *Bacillus subtilis* cannot survive in benzoic acid solution in the presence of carbon dioxide. Benzoic acid is more effective against yeasts than against moulds. It does not stop lactic acid and acetic acid fermentation. The quantity of benzoic acid required depends on the nature of the product to be preserved, particularly its acidity.

In case of juices having a pH of 3.5 to 4.0, which is the range of a majority of fruit juices, addition of 0.06 to 0.10 per cent of sodium benzoate has been found to be sufficient. In case of less acid juices such as grape juice at least 0.3 per cent is necessary. The action of benzoic acid is reduced considerably at pH 5.0. Sodium benzoate in excess of 0.1 per cent may produce a disagreeable burning taste. According to F.P.O. its permitted level in RTS and nectar is 100 ppm and in squash, crush and cordial 600 ppm. In some European countries, especially Germany, generally methyl, ethyl and propyl esters of para-hydroxy benzoic acid are used. They are, however, not used in India. In the long run benzoic acid may darken the product. It is, therefore, mostly used in coloured products of tomato, phalsa, jamun, pomegranate, plum, water-melon, strawberry, coloured grapes, etc. The preservative should never be added in solid form but should be dissolved in a small quantity of juice or water, and the solution added to the bulk of the product. If this care is not taken, the solid may settle undissolved at the bottom of the container with the result that fermentation may start before the action of preservative can begin.

A number of chemicals such as hydrogen peroxide, formaldehyde, halogenated acetic acid, salicylic acid, etc., which were used as preservatives some years ago, have now been banned in many countries. In recent years, sorbic acid and tylosin, etc., are being tried

Table 1

S. No.	Food Product	Preservative	Parts per million (ppm)
1	Fruit, Fruit pulp or juice (not dried) for conversion into jam or crystalized, glazed or cured fruit or other products		
	(a) Cherries Sulphur dioxide		3000
	(b) Strawberries and raspberries	- do -	2000
	(c) Other fruits	- do -	1000
2	Fruit Juice concentrate	- do -	1500
3	Dried fruits	- do -	
	(a) Apricots, peaches, apples, pears and other fruits	- do -	2000
	(b) Raisins and sultanas	- do -	750

4	Squashes, crushes, fruit syrups, cordials, fruits juices and barley waters	Sulphur dioxide or benzoic acid	350 650
5	Jam, marmalade, preserve, canned cherry and fruit jelly or benzoic acid	Sulphur dioxide 200	40
6	Crystallized, glazed or cured fruit (including candied peel)	Sulphur dioxide	150
7	Fruit and fruit pulp not other-wise specified in the schedule	- do -	350
8	Sweetened ready-to-serve beverages or benzoic acid	Sulphur dioxide 120	70

Table 2

The concentration of Sulphur dioxide required to prevent the growth of microorganism at different pH levels are as under:

pH	Organisms and sulphur dioxide concentration (ppm)			
	<i>Saccharomyces ellipsoideus</i> (Yeast)	<i>Mucor</i> (Mould)	<i>Penicillium</i> (Mould)	Mixed bacteria
2.5	200	200	300	100
3.5	800	600	600	300
7.0	above 5000	above 5000	above 5000	above 1000

Fruits and Vegetables Processing - Preparation of Common Juices and Beverages**Fruit Beverages**

Objectives: At the end of this lesson you shall be able to

- describe fruit beverages
- state the methods of production
- determine acids in fruits and vegetable products.

Introduction

A wide range of drinks can be made using extracted fruit juice or fruit pulp as the base material. Many are drunk as a pure juice without the addition of any other ingredients, but some are diluted with sugar syrup. The types of drink made from fruit can be separated into two basic types;

- Those that are drunk straight after opening
- Those that are used little by little from bottles which are stored between use.

The former groups should not require any preservative if they are processed and packaged properly. However, the latter group must contain a certain amount of permitted preservatives to have a long shelf-life after opening.

Each of the above products is preserved by a combination of natural acidity, pasteurisation and packaging in sealed containers. Some drinks (syrups and squashes) also contain a high concentration of sugar which helps to preserve them.

Beverages

Beverages are potable drinks which have thirst-quenching, refreshing, stimulating and nourishing qualities. By refreshing, one means the replenishment of fluid loss from the body due to perspiration. Simulation results in increase of the heart beat and blood pressure. This is due to the intake of spirits (alcohol) or tea (tannin) and coffee (caffeine). Nourishment is provided by the nutrients in the beverages, especially fruit juices.

Most of the beverages supply energy in the form of sugar or alcohol. They also provide other nutrients like mineral salts and vitamins. For example, milk gives calcium and citrus fruits give vitamin C.

Generally, people drink for one or more of six reasons; to quench thirst, to get drunk, to enjoy a social setting (social drinking), to enjoy the taste of the beverage, to feed an addiction (alcoholism), or as part of a religious or traditional ceremony or custom (proposing toast).

Classification of beverages

A beverage is a liquid formulation specifically prepared for human consumption. The word "Beverage" has been derived from the Latin word "bever" meaning rest from work. After work, one tends to feel thirsty due to fluid loss through perspiration and one is inclined to drink water or other potable beverages to compensate fluid loss.

Beverages can be broadly classified into two. They are Alcoholic Beverages and Non-alcoholic Beverages.

Again non alcoholic beverages can be classified into

Carbonated non alcoholic beverages

Non carbonated non alcoholic beverages

Fruit Juices, Squashes, Cordial, Nectar and Syrups comes under later category.

Fruit Beverages

- **Unsweetened Fruit Juices** - It is a pure fruit juice with nothing added which has 100% fruit juice and natural TSS %
- **Sweetened Fruit Juices**- Beverage with minimum 80% fruit juice and 10% TSS (min) is called Sweetened fruit juice.
- **Nectars** -It has 25% fruit juice and minimum TSS 15% for citrus fruits TSS should be minimum 40%
- **Squashes**-- They contain at least 25% fruit pulp and 40% TSS. They are diluted with water before serving
- **Cordials** - Beverage which has minimum 30% TSS and 25%(min) fruit juice is called Cordial.
- **Syrups** - They have higher sugar content. TSS% of syrups is 65%(min) and they contain at least 25% juice.

Method of production

For all the fruit based beverages, the first stage is the extraction of juice or pulp from the fruit. The following are the key manufacturing stages:

- Selection and preparation of raw material
- Juice extraction
- Filtration (optional) Batch preparation
- Pasteurisation
- Filling and bottling.

Any fruit can be used to make fruit juice, but the most common ones include pineapple, orange, grapefruit, mango and passion fruit. Some juices, such as guava juice, are not filtered after extraction and are sold as fruit nectars.

Preparation of raw material

Select mature, undamaged fruits. Any fruits that are mouldy or under-ripe should be sorted and removed. Wash the fruit in clean water. It may be necessary to chlorinate the water by adding 1 tablespoon of bleach to 5 litres of water. Peel the fruit and remove stones or seeds. If necessary, chop the fruit into pieces that will fit into the liquidiser or pulper. Remember that at this stage,

you are exposing the clean flesh of the fruit to the external environment. Make sure that the utensils are clean. Do not leave the cut surfaces exposed to the air for long periods of time or they may start to turn brown and this will discolour the juice. The fruit pieces can be placed in water that contains lemon juice (250ml lemon juice per litre of water) to stop them browning.

Juice extraction

There are several methods to extract juice depending on the type of fruit you use. For citrus fruits which are naturally juicy, the best option is to use a hand presser or a revolving citrus 'rose'. Some fruits such as melon and papaya are steamed to release the juice. Apples are pressed and fruits such as mango, guava, sour sop, pineapple, strawberry must be pulped to extract the juice. The fruit pieces are pushed through a perforated metal plate that crushes and turns them into a pulp. Some fruits can be pulped in a liquidiser and then filtered to remove the fruit pieces. There is a range of equipment available that varies in size and in the type of power supply (some are manual while the larger ones require electricity). For the small scale processor, the Mouli Legume or a hand-powered pulper/sieve which force the fruit pulp down through interchangeable metal strainers is sufficient.

At slightly higher production levels, it is necessary to use a power source to achieve a higher throughput of juice. A multi-purpose food mixer is strongly recommended. This has a pulping attachment that is similar to the Mouli Legume and it can also be used for other operations such as liquidising and mixing. For large-scale production, an industrial pulper-sieving machine is necessary. This also acts by forcing the fruit pulp through a fine cylindrical mesh.

Filtering

To make a clear juice, the extracted juice or pulp is filtered through a muslin cloth or a stainless steel filter. Some of the larger filter presses have a filter included. Although juice is naturally cloudy, some consumers prefer a clear product. It may be necessary to use pectic enzymes to break down the pectin and to help clear the juice. Pectic enzymes may be difficult to find and expensive and therefore should only be used if really necessary and readily available.

Batch preparation

When the juice or pulp has been collected, it is necessary to prepare the batch according to the chosen recipe. This is very much a matter of choice and judgement, and must be done carefully to suit local tastes. Juices are sold either pure or sweetened. Fruit squashes would normally contain about 25% fruit material mixed with a sugar syrup to give a final sugar concentration of about 40%. Squashes are diluted with water prior to use and, as the bottle is opened, partly used and then stored, it is necessary to add a preservative (for example 800ppm sodium benzoate).

Another popular product is fruit nectar, which is a sweet mixture of fruit pulp, sugar and water which is consumed on a 'one shot' basis. Essentially, these consist of a 30% mix of fruit pulp and sugar syrup to give a final sugar level of about 12-14%. All fruits contain sugar, usually around 8-10%. The actual levels vary from fruit to fruit and with the stage of ripeness of the fruit. They also vary within the same fruit grown in different parts of the world. The addition of sugar to the fruit pulp to achieve the recommended levels for preservation must take into account the amount of sugar already present in the juice. It is important to achieve the minimum level that will prevent the growth of bacteria, however, once that level has been achieved, it is possible to add more if the consumers require a sweeter product. The amount of sugar added in practice is usually decided by what the purchasers actually want. The Pearson Square is a useful tool to use to help with batch formulation and to calculate the amount of sugar to be added for preservation.

In all cases, sugar should be added to the fruit juice as a sugar syrup. The syrup should be filtered through a muslin cloth prior to mixing to remove particles of dirt which are always present. This gives a clearer, higher quality product.

Pasteurisation

All the products mentioned above need to be pasteurised at 80-95°C for 1-10 minutes prior to hot-filling into bottles. At the simplest level, this may be carried out in a stainless steel, enameled or aluminium saucepan over a gas flame, but this can result in localised overheating at the base of the pan, with consequent flavour changes. Care is needed when producing pineapple juice due to a heat resistant enzyme in the juice.

The enzyme damages skin after prolonged contact and workers should therefore wear gloves to protect their hands. The juice must be heated to a higher temperature for a longer time to destroy the enzyme (e.g. boiling for 20 minutes). It is best to use stainless steel pans to heat fruit juice as the acidity of the juice can react with aluminium in aluminium pans during prolonged heating. However, large stainless steel pans are very expensive and may not be affordable by the small scale processors. To get round this problem, it is possible to use a large aluminium pan to boil the sugar syrup. The boiling syrup can then be added to a given amount of fruit juice in a small stainless steel pan. This increases the temperature of the juice to 60-70°C. The juice/syrup mixture is then quickly heated to pasteurising temperature. Another option is to pasteurise the juices once they have been bottled. The bottles are placed in a hot water bath which is heated to 80°C. The bottles are held in the hot water for the given amount of time until the contents reach the desired temperature. The length of time required in the water bath depends on the size and volume of the bottles. A thermometer should be placed in one of the bottles, which is used as a test bottle per batch, to monitor the temperature and to ensure that the correct temperature has been reached. This method of pasteurisation has benefits but also has problems.

Juice is pasteurised within the bottle so the chance for re-contamination of the juice is reduced. Difficult to ensure the internal temperature of the bottles reaches the desired pasteurizing temperature. No need for large stainless steel pans for pasteurization. Require glass bottles for pasteurizing. The next industrial jump in pasteurisation is an expensive option that involves the purchase of a double-jacketed steam kettle in stainless steel and a small boiler. The total cost is likely to be very high, which is only viable for larger scale operations.

Filling and bottling

In all cases, the products should be hot-filled into clean, sterilised bottles. A stainless steel bucket, drilled to accept a small outlet tap, is a very effective bottle filler. The output

can be doubled quite simply by fitting a second tap on the other side of the bucket. After filling hot, the bottles are capped and laid on their sides to cool prior to labeling.

Quality control

The freshness and quality of the expressed fruit juice is central to the quality of the final product. As soon as the juice is expressed from the fruit it starts to deteriorate, both as a result of chemical activity (enzyme action) and bacterial spoilage. It is important to move from the juice extraction stage to pasteurisation as quickly as possible to minimise any spoilage. Extracted fruit juice that is left to stand for long periods in the heat will start to ferment and may start to discolour due to enzyme activity. The juice should be stored in a refrigerator (if one is available) or in a cool place and away from the direct sunlight. It should be collected into a clean, sterile container (food grade plastic buckets is the best option) and covered to keep out dirt, dust and insects. For the best quality product, it is essential to work quickly between the extraction of the juice and the bottling stage. The longer the juice is out of the bottles, the more chance there is of contamination.

As in all food processing enterprises it is necessary to ensure that the fruit products are correctly formulated and priced to meet the customer's requirements, and that production costs are minimised to ensure that a profit is made. The quality of each day's production should be monitored and controlled to ensure that every bottle of juice has the correct keeping and drinking qualities. In particular the following points should be observed:

- Only fresh, fully ripe fruit should be used; mouldy or insect damaged fruit should be thrown away. All unwanted parts (dirt, skins, stones etc) should be removed.
- All equipment, surfaces and floors should be thoroughly cleaned after each day's production.
- Water quality is critical. If in doubt use boiled water or add one tablespoon of bleach to 5 litres of water to sterilise it. If water is cloudy, a water filter should be used.

- Pay particular attention to the quality of re-usable bottles, check for cracks, chips etc and wash thoroughly before using. Always use new caps or lids.
- The concentration of preservative should be carefully controlled for correct preservation of squashes and cordials, and may be subject to local laws. Check first and use accurate scales to measure the preservative.
- The temperature and time of heating are critical for achieving both the correct shelf life of the drink and retaining a good colour and flavour. A thermometer and clock are therefore needed.
- The correct weight should be filled into the bottles each time.

Determination of % of acidity by titration

It is the sugar/acid ratio which contributes towards giving many fruits their characteristic flavour and so is an indicator of commercial and organoleptic ripeness. At the beginning of the ripening process the sugar/acid ratio is low, because of low sugar content and high fruit acid content, this makes the fruit taste sour. During the ripening process the fruit acids are degraded, the sugar content increases and the sugar/acid ratio achieves a higher value. Overripe fruits have very low levels of fruit acid and therefore lack characteristic flavour.

Titration is a chemical process used in ascertaining the amount of constituent substance in a sample, e.g. acids, by using a standard counter-active reagent, e.g. an alkali (NaOH).

Once the acid level in a sample has been determined it can be used to find the ratio of sugar to acid.

There are two methods specified for the determination of the titratable acidity of fruits:

- Method using a coloured indicator;
- Potentiometric method, using a pH meter, which should be used for very coloured juices.

Material:

A laboratory burette of 25 or 50ml capacity or an automatic burette is used.

- A 10ml pipette
- beaker (250ml),
- a filter (muslin cloth or fine filter)
- An extractor or homogeniser
- A bottle of distilled water.
- **Sodium Hydroxide (NaOH):** The Standard Laboratory solution of 0.1N which is used in the actual titration is considered to be dilute, and can readily be purchased in this form.
- **Phenolphthalein:** This is a 1% w/v solution of phenolphthalein in 95% v/v ethanol which is flammable and toxic if ingested. This is only required for the method using a coloured indicator.

- **Indicator stripes** To check the exact point of neutrality an indicator stripe should be used. Not necessary if pH Meter is used.

To evaluate the lot selected for inspection, take a sample of at least 10 fruits of each size at random from the reduced sample. However, fruits should be free from defects such as sun scorch and pest or disease damage, which may have affected the normal ripening process.

Sample preparation

Depending upon the type of produce, either cut the fruit in half and squeeze out the juice with an extractor or a juice-press e.g. citrus fruits, or homogenise the flesh into a pulp. The juice of all squeezed fruits is mixed.

The skin and solids should not be included; the solids being filtered out through muslin cloth or fine filter extracting as much juice as possible. Use a clean and dry safety 10ml pipette. Draw up 10ml of juice and discharge it into a 250ml beaker. Using another clean and dry pipette draw up 50ml of distilled water and add to the juice in the beaker.

Measurement

Method using a coloured indicator

Add 3 drops of phenolphthalein to the juice/water solution in each beaker from a dropping pipette which is specifically kept for that purpose ensure the tap on the burette is shut and using a funnel pour the 0.1N solution of NaOH into the burette until it reaches the zero mark. Do not spill the solution onto the skin.

Slowly titrate the NaOH into the juice/water solution (with a 25ml burette or an automatic burette). Care must be taken that the NaOH is dropped directly into the solution and does not adhere to the glass, otherwise the reading may be false. While titrating care must be taken

to continually stir the solution in the beaker to keep it thoroughly mixed. This is essential, particularly when the solution nears neutrality. It is important to determine the point of neutrality or the end point of titration very exactly. The phenolphthalein indicator changes very rapidly from colourless to pink and the end point can easily be missed, which will give an inaccurate reading for the test. It is important therefore that towards the end of the titration the NaOH is added a drop at a time.

Using phenolphthalein as an indicator, the point of neutrality is reached when the indicator changes from colourless to pink. The indicator colour must remain stable (persisting for 30 seconds) and be light pink when viewed over a white background. However, the shade can vary depending on the type of juice being tested. If the point of neutrality is missed, i.e. the colour of the indicator is too dark, the test is not acceptable and must be repeated. An indicator stripe should be used to avoid the neutral point of pH 8.1.

- Read the amount of NaOH used (titre) on the burette and record this figure.
- Re-fill the burette for each subsequent test.
- Clean the equipment thoroughly and rinse with distilled water. Detergents must not be used

When testing very acidic juices e.g. lemons and limes a larger amount of NaOH is required. Therefore, when the NaOH reaches the 25ml mark on the scale the burette tube should be recharged as described above. When the end point is reached the various readings are added together and recorded to produce a figure of NaOH used for each titration.

Tomato products - technology of manufacturer of tomato products

Objectives: At the end of this lesson you shall be able to

- state various tomato products
- explain the methods of preparation of tomato juice
- state the precautions to be taken in preserving tomato product.

Tomato:

Tomato has red colour due to lycopene, beta carotene pigment tomatoes have a rich flavor, low liquid content, very soft flesh which break down easily.

Nutritive value of tomato (per 100 gm)

Energy (kcal)	Protein (g)	Fat	Carbohydrate	Cal (mg)	Iron (mg)
23	1.9	0.1	3.6	20	1.8

Tomato contain chemical compounds called enzymes that cause the loss of the colour, loss of nutrients and flavor changes when product are preserve. These enzymes must be inactivated to prevent such reactions takes place. Enzymes are inactivated by the blanching process.

Explain the method of preparation:

General methods involved in the preparation of tomato products

Products:

- 1 Selecting the tomatoes select fresh ripe, deep red tomatoes.
- 2 Wash the tomatoes in running water.
- 3 Blanching.

Blanching:

Blanching is the exposure of the tomato to boiling water or steam for a brief period of time (usually 2 to 5 minutes) The tomatoes must then be drained of the heat water and rapidly cooled in ice water to prevent cooking. Blanching also helps to destroy micro-organisms on the surface of the tomato.

- 4 Place the tomatoes in ice cold water.
- 5 Remove the skin of the tomatoes.

Peeling:

After blanching remove outer layer of tomato removing of outer layer is called peeling

- 6 Peeled tomatoes insert into pulper for pulp extraction.

Pulping:

Extraction of pulp by pulper which separate seeds from the pulp.

Lycopersion esculentum and family solanaceae. Tomatoes is grown both in summer and winter but these grown is winter contain more total solids. Tomato are used to make juice, sauce, ketchup, puree, chutney, paste, soup etc

- 7 **T.S.S. checking:** T.S.S. shows consistency of final product its called end point.

At first take a few drop of semi final product and smear it, refractometer and check reading in the light source.

- 8 **pH Test:** pH shows acidity of product its checked by pH meter. pH meter has a rod which neutralize by distilled water then rod dip in product.
- 9 Sterilize empty bottles and filled bottle.

Filling: To prevent contamination the tomato product passes from the receiving tanks to the filling machine at a temperature lower than 190°F (88°C)

Sterilization:

The aim is complete organism because of the resistance power of heat some micro organism are high which decomposed the product. Process are done at 121°C (250°F) for 15 minutes in autoclave machine.

- 10 Pasteurize filled bottle.

Pasteurization:

Destruction of micro - organism but not all pathogenic. The Process of heating at boiling temperature or slightly below it for a sufficient length of time to kill the micro-organisms which cause spoilage, is called pasteurization

Tomato Juice:

Tomato juice is consumed as refreshing breakfast drink. The varieties with deep red colour and high soluble solids content are selected for juice extraction

FPO Specification:

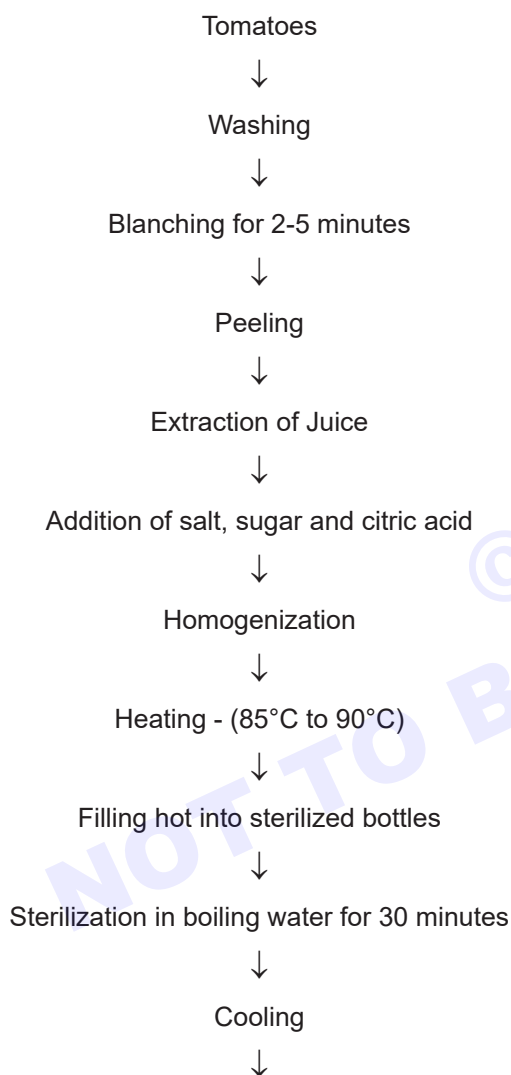
Tomato Juice contain:

- 1 Total soluble solids - 5%
- 2 Permitted additives - salt, sugar, citric acid

Tomato Juice:

Select ripe full mature tomato and remove all undesirable portion such as stem, blemish and over ripe tomato. Properly wash by running water tomatoes are blanched for 2 to 5 minutes and remove outer layer and extract pulp by pulper and add sugar salt, citric acid than homogenize this mixture so that particle become equal in size and can not be separated to each other .Mixture take on heat at 85°C to 90°C for few minutes .when mixture consistency become 5% it remove from heat and filling hot into sterilized bottles this filled bottle are capped and its kept on boiling water for sterilization than cool temperature.

Flow Chart



Storage at ambient temperature cool and dry place

Puree and paste:

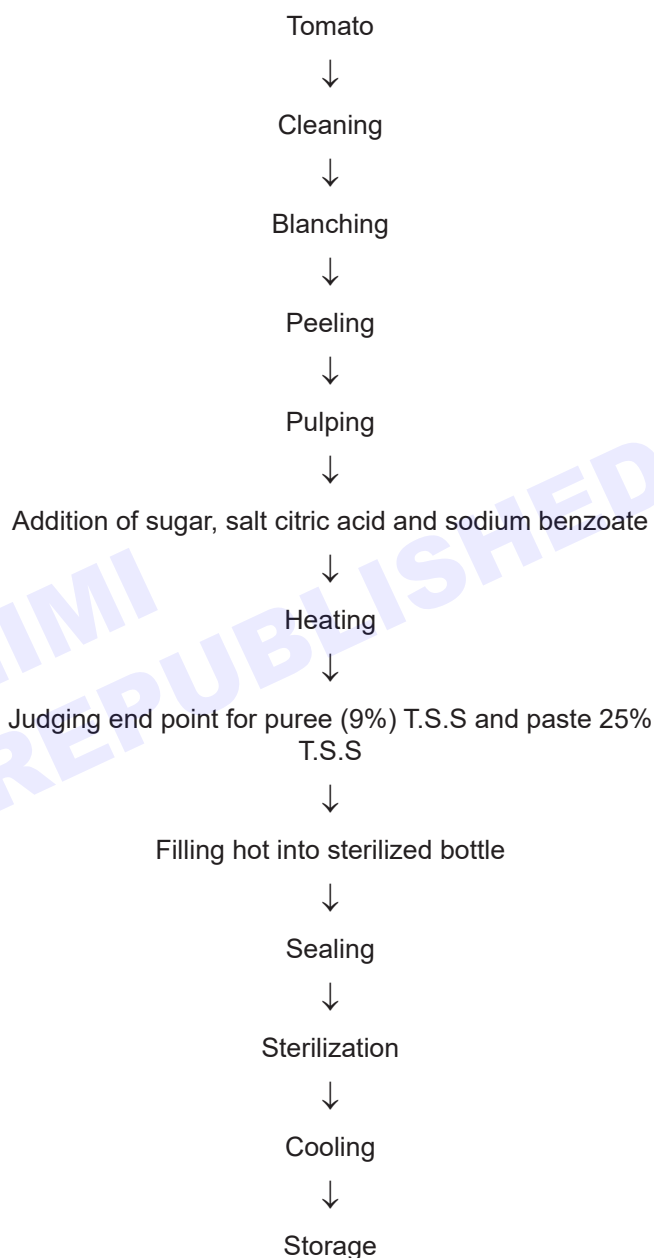
Tomato puree contain a total soluble solid not less than 9% . Tomato puree is the product obtained by evaporation of tomato juice .Tomato paste is manufactured by concentration of tomato juice and it shall contain total soluble solids not less than 25% on salt free basis.

Preparation:

Select ripe full mature tomato and remove all undesirable portion from tomato properly wash by running water

tomatoes are blanched for 2 to 5 minutes and remove outer layer and extract pulp by pulper and add sugar, salt citric acid and sodium benzoate and heating until its consistency become 9% for puree and 25% for paste, its heated to 85-90°C. When obtained end point its remove from heat and filling hot into sterilized bottle and sealing. Sterilize filled bottle in boiling water for 30 minutes, cooled and stored.

Flow Chart



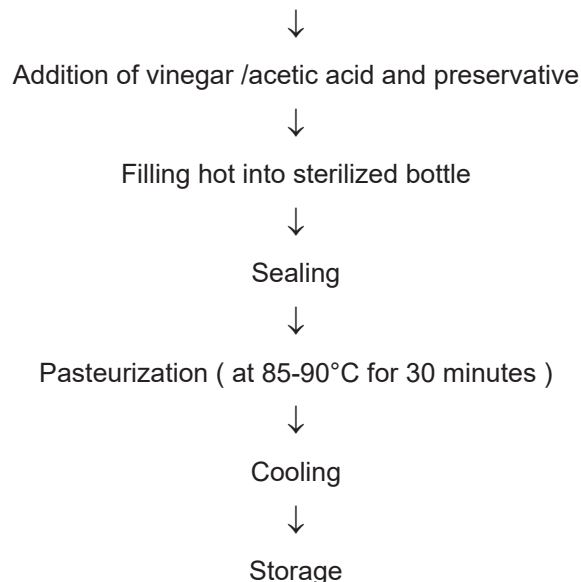
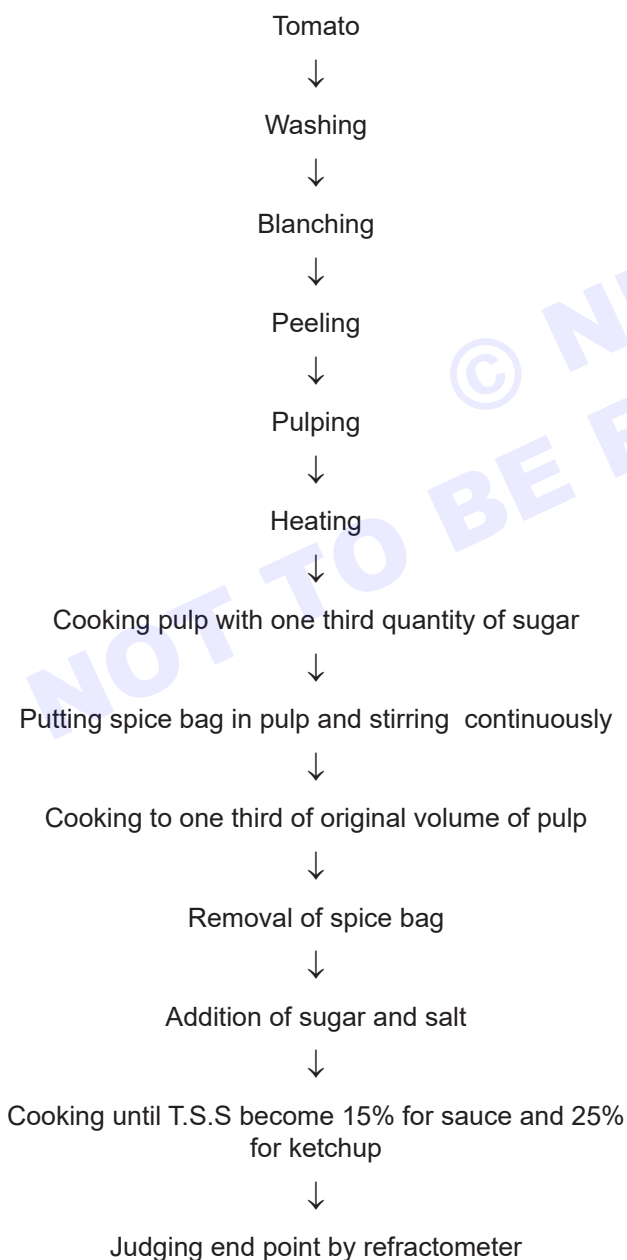
Sauce and ketchup:

There is no more difference between sauce and ketchup. Sauce and ketchup consists of pulp infused with spices. Its clean and sound product mode be concentrating tomato juice with spices, salt, sugar, vinegar with or without onion and garlic. Contains not less than 12% tomato solids. Sauce contain 15% T.S.S and ketchup contain 25% T.S.S acidity not less than 1% and mold count not more than 40% of field examined

Preparation:

Select tomatoes for sauce and ketchup preparation. Wash it by running water and blanch then removing outer layer add clean onion, ginger and garlic with tomato into pulper for pulp. Pulp are kept on the heat. The spices are coarsely ground and tied loosely in a muslin cloth tomato juice is transferred into a steam jacketed kettle along with 4/3 the weight of sugar and spice bag. The juice is boiled with continuous stirring. When the brix of the juice reaches 18% the balance of sugar and salt are added. The spice bag is squeezed and removed. The cooking is stopped when the soluble solids reaches 15% for sauce and 25% for ketchup. Sodium benzoate is dissolved in a small quantity of hot water and added, followed by acetic acid. Sauce /ketchup is filled hot (85°C) into the bottles to the brim and sealed immediately the bottles are pasteurized then cooling and store at ambient temperature.

Flow Chart



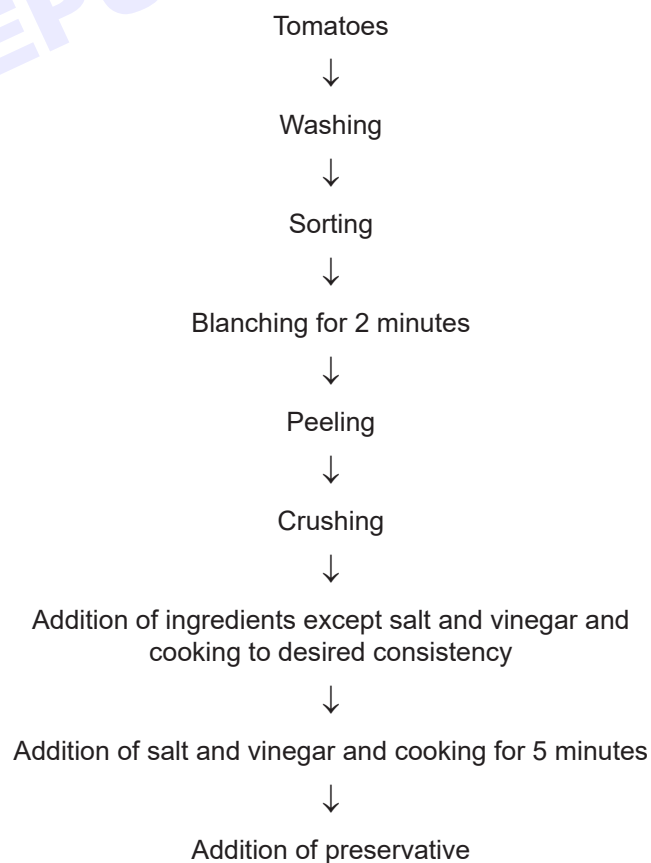
Tomato Chutney:

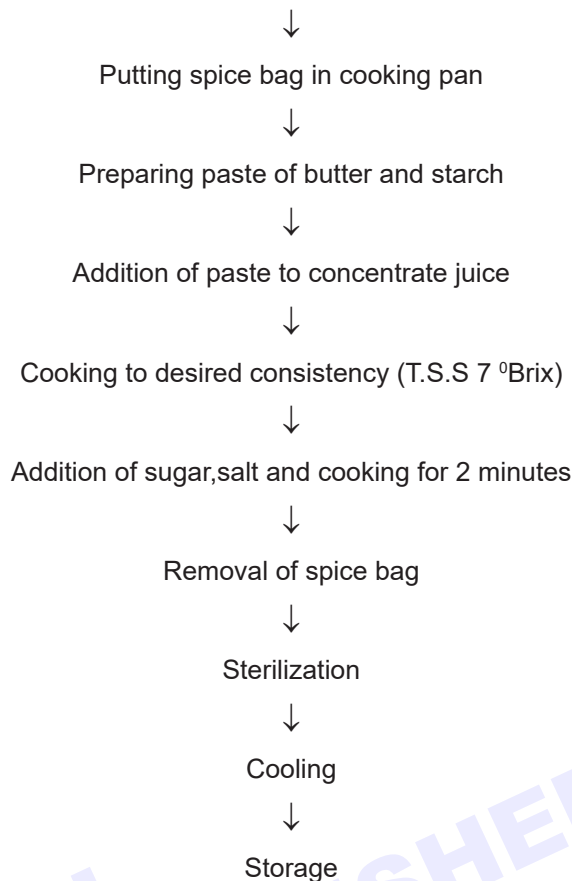
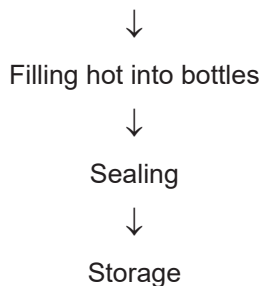
Tomato chutney prepared by whole tomato or tomato puree. It contain 50% T.S.S

Preparation:

Take full mature tomatoes and washing with running water. Remove stems and all undesirable portion from tomato. Tomatoes are blanch and peel off then crush and addition of ingredients except salt and vinegar and cook for 5 minutes and add preservative. Filling hot into sterilized bottle and sealing store at ambient temperature

Flow Chart





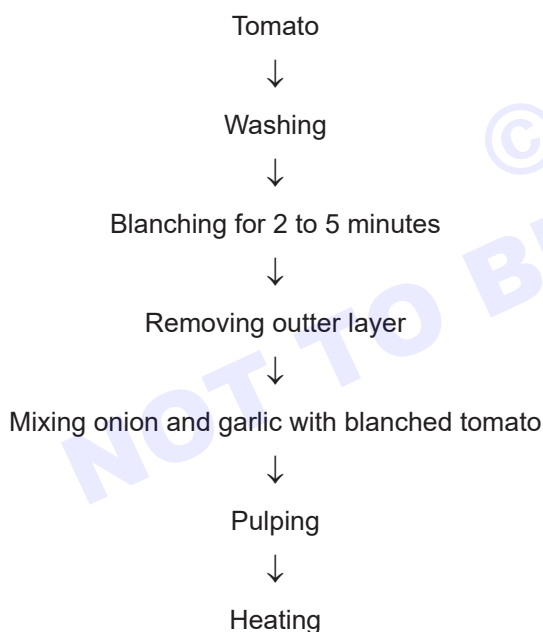
Tomato Soup

Tomato Soup is widely used as an appetizer. It is consumed immediately after the preparation and can be preserved by bottling. It shall contain total soluble solids not less than 7%

Preparation:

Tomato are cleaned,washed and blanch for 2 to 5 minutes. Removing of outer layer. Peeled onion and garlic and mix with peeled tomato and pulped by pulper. Heating the juice and put spic bag in cooking pan. Butter and flour are mixed and make a paste and added to cooking tomato juice. When T.S.S become 7% addition of sugar and salt and cooking for few minutes. Removal of spice bag and filled into sterilize bottle and seal them. Sterilize filled bottle then cool and storage.

Flow Chart :



Precaution:

- 1 Utensils should be clean and sterilize
- 2 All machinery should clean and disinfected
- 3 Apron, gloves, caps etc should be clean and sterilized
- 4 Avoiding prolonged heating and cooling the product quickly
- 5 Percentage of sodium benzoate should not be more than 750 P.P.M
- 6 Not using Iron and copper equipment at any stage of processing because lycopene turns brown. Iron forms black compounds with the tannin and discolored product.
- 7 For sauce and ketchup preparation tomato should be take both types (Juicy and Hybride)

Drying

Objectives: At the end of this lesson you shall be able to

- define the concept of drying
- explain the characteristics of dried fruits and vegetables.

Fruits and vegetables drying

Food Dehydration is the oldest form of food preservation. In the beginning, people used a lot of salt to preserve foods, and they dried their food in the sun or on stove tops. Today we have the food dehydrator to help in the process of drying.

Food dehydration is safe because water is removed from the food, mold and bacteria cannot grow on it; thus it will not spoil. There is, however, a loss of vitamin A and C in dried foods due to heat and air. It usually takes vegetables 6-16 hours to dry, and fruit 12-48 hours. One can dry fruit and vegetables, and make jerky and fruit leather.

General methods of fruits and vegetables drying

- 1 Sun Drying
- 2 Oven Drying
- 3 Electric Dehydrating

Characteristics of dried fruits and vegetables

Dried fruits are a good source of energy because they contain concentrated fruit sugars. Fruits also contain a rather large amount of vitamins and minerals. The drying process, however, destroys some of the vitamins, especially A and C. Exposing fruit to sulfur before drying helps retain vitamins A and C. Sulfur destroys thiamine, one of the B vitamins, but fruit is not an important source of thiamine anyway. Many dried fruits are rich in riboflavin and iron.

Vegetables are a good source of minerals and the B vitamins thiamine, riboflavin, and niacin. Both fruits and vegetables provide useful amounts of the fiber (bulk) we need. Save the water used for soaking or cooking dried foods because this nutrient-rich water can be used in recipes to make soups, sauces, and gravy.

Drying - II

Objectives: At the end of this lesson you shall be able to

- describe the different types of drier
- explain blanching process.

Drier type	Usual food type
Air convection driers	
Kiln	Pieces
Cabinet, tray or pan	Pieces, purées, liquids
Tunnel	Pieces
Continuous conveyor belt	Purées, liquids
Belt trough	Pieces
Air lift	Small pieces, granules
Fluidized bed	Small pieces, granules
Spray	Liquid, purées
Drum or roller driers	
Atmospheric	Purées, liquids
Vacuum	Purées, liquids
Vacuum driers	
Vacuum shelf	Pieces, purées, liquids
Vacuum belt	Purées, liquids
Freeze driers	Pieces, liquids

Blanching

Blanching - exposing fruit and vegetable to hot or boiling water - as a pre-treatment before drying has the following advantages:

- It helps clean the material and reduce the amount of micro-organisms present on the surface;
- It preserves the natural colour in the dried products; for example, the carotenoid (orange and yellow) pigments dissolve in small intracellular oil drops during blanching and in this way they are protected from oxidative breakdown during drying;
- It shortens the soaking and/or cooking time during reconstitution.

During hot water blanching, some soluble constituents are leached out: water-soluble flavours, vitamins (especially vitamin C) and sugars. With potatoes this may be an advantage as leaching out of sugars makes the potatoes less prone to turning brown.

A suitable water-blanching method in traditional processing is as follows:

- The sliced material is placed on a square piece of clean cloth; the corners of the cloth are tied together;
- A stick is put through the tied corners of the cloth;
- The cloth is dipped into a pan containing boiling water and the stick rests across the top of the pan thus providing support for the cloth bag.

The average blanching time is 6 minutes. The start of blanching has to be timed from the moment the water starts to boil again after the cloth bag has been dipped into the pan. While the material is being blanched the cloth bag should be raised and lowered in the water so that the material is heated evenly.

When the blanching time is completed the cloth bag and its content should be dipped into cold water to prevent over-blanching. If products are over-blanching (boiled for too long) they will stick together on the drying trays and they are likely to have a poor flavour.

Green beans, carrots, okra, turnip and cabbage should always be blanched. The producer can choose whether or not potatoes need blanching. Blanching is not needed for onions, leeks, tomatoes and sweet peppers. Tomatoes are dipped into hot water for one minute when they need to be peeled but this is not blanching.

Preservation using Dehydration and Drying

Objectives: At the end of this lesson you shall be able to

- explain dehydration and drying
- explain the food drying principles
- explain the after drying procedure
- explain the Packing and storing process.

Dehydration

Dehydration is an alternative to canning (called “bottling” in the UK) and freezing fruits and vegetables. If you have a surplus of fruits or vegetables from your garden, but lack the canning equipment or freezer space, drying may be the right method for you!

Dehydrated foods have a number of advantages: Dehydration is a low-cost way to preserve food that is free from concerns about botulism, the dried foods require less storage space than canned goods, and there's no freezer to keep running.

Food dehydration is both a desirable and appropriate technology for many reasons which include increasing the shelf-life of food without having to use refrigeration, and reducing product size which can maximize storage space. Also, the process of dehydration is used to enhance foodstuffs directly (i.e. jerky, fruit leather) and indirectly (i.e. spices).

Drying or dehydration, the oldest method of food preservation, is particularly successful in the hot, dry climates. Quite simply, drying reduces moisture necessary for bacterial growth that eventually causes deterioration. Successful dehydration depends upon a slow steady heat supply to assure that food is dried from the inside to the outside. Drying is also an inexact art. Size of pieces, relative moisture, and the method selected all affect the time required to dehydrate a food adequately.

Dehydration requires the removal of most of the water from the food using a drying technique involving air circulation and low levels of heat.

Sometimes a fan is used but more often the circulation is produced by the simple effect of rising warm air. Most dehydration units have an electrical element in the bottom to produce the heat. The unit is vented at the bottom and

top. The hot air rises passing around and through the foods, which are placed on screens to allow maximum circulation.

To insure adequate dehydration the foods are generally prepared for the drying process by slicing them very thin. The warm air picks up moisture from the food and carries it out the top of the unit, while cooler and dryer air flows in from the bottom.

For best results the temperature should be raised very gradually over a period of hours. Otherwise the outside of the food could become dry, locking the moisture in the inside and preventing the food from drying completely.

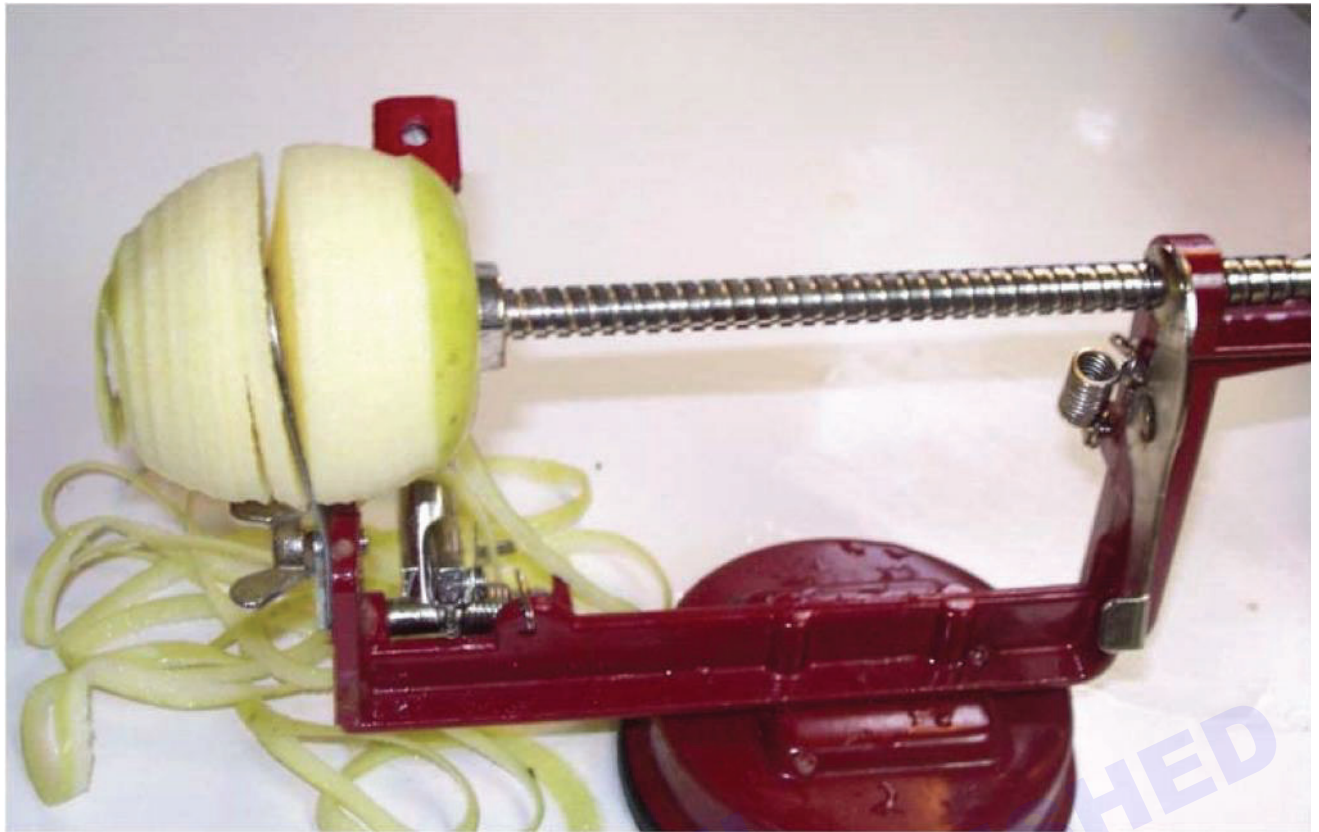
Inexpensive food dehydration units for home use are readily available and are very effective. Solar energy also works very well as a heat source for dehydrating foods, and many foods are dried simply by placing them out in the open air in a sunny location (preferably with some protection against insects.)

Dehydrated foods do not require refrigeration. Without moisture the microorganisms that are responsible for food spoilage cannot grow. Care must be taken to insure that most of the water is removed or spoilage, usually from mold, could become a problem.

The thinly sliced fruits or vegetables are placed on the screens in single layers, with no overlap, which allows for maximum air circulation. The temperature is set at the lowest setting at first and then gradually increased over the next few hours to prevent the outside of the fruit from drying first, locking moisture on the inside. The fruit or vegetable must be dried all the way through for proper preservation and storage preparation.

The dried fruits and vegetables are cooled to room temperature and then place in airtight containers such as plastic bags or glass jars. Glass jars could break in

Fig 1



an earthquake so plastic storage containers may be preferable

Dehydrated foods will keep for a year or longer when stored in airtight containers or plastic bags. The dryer the food the longer it will store. As with all preservation techniques some nutritional value is lost during the drying process, but dehydration remains one of the best ways to prepare food for storage without refrigeration or sterilization. Dried foods are light and compact making them ideal for back packing and food storage. Dehydrated foods by soaking them in water for a few hours before using them, but most dehydrated fruits are eaten as-is. Dehydrated vegetables are great for soups and stews.

It is not necessary to peel fruits before dehydrating them, but peeled fruits will dry faster. This handy countertop apple peeler also cores the apples and slices them into very thin and uniform slices for dehydration. Also can use it to slice and core your apples without peeling them. Thin and uniform slices will dry quicker and more efficiently.

Food Drying Principles:

Dehydrating your own produce does require time and some knowledge of food drying principles.

The main principle behind food dehydration is simple: to remove an ample quantity, or the majority (depending on the desired product), of water content from food products. Since the water content of foods is high, 80-95% in many fruits/vegetables and 75% or less in meats, the product weighs much less, and its volume is reduced. Also, without water, the food becomes an unfavorable medium for the growth of bacteria or fungi. If dehydrated

when ripe, determined from a nutritional standpoint, the maximum quantity of nutrients can be preserved.

Food dehydration has traditionally been done by simply laying food out in the sun to dry, climate/weather permitting. With the right food, in the right conditions, there may be little need to improve upon this simple setup. However, there are a handful of reasons people have sought other ways to dehydrate their food. Some practical reasons include avoiding the risk of exposing the food to animals which could take and eat the food, or insects which may want to lay eggs in it. A more scientific reason would be to avoid nutrient degradation that would occur from prolonged exposure to the sunlight. In addition, there exists the potential of wrongly interpreting/predicting the weather and having spoilage from rain or lack of sun.

Foods may be sun dried with or without a solar dehydrator, in a gas or electric oven, or with a portable electric dehydrator. Dehydrators with thermostats provide better control over poor weather conditions and food quality than sun drying. An effective solar dehydrator is the shelf above the back seat of a car. Clotheslines are another popular drying rack for ears of corn and strips of jerky.

Sun drying:

Prepared foods are placed on drying trays. Stainless steel screening and thin wood lath are good materials for home-constructed drying trays. Do not use galvanized, copper, fiberglass, or vinyl screening. Aluminum screening reacts with acids in the fruit and is less desirable.

Fig 2



Trays measuring about 14" x 24" x 1" are an easy size to handle. If trays are to be used in an oven, they should be 1 1/2" smaller in length and width than oven shelves to allow air circulation. Place trays of food away from dusty roads and yards. Elevate them at least 1" above the table with spools or bricks to allow good air circulation below the food. Cover the food with a muslin or cheesecloth tent to protect it from insects.

Dry fruits and meats in direct sunlight; move trays periodically to assure direct sun exposure. Place vegetables in the shade to prevent excessive color loss. If rain threatens or food requires more than one day to dry, cover with a waterproof material or place the food in a sheltered area.

To destroy insects or their eggs that may be on sun-dried foods and to remove additional moisture in thicker pieces, heat foods in a 150 °F oven for 30 min.

Oven drying:

Either build trays as described for sun drying or convert oven racks to drying racks by stretching muslin or cheesecloth across the oven rack. Secure with toothpicks or long sewn stitches. Alternate trays in the oven periodically to assure even drying.

Set oven control at its lowest setting, but not below 140°F-150°F. If using an electric oven, wedge a potholder between oven and door to allow a 1 opening. Moisture from the drying food will vent through this opening. Close the door on a gas oven, as into vent will permit moisture to escape.

Dehydrators:

There are two types of dehydrators: solar and electric. For each type of dehydrator, prepare food and place on racks.

If using a solar dehydrator, adjust the position of the food throughout daylight hours to keep in direct sunlight.

The modern food dehydrator is designed to produce hot air and distribute it equally inside a light-less chamber or cabinet. Included in this design is the control of the air's temperature and the duration of hot air distribution. As a result, many modern food dehydrators rely on electricity, rather than the Sun, to create and distribute hot air in a uniform and uninterrupted fashion.

Food Preparation :

While the actual process of dehydrating food is hands-free, some minor preparation is (usually) recommended. Also, when dehydrating meat, curing is the last step.

Preparation

- 1 Some foods should be washed before drying. Foods such as herbs, berries and seedless grapes need only be washed before dehydrating.
- 2 Keep pieces uniform in size and thickness for even drying. Slices cut 1/8 to 1/4-inch in thickness will dry more quickly than thicker pieces.
- 3 Prepare foods to be dehydrated as you want them to be served. Apples, for example, may be sliced, cut into rings, or pureed for fruit leather.
- 4 Select the best fruit and vegetables. As with canning and freezing, dehydrated foods are only as good as the fresh fruit or vegetables. When selecting fruits and vegetables for dehydration, choose ones that are ripe, unbruised and at peak-eating quality.
- 5 **Vegetables:** Choose tender vegetables. Wash, remove any damaged areas, and cut into even pieces. Blanch, then chill as though preparing for the freezer.

- 6 **Blanching Vegetables:** To make re-hydration easier, vegetables that have hard cell structures are blanched so that they are slightly softened. Vegetables that may need this treatment include: beans, broccoli, carrots, cauliflower, celery, and peas.

Do not blanch mushrooms, onions, or sweet peppers. To blanch in boiling water, use one pound of food for each gallon of boiling water. Immerse vegetable into the boiling water using a wire basket or mesh bag, cover kettle, and boil for about 5 minutes. Blanching water may be reused until it becomes cloudy. Drain vegetables thoroughly. To steam blanch, place 1" of water in kettle and bring to a rolling boil. Suspend thin layer of vegetables in basket or loose cheesecloth bag. Cover and steam blanch around 5 minutes as well.

- 7 **Fruit:** Choose firm, mature fruit. Wash, peel if desired, remove any damaged areas, and cut into even-sized pieces or slices. Some fruits require little or no pretreatment. However, pretreat apples, apricots, bananas, cherries, peaches, and pears by one of the following methods to reduce vitamin and flavor loss, browning, and deterioration during storage. Immerse fruit in a solution of one of the following to a gallon of water: 1 tbsp of sodium bisulfate or 2 tbsp of sodium sulfite or 4 tbsp of sodium metabisulfite. These pretreatment mixtures are available from some grocery stores, pharmacies, and wine-making shops.

Fig 3



Soak fruit pieces for 5 min. and fruit halves for 15 min.

Approximately 5% of asthmatics are sensitive to sulfites. Use one of the following pretreatments if sulfites present a potential health problem

- 8 Steam blanch fruit for 5-6 min.; water blanch fruit for 4- 5 min. Dip prepared fruit in a saline solution composed of 2-4 tbsp of salt and 1gallon of water for 10-15 min.
- 9 **To prevent browning:** Acidify or add sugar to fruit. In order to preserve vitamin content and avoid browning fruits such as apples, lemon juice, which contains citric acid, may be applied to the fruit's exposed surfaces or dip fruit in a commercial ascorbic acid/water

mixture from the grocery store. Follow manufacturer's instructions when preparing and using the solution.

Try steaming, sulfuring or coating light-colored fruits and vegetables with acids such as lemon juice or ascorbic acid (FruitFresh) before drying. Steaming or blanching also is recommended for vegetables to inactivate enzymes that cause vegetables to mature, or toughen during drying. However, most fruits don't require this.

- 10 **Curing Meat:** In order to kill any potential bacteria left in the meat after dehydration, the meat is cured by placing it in a warm oven (160 °F) for 1 hour.
- 11 **Meat :** Choose lean cuts of beef or venison. Partially freeze and remove all visible fat. Slice with the grain of the meat into strips, 1" wide, 1/2" thick and 8-10" long. Pound strips flat to tenderize and season with salt, chili, or other desired flavors. Marinate and keep in a cold place for additional tenderness and flavor. Popular marinades include teriyaki, sweet and sour, soy, Worcestershire, and chili sauces.

Fig 4



During Drying

- 1 Select the drying method and equipment that is right for you. Foods can be dried in a conventional oven, a commercial dehydrator, or in the sun. Drying times vary with the method and foods chosen. Be sure to read the instructions with your dehydrator.
2. Maintain 130 °F to 140 °F with circulating air: Remove enough moisture as quickly as possible to prevent spoilage. A drying temperature of 130 degrees F to 140 degrees F allows moisture to be removed quickly without adversely affecting food's texture, color, flavor and nutritive value. If the initial temperature is lower, or air circulation is insufficient, foods may undergo undesirable microbiological changes before drying adequately. If the temperature is higher, or humidity too low, nutrients can be lost or moisture may be removed too quickly from the product's outer surface. This causes the outer surface to harden and prevents moisture in the inner tissues from escaping. When testing for sufficient dryness, cool foods before testing.
- 3 Know when your food is dry: Some foods are more pliable when cool than warm. Foods should be pliable and leathery, or hard and brittle when sufficiently dried. Some vegetables actually shatter if hit with a hammer. At this stage, they should contain about 10 percent

moisture. Because they are so dry, vegetables do not need conditioning like fruits.

After Drying (for fruit only)

- 1 Allow dried FRUIT (not vegetables) time to “condition”: When dry, allow fruit to “condition” for four to 10 days before packaging for storage. The moisture content of home dried fruit should be about 20 percent. When the fruit is taken from the dehydrator, the remaining moisture may not be distributed equally among the pieces because of their size or their location in the dehydrator. Conditioning is the process used to equalize the moisture. It reduces the risk of mold growth.
- 2 To condition the fruit, take the dried fruit that has cooled and pack it loosely in plastic or glass jars.
- 3 Seal the containers and let them stand for 7 to 10 days.

The excess moisture in some pieces will be absorbed by the drier pieces.

- 4 Shake the jars daily to separate the pieces and check the moisture condensation. If condensation develops in the jar, return the fruit to the dehydrator for more drying.

After conditioning, package and store the fruit as described below.

Packaging the dried foods

- 1 **Seal the dried food:** Dried foods are susceptible to insect contamination and re-adsorption of moisture and must be properly packaged and stored immediately. First, cool completely. Warm food causes sweating which could provide enough moisture for mold to grow. Package dehydrated foods in tightly sealed containers, such as moisture-proof freezer containers or polyethylene bags, or dark scalded (sterilized) glass jars.
- 2 **Choose the right containers:** Glass jars, metal cans or boxes with tight fitted lids or moisture-vapor resistant freezer cartons make good containers for storing dried foods. Heavy-duty plastic bags are acceptable, but keep in mind that they are not insect and rodent proof. Plastic bags with a 3/8-inch seal are best to keep out moisture.
- 3 Fruit that has been sulfured should not touch the metal.

Place the fruit in a plastic bag before storing it in a metal can. Sulfur fumes will react with the metal and cause color changes in the fruit.

- 4 Pack as tightly as possible without crushing.
- 5 Pack food in amounts that will be used in a recipe. Every time a package is re-opened, the food is exposed to air and moisture that will lower the quality of the food.

Test for Dryness

Rely on appearance and feel to judge dryness. Cool a test handful a few minutes before deciding whether the

food is done. Consider fruit dry when no wetness can be squeezed from a piece which has been cut - it should be rather tough and pliable. Consider vegetables dry when brittle.

Storing the dried foods

- 1 Store in a cool, dark, dry place. Food quality is affected by heat. The storage temperature helps determine the length of storage; the higher the temperature, the shorter the storage time. Most dried fruits can be stored for 1 year at 60°F, 6 months at 80°F. Vegetables have about half the shelf-life of fruits.
- 2 Use foods within six to 12 months for best quality.
- 3 Check dried foods frequently during storage to see if they are still dry. Foods that are packaged seemingly “bone dry” can spoil if moisture is reabsorbed during storage. Glass containers are excellent for storage because any moisture that collects on the inside can be seen easily. Foods affected by moisture, but not spoiled, should be used immediately or re-dried and repackaged. Moldy foods should be discarded.

Pre-drying and post-drying treatments for fruits and vegetables

Steam blanching is safe pre-treatment which can prevent spoilage - especially of low acid foods such as vegetables.

Important post-drying treatments are:

- **Conditioning** - i.e. leaving in open air for long periods to equalize moisture content.
- **Pasteurizing** - i.e. exposing the dried foods to high heat to eliminate harmful organisms

Preparing for Eating:

Fruits: Cover with boiling water in saucepan and simmer the fruit covered for 10-15 min. Sweeten to taste at the very end of cooking. Remove from heat and cool still covered.

Vegetables: Soak all vegetables except greens in cold water until they are nearly restored to their original texture. Use only enough water to cover and always cook in the soaking water. Cover greens with enough boiling water to cover and simmer until tender.

Electric Food Dehydrator:

To serve as a control and as a reliable counterpart for comparison, a conventional electric food dehydrator was obtained and used. It pros and cons were evaluated from experience.

Pros :

- Reliable o Easy to use

Cons

- High Electricity Demand (350W-1000W or more)/High Operating Cost
- Impractically expensive for a small farm to consider using
- Small loads are also unreasonable at this operating cost, for anyone

Jam, jelly & marmalade

Objectives: At the end of this lesson you shall be able to

- define the content of jam, jelly and marmalade
- explain the preparation method of jam, jelly and marmalade
- explain the pectin content
- difference between jam and jelly.

Introduction

Among preserved fruit jam, jellies and marmalades form an important class of product. Manufacture of these product is one of the oldest and important of fruit product industries.

Definition

Jam : Jam is prepared by boiling the fruit pulp with sugar to a moderately thick consistency without retaining the shape of fruit. The finished product should contain not less than 68% T.S.S (Total soluble solid).

In its preparation about 45 part of fruit should be used for every 55 part of sugar.

Jelly : Jelly is prepared by boiling with or without water expressing and straining the Juice, adding sugar and concentrating to such consistency, that gelatinized take place on cooling. It should contain not less than 65% T.S.S (Total soluble solid)

A perfect jelly should be transparent and retain its shape when removed from the mould. When it is cut, should retain its shape and show a clear cut surface. About 45 part of fruit juice and fruit pulp extract should be used for every 55 part of sugar.

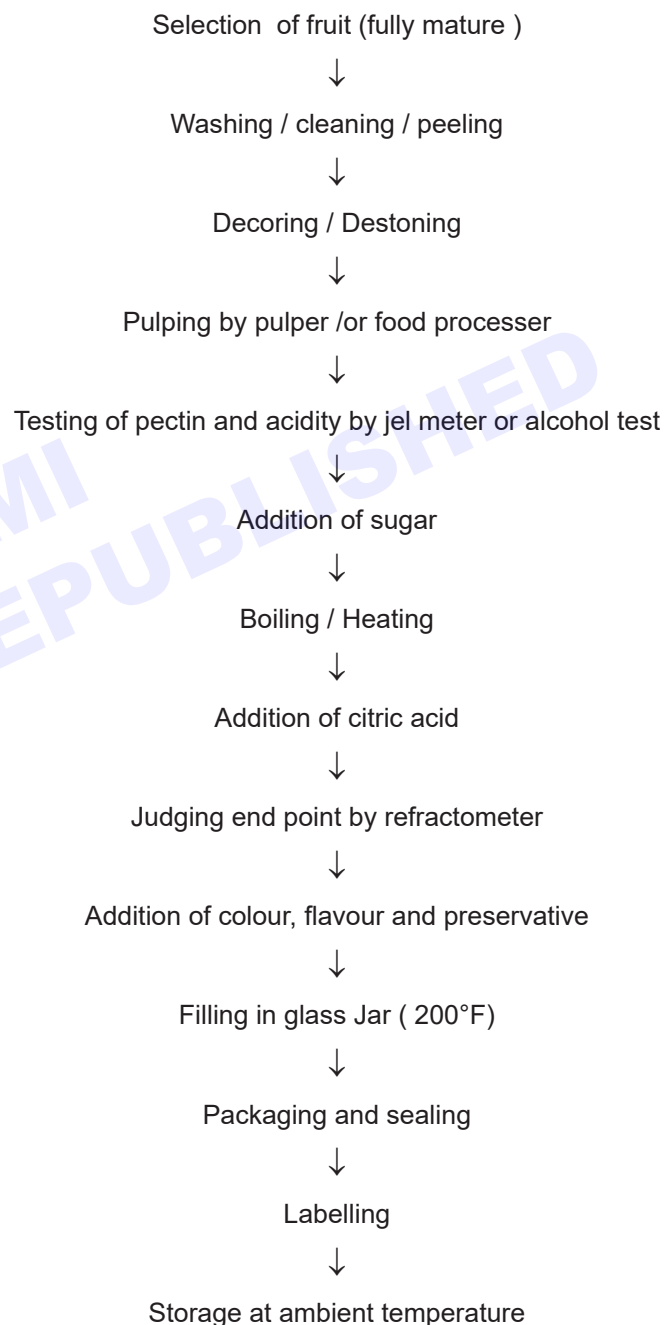
Marmalade is jelly like product in which the shread or slice of the fruit or the peel are suspend.

Principle of Jam, jelly and Marmalade

Three substance are essential for the preparation of fruit jam or jelly. These are pectin, acid and sugar. Gel formation is a colloidal phenomenon influenced by the concentration and constitution of pectin. Size of pectin molecule, hydrogen ion concentration and sugar concentration. The combinations of high solid content and low pH of these product prevent the development of spore forming bacteria and assure long keeping qualities.

Principle of use of mild antiseptic : Mild anti septic material such as sugar, salt, vinegar, spices and chemical preservative are inactive those micro organism which is present in food product which decompose of food product.

Flow digram or flow sheet of Jam processing



Selection of Fruit

Fresh fruit are rich in pectin and flavor are more suitable and also pulp preserved by any known method of food preservation can be used.

Washing /cleaning / Peeling: Fruit and vegetable are washed with water to remove dust, insect, mold spores, plant part and any other foreign materials. Spray washing and through washing is essential for good result. Fruit and vegetable are washed either by drum or agitation in water by compressed air. Spray washing is more efficient than other.

Peeling: After washing and cleaning some fruit require removing of outer layer before pulping its called peeling. One of the following

- 1 Hand peeling or manual
- 2 Peeling by heat or blanching
- 3 Mechanical peeling
- 4 Lye peeling
- 5 Acid peeling

1 Hand Peeling: Stainless steel knives are used for peeling of fruit. Special knives with curved blade with and adjustable guide to limit the depth of peel are available. It is method has several advantages but in involve high labour costs.

2 Peeling by heat: Boiling water or steam loosen the peel of some fruit and vegetable such as peaches, tomato, potato. The loosened skin can be easily peeled from the fruit by hand.

3 Mechanical peeling : Apple, carrot, potato etc are peeled by machine. Mechanical peelers consisting of a cylinder inner walls of which and the bottom are coated with carborandum and abrasive material. During its circulate water is sprayed in it to cylinder washing away the better peeling facilities the peeling process.

4 Lye peeling: 1-2% Boiling caustic soda solution (Lye) for 30 seconds to 2 minutes depending on their nature and maturity. Such as apricots, peach, sweet orange, mandarin.

5 Acid peeling: Fruit are dipped in hot 0.05% oxalic acid, 0.1% citric acid and 0.1% tartaric acid. Acid removed the peel during and through washing remove excess acid.

Cutting: Washing of fruit remove excess acid. Fruit are cut by knives.

Decoring /Destoning: Removing unwanted and unedible portion of fruit and vegetable. Its called decoring or destoning.

Pulping: Pulping is done by pulper

Testing of pectin: About 0.6 to 1.0% pectin is essential of give proper set to the product.

Alcohol test: Take 5ml extract in a spirit test beaker add to 10ml spirit or alcohol by the side of beaker, shake it slowly. Allow it to settle for 2 minutes. Pectin will clots it is not soluble in alcohol.

- 1 Extract rich in pectin form a single, transparent lump means equal quantity of sugar is added to the extract
- 2 Extract contain moderate amount of pectin form the clot will be less firm and fragmented means 3/4 amount of sugar is to be added to the extract.
- 3 Extract contain poor amount of pectin form a numerous small granular clot means 1/2 amount of sugar is to be added to the extract.

Jel Meter Test: A jel meter is a graduated glass tube with an opening at each end. It is used to determine the amount of pectin in fruit juice. The rate of flow of the juice through this tube is used as a measure of jellying power of the juice therefore it is a index to the amount of sugar to be used.

Addition of Sugar: Generally pure cane sugar is used. The finished jam should contain 32-50% invert sugar to avoid crystallization of cane sugar, If necessary glucose syrup is added.

Boiling: Addition of sugar and heating cooking is carried out in steam jacketed pans, made from metal, aluminium, stainless steel or copper heavily coated with tin.

Addition of citric acid: Generally citric, malic or tartaric acid are used to supplement the acidity of fruit pulp. Acid concentration of 0.5 to 1% in the final product.

End point or Judging point

Refractometer : It is necessary to cool the sample of jam or jelly to room temperature 20°C (68°F). A small portion of boiling. Jam is removed and placed in a suitable metal container which is closed and submerged in cool water. When the sample has cooled it is mixed thoroughly and smeared over refractometer prism. Then the reading is taken. During that time the jam continues cooking so the sample reading should be performed relatively fast in order not to over cook the preserve.

Addition of colour flavor preservative

Colour: Only permitted edible colour should be added end of the cooking period

Flavour: Addition of flavor according to the product. These should be added the end of the cooking period.

Preservative: Preservative is used not more than, SO₂ is 40 ppm and sodium benzoate is 200 ppm

Filling / Packing / Sealing: After end point is reached the product is allowed to cool to about 200°F and filled in to jars at this temperature mechanically or manually sealing and labeling properly.

Storage: Storage it ambient temperature

Jam and jellies are made from fruit pulp and fruit extracts. It is not necessary to peel the fruit. Fruit like orange or lemon need peeling fruit are cut in to thin slices to flavor better extraction.

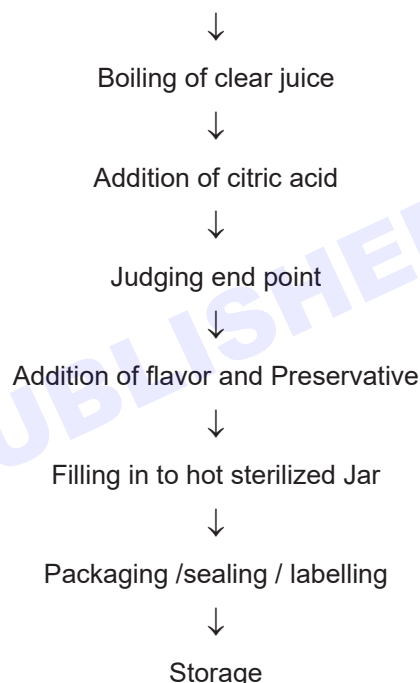
Specification of Jam, jelly, and Marmalade

S.No.	Product	T.S.S Mimium	Fruit Content Mimium	Acidity Max	Preservative SO ₂ /Sodium Benzoate Maximum
1	Jam	68%	45	0.5 - 1%	Not more than 40/200 ppm
2	Jelly	65%	45	0.5 - 1%	Not more than 40/200 ppm
3	Marmalade	65%	45	0.5 - 1%	Not more than 40/200 ppm

List the step of different type of Jam

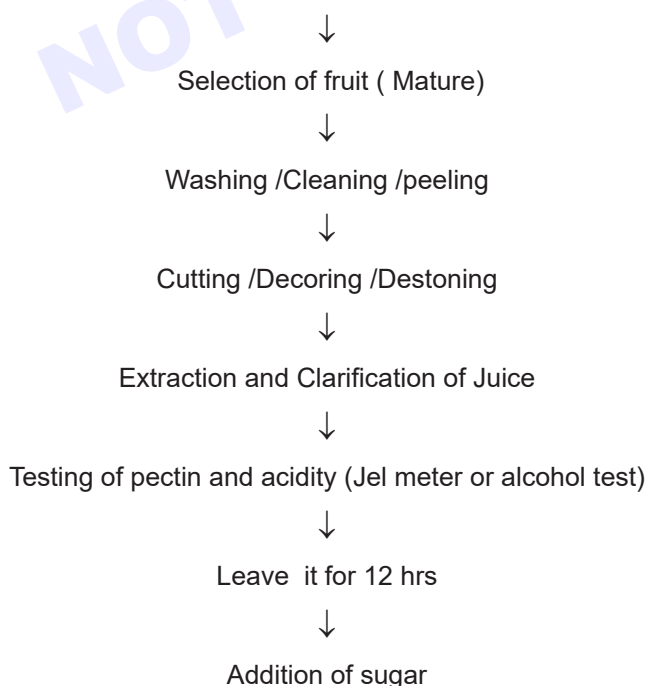
- 1 **Apple:** Select fruit - washing - Cleaning - Decoring - cut into pieces - Pulping.
- 2 **Pine apple:** Select fruit - Peeling - Washing - Pulping
- 3 **Mix and fruit Jam:** Straining - Select - Washing - cleaning - Decoring - Cutting - Pulping
- 4 **Guava:** Select fruit - Washing /cleaning / cut into pieces
- 5 **Pampkin:** Select fruit - Peeling - Washing - Cleaning - cut in to pieces - pulping

There are require good hygiene packaging with odour and chemically resistance materials can be packed in poly propylene. PET (Polyester) container and pouch make by metalized PET with HD- LDPE and foil laminates



Jelly Preparation :

Common flow sheet of Jelly processing



- 1 Selection of fruit - Same as jam method
- 2 Washing /cleaning/peeling - Same as Jam method
- 3 Cutting /Decoring /Destoning - Same as Jam method

Extraction and Clarification :

That is major difference between Jam and jelly preparation. In jelly processing a clean extract of the fruit is taken and cook with sugar. After cooking the cooked pulp is pressed in any mechanically extractor. The extract is clarified by passing it through bags made by linen flannel felt or cheese cloth folded several layers/jelly filter bag, because Jelly is transparent product.

Testing of pectin and acidity: Same as jam

Pectin Extraction: Extract leave it for 12 hrs for extraction of pectin

Addition of Sugar: The quality of sugar to be added is directly proportional to the amount of pectin and acid present in extract. As the pectin content of fruit very different quantities of sugar would be needed for different

types of fruits. If the extract is rich in pectin one kg of sugar per kg of the extract is added.

Addition of citric acid: Same as Jam method

Packaging /sealing /Labelling: Same as Jam method

After filling the containers cool, about 70°F for proper setting of the jelly

Marmalade: Generally the marmalades are prepared from citrus fruit, during the preparation of marmalade pectin and acid contents in marmalade should be slightly higher than of jellies. The difference between jelly and marmalade is only in suspended of fruit slices or fruit peels in marmalade. Good suspension material such as sweet orange and malta peels.

Flow sheet or flow digram of Marmalade Processing

Selection of fruit (Mature and Juice)



Washing /cleaning /peeling



Extraction and clarification of juice



Testing of pectin and acidity



Leave it for 12 hrs



Addition of sugar



Boiling of clean Juice



Prepare of peels



Addition of citric acid



Judging end point



Addition of flavor and prepared peels



Fill into hot sterilized jars



Packaging /sealing /labelling



Storage

Preparation of peels :

The peels are cut in to shred 3/4 inch to 1 inch long and about 1/32 in to 1/20 inch thick they are soften by boiling in 0.25% solution of sodium carbonated or in water for 10 to 15 min. Then cooked peel is then added to the jelly toward the end of the boiling period.

In the preparation of marmalade all the conditions necessary for jelly making are applicable. The pectin and acid contents of the marmalades should be kept slightly higher than jellies. The difference is only is that there will be suspensions of fruit slices or fruit peels in a marmalade.

Difference between Jam and Jelly

S.No	Qualities Parameters	Jam	Jelly
1	Preparation	Jam is prepared by fruit pulp and sugar	Jelly is prepared by fruit extract and sugar
2	T.S.S	Finished product should contain not less than 68%	Finished product should contain not less than 65%
3	Appearance	Jam is clear but not transparent	Jelly is transparent and attractive
4	Colour	Add colour	Colour is not added
5	Viscosity	Jam is not viscous	Jelly is more viscous than Jam

Failure to set or defect of jam

- 1 Pectin is an important constituent in jam making, if the quantity of pectin is low or insufficient quantity
- 2 If the boiling temperature is not attained during jam preparation
- 3 If the optimum conditions like pH and TSS (Total Soluble Solid) not maintained
- 4 If it is cooked for long time, pectin breaks down and more inversion of sucrose causes glucose crystallization.

5 If cooked for a short time inversion causes crystallization of sucrose.

Problem in jelly making

Lack of acid or pectin: Lack of acid or pectin, or of both, in the fruit used or insufficient cooking of the fruit slices resulting in inadequate extraction of pectin and acid.

Addition of too much sugar: It results in a syrupy or highly soft jelly which can be corrected by addition of sufficient quantity of fresh strained extract rich in pectin.

Cooking below the end-point: If the cooking is stopped before the percentage of total soluble solids reaches 65, the jelly may remain syrupy and highly soft.

Prolonged cooking: In the presence of acid the coagulating property of pectin is destroyed if it is heated for a long time, hence prolonged heating should be avoided

Jelly become cloudy or foggy if use non-clarified juice or extract to make jelly.

Use of immature fruits: Green, immature fruits contain starch which is soluble in the juice and therefore, gives it a cloudy appearance

Over-cooking: Such jellies are gummy or sticky on account of their high viscosity and do not become clear after pouring into containers.

Non-removal of scum: The jelly becomes cloudy when the scum is not removed before pouring

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Packaging materials

Objectives: At the end of this lesson you shall be able to

- explain types of packaging material
- explain the packaging merits and demerits.

Glass container

Glass containers are made from quartz, sand, soda ash and lime stone. Some compounds are used to give colour such as:

Sl.No	Compounds	Colour
1	Cobalt oxide	Blue
2	Ferrous sulphate or chromium oxide	Green
3	Ferric oxide chromium oxide	Yellow
4	Calcium fluoride	Milky

Glass containers are suitable for those products which are not processed at high temperature. Glass container which neck conical in shape is called bottle and broad is called Jar. It is widely used to package products which are stored long periods.

Merits of glass container

- 1 Its does not contaminate food materials
- 2 Contents being visible can be easily displayed
- 3 Glass is easily formed into almost any shape
- 4 Its can be reused.

Tin container

Tin cans are made of thin steel plate of low carbon content lightly coated on both side with tin metal steel plate are made of carbon, sulphure, phosphorus, copper, manganese and silicon.

Types of Plastics:

S. No.	Types	Characteristics
1	Cellulose film or cellophane	Transparent flexible, heat resistant gas resistant (In dry)
2	Cellulose acetate	Resistant to heat and moisture
3	Polyethylene	It is available in three density. High density packaging material are used for packaging of fat, oil, gas etc.
4	Polystyrene	Low density
5	Vinyl	Its flexible, soft and shiney, resistant to oil, fat and oxygen
6	Saran (Plastic)	Its protect food material to moisture, contamination
7	Polyester	Resistance to heat

Coating should be properly other wise it cause corrosion which spoiled food material.

Lacquering

Coating of steel plate is called lacquering is necessary for tin container because when content of the can react with these uncoated spots resulting in discoloration of the product or corrosion of the tin plate.

Types of lacquering

- 1 Acid - resistant
- 2 Sulphur - resistant
- 1 **Acid – resistant:** Acid resistant lacquer is a golden coloured enamel and cans coated with it are called R-enamel means its suitable for packing acid fruits.
- 2 **Sulphur – resistant:** This lacquer is also of a golden colour and cans coated with it are called C-enamel its suitable for non- acid foods.

Merits of can

- 1 Light weight
- 2 Easy to handling
- 3 Low cost
- 4 Can be handled by high speed machines

Plastics

Plastic packaging material are usual both form like pouches and bottles.

Aluminium foil

Foils are good barriers to gases, vapours and water vapour, foils of thickness 8 to 40 microns are generally used in food packaging, foils are soft and susceptible for creasing, folding and rupture, which effectively reduce their protective qualities.

Hence, foil is generally used as an inner layer.

Understanding the label

After packaging labels are required on finished products for distribution and sale. Label can describe the quality of products label should be clean and informative. The name of and address of manufacturer, ingredients, additives, net weight or volume of the product should be shown on the label. Attractive label helps in the marketing of the products.

Importance of label

Food labels provide nutritional labelling for most foods. The food is designed to help people choose foods for a healthful diet. Food label provide the detail of product like batch No. Date of manufacturing, Date of Expiry, shelf life food label help in the traceability of the product. Food labels, helps in the marketing of the Product.

Labeling requirement

Labelling is the important aspect of food processing. The following information is required on label in both English and local languages.

- 1 Name of the product
- 2 Net weight
- 3 Grade designation
- 4 Lot / Batch/ Code number
- 5 Country of origin
- 6 Name and address of manufacturer
- 7 Best before date
- 8 Date of packing
- 9 Bar code
- 10 Nutrition facts table
- 11 License No.
- 12 Marketing by
- 13 Ingredients

PET bottles

PET means polyethylene terephthalate is one of the most commonly used food grade packing plastics due to its chemical inertness and appealing physical properties.

The PET is derived from oil and is formed by polymerization reaction between an acid and an alcohol.

PET is the material which is mostly used in beverage bottles like water bottles. Its properties as a light weight tough material, with excellent optical properties and adequate gas barrier, flexible

Food Packing

Objectives: At the end of this lesson you shall be able to

- explain about different packing material and its suitability
- explain about the function of packing.

Food packaging is the enclosing of food that requires protection from tampering, whether by physical, chemicals, or biological needs. It also shows the product that is labeled to show any nutrition information on the food being consumed.

Food packaging's functions

Food packaging's functions are as diverse as they are important. They are broken down as follows.

- 1 Containment:** For items that are granulated, paperbased packages are the best with a sealing system to prevent moisture infiltration of the product. Other products are packaged using metal cans, plastic bags and bottles, and glass. Another factor in containment is packaging durability, meaning the packaged food has to survive transport from the packaging at the food processing facility to the supermarket to the home for the consumer.
- 2 Protection:** The packaging must protect the food from biological agents like rats, insects, and microbes; from mechanical damage such as product abrasion, compressive forces, and vibration; and from chemical

degradation such as oxidation, moisture transfer, and ultraviolet light.

- 3 Communication:** Packaged food must be identified for consumer use mainly with label text and graphics. It can also be shown with the food package's shape such as the Coca-Cola bottle or the can of Spam. Other well known food package shapes include the potato chip bags and milk bottles. These packages also detail nutritional information, if they are kosher or halal approved, manufacturer, product size (volume or weightbased), and the Universal Product Code (UPC).
- 4 Functionality:** That the package is easy to use for both manufacturers and consumers. These products can be purchased all at once such as frozen pizza or as part of a larger package such as a twelve pack of beer. Another use may be to see if the package can go through a microwave process such as a TV dinner. Other items included pour spouts already on the bottles are other methods to ease dispensing of the product.

5 Environmental issues: This means that we must be done to reuse the packaging, reducing the size of the packaging, and then recycling of the products to be remanufactured.

6 Package safety: That the package be used for safety of the food from the package or vice versa. This includes any metal contamination issues from a can to the food product or any plastic contamination from a bottle to a food product as well.

Packaging

Objectives: At the end of this lesson you shall be able to

- explain what is packaging
- write about the different packaging techniques.

Packaging

Proper packaging of a product can reduce not only bruising and crushing, but can also improve marketing of produce, reduce moisture loss, prevent (re-) contamination of the product with spoilage organisms, reduce pilferage, maintain a sanitary environment during marketing. All aspects of packaging must be taken into account when considering the introduction of new packaging. These aspects involve, among others, cost of packaging material, labour, acceptance by trader and consumers and changes in product condition. The ultimate goal of packaging must lead to easier handling of the produce, a better quality and better marketable product. The characteristics of packaging are to contain, to protect, to communicate and to market the product.

To contain produce

- 1 As an efficient handling unit, easy to be handled by one person.
- 2 As a marketable unit. e.g. units with the same content and weight.

To protect produce against

- 1 Rough handling during loading, unloading and transport rigid crate.
- 2 Pressure during stacking.
- 3 Moisture or water loss with consequent weight and appearance loss.
- 4 Heat: air flow through crate or box via ventilation holes.
- 5 Fumigation possible through ventilation holes.

Labelling:

- 1 Identification: a label with country of origin, volume, type or variety of product, etc. printed on it.
- 2 Marketing, advertising: recognisable trade name and trademark.

Advantage:

- 1 Proper packaging will lead to reduced injuries of fruits and vegetables and subsequently to improvement of appearance.
- 2 Standard units (weight, count) of a certain produce will increase speed and efficiency of marketing.

- 3 With reduced costs of transport and handling, stacking and combining of packages into layer units like pallets is possible. A more efficient use of space and reduced losses will lower the marketing costs.

- 4 Labels and slots facilitate inspection.

Prepackaging or retail packaging of certain commodities in specially designed consumer packages has the following advantages:

- 5 Deterioration or decay is slowed down.
- 6 The reduction of spoilage caused by consumers selecting out of a bulk of produce.
- 7 Time needed for weighing and checking after selecting by the consumer will be reduced.
- 8 Advertisement by abundant supply.
- 9 More protection to the product.

Deterioration or decay is decreased because the prepackages create a micro-climate with a lower oxygen and a higher carbon dioxide level and a higher relative humidity is reached. Too high a relative humidity, however, can lead to sprouting of roots and tubers and low oxygen levels will decrease respiration to such a level that produce will suffocate and rot. In general, leafy vegetables require a high relative humidity level to prevent wilting and only a few holes in the package are recommended. Root crops require more holes, or even the use of nets as packaging material because too high relative humidities or too low oxygen levels cause sprouting.

Classification and designs for packaging

There are many different types of package in use throughout the world many of which have been carefully evaluated with respect to produce and market system, while other types have often been adopted for general use without thorough evaluation. Changes to improve such packages are still required. Some different types of package include:

- 1 Sacks: flexible, made of plastic or jute.
- 2 bags: small size sack
- 3 nets: sacks made of open mesh
- 4 Wooden crates.
- 5 Carton or fibreboard boxes.

- 6 Plastic crates.
- 7 Pallet boxes and shipping containers.
- 8 Baskets: made of woven strips of leaves, bamboo, plastic, etc.
- 9 Sacks and nets

Materials

The materials used for sacks and nets may be woven natural fibre (jute, kenaf, sisal, cotton), woven synthetic (polypropylene, polyethylene), knitted natural fabric (cotton), knitted synthetic (polyethylene) or non-woven synthetic (propylene). Advantages and disadvantages of sacks and nets. The advantages of using sacks and nets are merely financial. The sacks and nets are cheap, have a low weight/ volume ratio and, if made of a synthetic material, will not rot. The disadvantages include a low protection against puncturing, compression, vibration and impact injuries such as dropping, difficult stacking, a low rate of vapour transmission and the need of special stitching equipment. In general, nets are only suitable for hard produce such as coconuts and root crops (potatoes, onions).

Wooden crates

Advantages and disadvantages

Commonly used are wire bound crates for citrus/potatoes, wooden trays for tomatoes and wooden field crates.

The advantages of wooden crates are:

- 1 The crates can be manufactured and repaired locally.
- 2 Wood is relatively resistant to different weather conditions and (sea)water.
- 3 Wooden crates are often used on more than one journey and have a higher efficiency for larger fruits, e.g. watermelons.
- 4 Most crates have good ventilation and fast pre-cooling is possible.

Disadvantages of wooden crates are:

- 1 Untreated wood can easily become contaminated with fungi and bacteria.
- 2 Treatment of wooden crates with paint or other chemicals may cause produce deterioration.
- 3 The material may be too hard or rough for produce like soft fruits, and therefore liners of a soft material may be needed.
- 4 Disposal of the crates after use.
- 5 Manufacturing of wooden crates puts an extra claim on the natural forest resources.

Design

A wooden crate consists of rigid corners with planks nailed or stretched against those corners. Plank thickness

varies normally between 3 and 8 mm. Cutting the wood will result in loss due to the saw thickness (2-3 mm). A slicing machine can be used for thin planks up to 6 mm but these machines are expensive. There are several different constructions possible for wooden crates:

Nailed crates: (e.g. apple or pear crate ,field crate)

Nailed crates are rigid and strong boxes which serve as multi-trip containers with a long life time. The planks have a thickness of at least 6 mm. Because of the rigidity the crate is quite heavy and the initial cost is high compared to, for instance, wirebound crates. Spacing between the planks, (bottom, sides) and/or between top side plank and the bottom of the next crate creates is recommended for good ventilation. Nailed crates are frequently used for domestic transport e.g. as a field crate or as a crate to transport produce from the producer to the wholesaler or trader. Water has no direct influence on the strength of the crate, but rot will. An advantage of nailed crates is Nailed crates are rigid and strong boxes which serve as multi-trip containers with a long life time. The planks have a thickness of at least 6 mm. Because of the rigidity the crate is quite heavy and the initial cost is high compared to, for instance, wire bound crates. Spacing between the planks, (bottom, sides) and/or between top side plank and the bottom of the next crate creates is recommended for good ventilation. Nailed crates are frequently used for domestic transport e.g. as a field crate or as a crate to transport produce from the producer to the wholesaler or trader.

Water has no direct influence on the strength of the crate, but rot will. An advantage of nailed crates is the possibility to repair the crate. Disadvantages of the rigid nailed crate include the high return freight volume. A partial solution to this problem is to put one crate in two other crates which are placed opposite each other; so three empty crates will take up the space of two stacked crates.

Stitched crates: (tomato)

Stitched crates are made of thin (3-4 mm) pieces of wood stitched together. Corner pieces, mostly triangular, provide the necessary strength to stack crates. This type of crate is mainly used for single journeys.

Wire bound crates: (orange crate, grapefruit crate, potato crate)

As a rigid, cheap crate with a good stacking strength it is mainly used for single journeys. Wire bound crates are stitched crates with a wire under the stitches which gives extra strength to the container. The wire also serves as a hinge and as a lock for the lid. These crates provide good ventilation and fast pre cooling is possible. The price of these crates is low Moulded trays, wrapped with film liners; combine four to six units (citrus, apple, etc.) to one larger unit. The tray will give the produce protection from the bottom side and some protection on the sides. The top will only be properly protected when the larger units are properly stacked. Most commonly used

materials are low- density polypropylene for bagging, regenerated cellulose or cellophane for overwrapping the trays and polyvinyl chloride film for overwrapping trays. Polyethylene and polypropylene have a low permeability for gases and vapour and it is necessary to make holes in the bags. Other materials have higher permeabilities or permeabilities for only one of the gases or vapour and even between different brands of the same material are differences in permeability. It is recommended to purchase film material suitable for a certain commodity and to test this film material first on a small scale.

Fibreboard boxes

Fibreboard boxes are frequently used because of their low weight, their range of sizes and shapes and their availability.

Tetra Pack

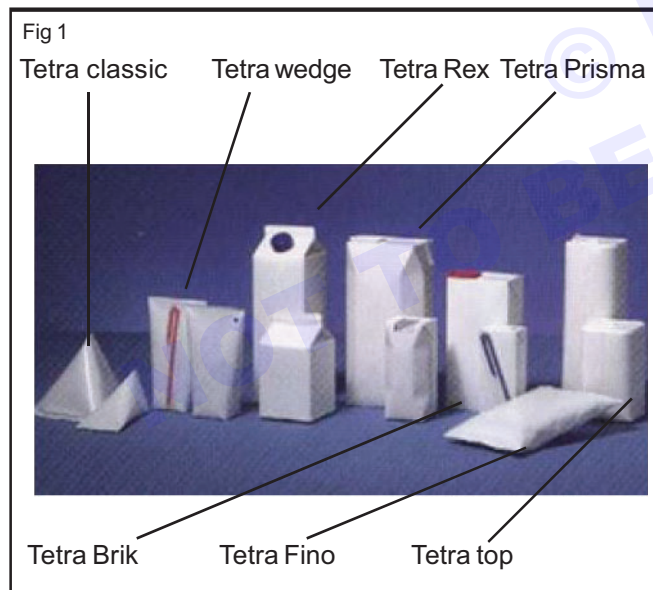
Objective: At the end of this lesson you shall be able to

- explain tetra pack
- explain types of tetra pack.

Tetra Pack and its Types

Tetra pack has developed a great many different package type, mostly for liquid beverages, and its used for aseptic packaging of beverages.

The various type of Tetra packages



The various package are supported to appeal different segment of customers. There are rather cheap packages as Tetra Fino Aseptic without any bottom and top folding and more exclusive one as Tetra prisma Aseptic

Materials

Solid fibreboard boxes (cartons): have a thickness between 0.85 and 3 mm. If treated with wax these boxes are reasonably moisture resistant. The boxes are used for tomato, cucumber and ginger transport. Most of them are printed with attractive colours, a brand name and a label. The information can be stamped on this label after filling the box.

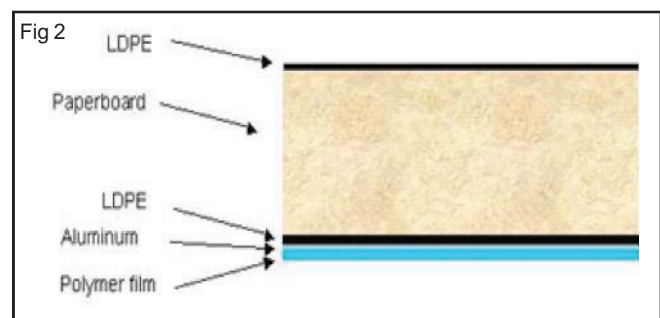
Corrugated fibreboard boxes: have a thickness varying from 12 up to 8 mm. The strength of corrugated fibreboard is determined by the type of fluting material, the type of facing material and its thickness and a single or double wall. Fluting and facings are kept in place by water resistant glue

The package material used in this work is a laminate structure consisting of (outside -Inside) Low Density polyethylene (LDPE), paper board, LDPE, aluminium foil polymer film (Shown in Figure 2)

Aluminium foil layer is located at the inside to create aseptic packages that are sustainable non diffusive and that protects the beverage from light.

LDPE layer are applied to protect the paper from moisture, to protect the printing and to glue the aluminium foil and the paper together.

The paper board that is responsible for the strength of the longitudinal sealings



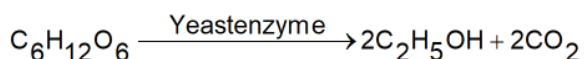
Wines

Objectives: At the end of this lesson you shall be able to

- perform alcoholic fermentation
- state the classification of fermented beverages
- state the preparation method of fermented beverages.

Introduction

Alcoholic fermentation is a process in which certain yeast decompose glucose in the feed stock in the absence of oxygen to produce alcohol and carbon dioxide.



Low alcohol content drinks are produced by fermentation of glucose or starch containing products and high alcohol ones are produced by distillation of their low alcohol products. Alcohol % age may vary from 4-70%

Alcoholic beverages have been known since antiquity. These are judged in terms of flavor and stimulating effect and hardly at all as sources of calories. They contain ethanol, commonly known as alcohol. Ethanol is a psychoactive drug, with a depressant effect. Significant blood alcohol content may be considered legal drunkenness as it reduces attention and slows reaction speed. Ethanol, being a psychoactive drug with a depressant effect, many societies regulate or restrict its sale and consumption. Alcohol has been widely consumed since prehistoric times by people around the world, as a component of the standard diet, for hygienic or medical reasons, for its relaxant and euphoric effects, for recreational purposes, for artistic inspiration, as aphrodisiacs, and for other reasons. Some drinks have been invested with symbolic or religious significance suggesting the mystical use of alcohol. However Alcoholic beverages can be addictive and the state of addiction to ethanol is known as alcoholism.

Alcohol is absorbed without prior digestion but the body has limited capacity to oxidize it that is the reason why alcoholic beverages are to be sipped instead of gulping them. As a drug the effect of alcohol varies from mental stimulation when small amount are consumed to loss of co-ordination and even death when large amounts are consumed.

Classification of Fermented Beverages

There are three main of alcoholic beverages

- 1 Beer Group
- 2 Wine Group
- 3 Distilled Liquors

Beer Group

Beer is an alcoholic beverage produced by saccharification of starch and fermentation of the resulting sugar. The starch and saccharification enzymes are often derived from malted cereal grains most commonly malted barley and malted wheat. Most of beer is also flavored with hops which add bitterness and act as natural preservative. Though other flavoring such as herbs or fruits may occasionally be included. The process of preparing beer is called brewing.

Beer is world's most widely consumed alcoholic beverage and is the most popular drink over all, after water and tea. The strength of beer is usually around 4% to 6% alcohol by volume (abv) although it may vary between 0.5% (de-alcoholized) and 20% with some breweries creating example of 40% abv and above in recent years.

Other members of this group are

- 1 Ale
- 2 Stout
- 3 Lager
- 4 Porter

Wine group

Wine is the oldest, of the alcoholic beverages made by the fermentation of grape juice. Wines differ greatly in their character because grapes grown in different regions differ in their composition, particularly with respect to their volatile components which contributes to flavor and bouquet and in the method used for wine making.

There are different varieties of wines and in many cases they are named by reference to their place of origin e.g. Champagne is produced in the district of champagne in France.

Wines can be divided into the following classes.

1 Fortified wine:

Fortified wines meaning that distilled spirits are added.

a Sherry :

A fortified wine that originated in the town of Jerez/Xeres (pronounced sherris) in southern Spain, hence the English word sherry. To help Sherry stay stabilized during early ocean voyages, brandy was added to the wine.

This is why Sherry is now a fortified (alcohol added) wine. Sherry is a blended wine of several years, not a single vintage wine. Sherry is usually considered an aperitif. There are dry sherries that can be served chilled, and sweet sherries for room temperature.

Fig 1



b Vermouth :

Vermouth is a fortified wine that is aromatized with a variety of herbs and spices. The word vermouth is derived from the German word for wormwood, wermut. Wormwood was the chief flavoring ingredient for vermouth until the herb was found to be poisonous.

c Port :

Port wine (also known as Vinho do Porto, Portuguese, Porto, and usually simply port) is a Portuguese fortified wine produced exclusively in the Douro Valley in the northern provinces of Portugal. It is typically a sweet, red wine, often served as a dessert wine though it also comes in dry, semi-dry, and white varieties. Fortified wines in the style of port are also produced outside Portugal, most notably in Australia, France, South Africa, Canada, India, Argentina, and the United States. Under European Union Protected Designation of Origin guidelines, only the product from Portugal may be labelled as port or Porto. In the United States, wines labelled "port" may come from anywhere in the world, while the names "Dão", "Oporto", "Porto", and "Vinho do Porto" have been recognized as foreign, non-generic names for wines originating in Portugal.

Port is produced from grapes grown and processed in the demarcated Douro region. The wine produced is then fortified by the addition of a neutral grape spirit known as aguardente in order to stop the fermentation, leaving residual sugar in the wine, and to boost the alcohol content. The fortification spirit is sometimes referred to as brandy but it bears little resemblance to commercial brandies. The wine is then stored and aged, often in barrels stored in a cave (pronounced kahv and meaning "cellar" in Portuguese) as is the case in Vila Nova de Gaia, before being bottled.

2 Red table wines:

Wine which is neither fortified nor sparkling in which skin of grapes is also used along with juice.

3 White table wines:

Wine which is neither fortified nor sparkling in which only juice is used.

4 Dessert wines:

Dessert wines, sometimes called pudding wines, are sweet wines typically served with dessert.

There is no simple definition of a dessert wine. In the UK, a dessert wine is considered to be any sweet wine drunk with a meal, as opposed to the white fortified wines (fino and amontillado sherry) drunk before the meal, and the red fortified wines (port and madeira) drunk after it. Thus, most fortified wines are regarded as distinct from dessert wines, but some of the less strong fortified white wines, such as Pedro Ximénez sherry and Muscat de Beaumes-de-Venise, are regarded as honorary dessert wines. In the United States, by contrast, a dessert wine is legally defined as any wine over 14% alcohol by volume, which includes all fortified wines - and is taxed more highly as a result. This dates back to a time when the US wine industry only made dessert wines by fortification, but such a classification is outdated now that modern yeast and viticulture can produce dry wines over 15% without fortification, yet German dessert wines can contain half that amount of alcohol.

- Ice Wine
- Raisin Wine
- Noble Rot Wine

5 Sparking wines :

Sparkling wine adds a hint of luxury to every good wine, through a fizzy/bubbly texture.

- **Champagne** - By far the most luxurious drink of all is Champagne, a well-known produce of France. Champagne is savored in moments of celebration, and the prices reach the levels of its worldwide fame.
- **Cava** - The Spanish have their delicious version of Sparkling wine, known as Cava, mostly coming as Brut and Semi-Sec, and as white and rosé.

Wines can be further divided into

a Sweet wines (above 4% sugar)

b Semi sweet wines (2- 4% sugar)

c Dry wines (less than 2% sugar)

Distilled Liquors

The alcoholic beverages containing 40-70% abv made up by distilling fermented liquors are called Distilled Liquors.

Ex. Whisky, Brandy, Rum, Gin

Usually distilled liquors other than gin are allowed to mature before consumption e.g. Whisky is matured in wooden cask for 5-15 years to become smooth and mellow.

- a **Whiskey** - Whiskey is made from the distillation of a fermented mash of cereal grains including barley,

corn (maize), rye, and wheat and is aged in wooden barrels generally made of charred white oak for 2 to 8 years before sale.

- b Brandy** - Brandy (from brandywine, derived from Dutch brandewijn, “burned wine”) is obtained by the distillation of fruit wines.
- c Rum** - Rum is obtained by the distillation of fermented sugar cane juice syrupy or molasses (sugarcane by product).
- d Gin** - This is a juniper-flavoured spirit made not via the redistillation of botanicals, but by simply adding

approved natural flavouring substances to a neutral spirit of agricultural origin. The predominant flavour must be juniper. Alcohol content is 60%.

- e Vodka** - Vodka is distilled liquor without any identifying characteristics except that of dilute alcohol. If is free from all traces of color and flavor vodka is made by diluting natural spirit obtained from wheat or other cereal grains or potato.

Traditionally, vodka is made by the distillation of fermented grains or potatoes, though some modern brands use other substances, such as fruits or sugar.

More Fermented Drinks

Product Name	Origin	What is it?	Alcohol
Dark Tea	China	Fermented tea.	0%
Basi	Phillipines	Fermented sugarcane	10-16%
Kvass	Russia, Lithuania	Fermented Rye	1%
Kefir	Northern Caucasus (Russia)	Fermented Milk	1%
Toddy	Asia, Africa & India	Fermented Palm Sap	3-6%
Makgeolli (Makkoli)	Korea	Fermented Rice Wine	6-8%
Huangjiu Shaoxing (a.k.a. Wine)	China	Chinese Rice Wine	13-16%

Process of wine making

Process of wine making starts with selection of grapes. Some varieties of grapes which are usually considered better than other are - Riesling, Gewürztraminer, Chardonnay, Sauvignon Blanc, Syrah, Merlot, Cabernet Sauvignon, Pinot Noir.

India's low level of wine production contrasts with its total grape output of around 1.7m tons per year; the majority is used for table grapes and raisins, with only about 10% going to the production of wine. An even lower proportion comes from high-quality international varieties, although Cabernet Sauvignon, Shiraz, Merlot and Zinfandel for reds and Chardonnay, Chenin Blanc, Clairette and Sauvignon Blanc for whites are all grown. Thompson Seedless and Sultana vines produce the majority of India's grapes, with other notable varieties including Isabella (local name: Bangalore Blue) and Muscat Hamburg (local name: Gulabi).

While selecting grapes for wine making it should be kept in mind that grapes should be ripe but not over ripe.

As °B of over ripe grapes is more than 24°B and if it is more, it decreases the fermentation process.

If it is less than 17°B than it may happen that required %age of alcohol is not reached.

Next to selection is de-stemming which is essential for red wine but not necessary for white generally it is avoided in the later case as it helps in refining of it. After that crushing is done manually or by machine. The mixture

of seed skin and pulp is called MUST.

Pressing of grapes is done with either roller press, basket press made by wood or stainless steel. When you transfer the must into the press, a large portion of the liquid will run through the press before any pressure has been applied to the skins. This is called free-run. If kept isolated, it often makes a better wine than the portion that is squeezed out of the skins, referred to as press-run.

When MLF is not taken in practice SO₂ is added before refining, otherwise it should be added after MLF. SO₂ comes in 2 specific forms for addition to wine, Potassium Metabisulfite (most common) and Efferbaktol. Potassium Metabisulfite is often shortened to “meta”SO₂ “Sulfite”, and comes in a white powder form. It can be dissolved into water and added to the must or finished wine. Later format for sulfite is in the form of effervescent self-dissolving granules called Efferbaktol. SO₂ is also available from Campden tablets, which look like aspirin. Campden tablets are made from Sodium Metabisulfite, a less desirable form of SO₂. However, they're easily measurable in small doses.

Refining which makes the must clear, is done with poly-lact and Albumax Bentonite. Sometimes it is not done with red wines. Whereas in white wine it should be done.

We will only be getting around 3 (Bordeaux) to 3.5 (Zin and Rhône)* gallons of finished wine from every 5 gallons of must! This comes out to 60-70% of the must volume.

Before making any adjustments, double-check °Brix after the grapes have been crushed and the must has had a chance to be completely mixed together. There is usually

a bit of variation in sugar levels between each and every bunch of grapes that make up the whole volume.

These differences are not only found in fruit coming from different sections of the same vineyard, but even off of the same vine. Therefore, the only way to get a truly accurate sugar reading for any must is to wait until the fruit has been completely processed and thoroughly mixed together.

You can measure the sugar level with a hydrometer or a refractometer

A hydrometer works by measuring the density of the liquid you're testing compared to water at a certain temperature. Temperature affects density, so it is important to have a sample close to your hydrometer's calibration temperature. If using a hydrometer: make sure to strain the sample of juice to remove any seeds and skins before filling the hydrometer jar. If the solids are left in the sample, these may cause the hydrometer to stick to the side of the jar, compromising the accuracy of the results. Another good technique for getting a clear juice sample is to place the sample in a freezer for 15-20 minutes. Decant off of the sediment that settles out.

However, because a Hydrometer works off of the principle of density, and density changes with temperature, you will need to allow the sample to warm back up to 68°F be accurate because this is where most hydrometers are calibrated. The hydrometer jar should contain enough sample that the hydrometer is always floating. Wait until it stabilizes and read the number where the top of the liquid meets the scale on the hydrometer.

Depending on the temperature of the sample, you should also add or subtract the amount indicated by the thermometer at the bottom of the hydrometer for the greatest amount of accuracy.

If your sugar level is lower than 22° Brix, add sugar to bring it up to the standard level (called chaptalizing the must). This is done with table sugar: 1.5 oz. of table sugar per US gallon of projected liquid raises the °Brix by 1°.

1 tsp of table sugar = 5 grams (.17 oz.)

8.8 tsp of table sugar = 1.5 oz.

After that check TA and pH Adequate pH for wines is 3.2-3.5 and %TA is 6.0-9.0 for red wine. The typical pH range for white wines is between 3.2 and 3.5

If pH is lower than 3.2 it means it is too sour. If it is more than 3.5 it decreases the shelf life of the wine.

The Primary fermentation takes 2 to 14 days or so there are over 30 cultured strains of yeast to choose from. There are yeast specific to varietals, yeast for emphasizing certain flavours, and yeast known for improving body and structure, etc. You can use a single strain, or a couple of different strains to blend them later and create a more complex final wine. The only caveat with using more than one yeast strain is that you can only use one strain per fermenter. So, if you want to explore using blends, then

you will need more than one fermenting vessel. The commonly used yeast strain is *saccharomyces cerevisiae*.

Once the fermentation has begun, the yeast will proceed to consume the sugars in the must/juice, producing CO₂ (bubbles) and alcohol. During this period, the skins will be carried upwards by yeast produced CO₂ and compact into a large mass that will be pushed up and out of contact with the liquid in the must.

This floating mass of skins is referred to as the cap. This cap needs to be broken-up and re-submerged several times a day. This process is referred to as "punching down the cap". Punching the cap protects the wine, aiding with extraction of color and flavor compounds from the skins, along with the dispersal of built-up heat. If the cap is exposed to the air for too long, the surface can dry out and allow the colonization of airborne bacteria. The most common one is acetobacter, (vinegar bacteria), though pretty much any one will ruin your wine. Since the rising alcohol levels in the fermenting must are high enough to kill airborne bacteria when it washes over them, submerging the skins helps to protect the wine from spoilage throughout the fermentation. In addition, mixing also promotes contact between the wine and the skins, aiding color and flavor extraction. Fermentation generates quite a bit of heat and the cap acts as an insulator. If not broken up, the cap does not allow the excess heat to escape, causing the fermentation to become too hot.

Try to avoid elevated fermentation temperatures because they antagonize yeast and cause fermentations to stick, as well as produce off flavors and aggressive qualities in the final wine.

Malolactic Fermentation (Secondary Fermentation) takes 2-6 weeks. The fermentation reaction is undertaken by the family of lactic acid bacteria (LAB); *Oenococcus oeni*, and various species of *Lactobacillus* and *Pediococcus*. While sometimes described as a secondary fermentation, chemically, malolactic fermentation is a decarboxylation, which means carbon dioxide is liberated in the process.

Racking is done to clarify MUST or wine with siphon or by pumps. The aging of wine is potentially able to improve the quality of wine. This distinguishes wine from most other consumable goods. While wine is perishable and capable of deteriorating, complex chemical reactions involving a wine's sugars, acids and phenolic compounds (such as tannins) can alter the aroma, color, mouthfeel and taste of the wine in a way that may be more pleasing to the taster. The ability of a wine to age is influenced by many factors including grape variety, vintage, viticultural practices, wine region and winemaking style. The condition that the wine is kept in after bottling can also influence how well a wine ages and may require significant time and financial investment

There is no going back and adjusting the wine once it is in the Bottle. The following checklists will help guide you through the steps needed to prepare the wine for bottling.

- 1 Check the pH/TA
- 2 Check the mouth feel/tannins

- 3 Check the clarity
- 4 Check the free SO_2
- 5 Check the Residual Sugar %

Some important conversions

$$\begin{aligned} \text{C}^\circ &= \frac{\text{F}^\circ - 32}{1.8} \\ 1 \text{ US gal} &= 3.78541 \text{ L} \\ 1 \text{ tsp} &= 0.166667 \text{ oz} \end{aligned}$$

In the market there are many additives are available that are helpful in breaking down the cell walls of the skin of grapes and makes the deep colour compound free. Ex. of that type of additive is Lallzyme.

Some others are helpful for mouth feel. More over there are some additives which provide nutrition to yeast. Yeast work good when there is sufficient nitrogen, amino acids, and micro nutrients.

Wine Defects:

When aroma, smell on appearance of wine affected by unpleasant characteristics it is called fault or defect of wine.

With proper technique you can greatly improve a spoiled wine, but it is rarely as good as it might have been if it had not gone bad to begin with.

It is sometimes difficult (If not impossible) to fix a wine defect after it has occurred. It is much better to prevent it in the first place.

Types of wine defects:

There are 3 types of defects that occur in wine and that are:

- 1 Defects that take place during wine storage & processing.
- 2 Defect from the growth of wine spoilage micro organisms.
- 3 Defect that take place after the wine is bottled.

H_2S gas rotten eggs smell. When excess sulphur-di-oxide is added in grape juice the yeast changes sulphur to hydrogen sulphide(H_2S). Sometime low nutrients during fermentation dirty lees also cause production of H_2S . To avoid this H_2S should not be added more than ppb(part per billion)morely nutrient should added time to time and too much use of lees should be avoided.

Presence of H_2S should be recognized only by sniffing, tasting and swirling should be avoided.

To remove H_2S , CuSO_4 is added but excess of CuSO_4 may result in excess of Cu and it may precipitate. Remeady for this is add citric acid. This helps the copper stay in solution and not form a precipitate.

Access of acid makes wine too tart to avoid this treatment with calcium carbonate(CaCO_3) or potassium carbonate (KCO_3) 2.52 gms of calcium carbonate per gallon of wine lowers the TA of wine by 1g/l.

Colour and aroma of wine also changes due to oxidation. The colour of wine changes red/white to brown and aroma changes to nutty, caramel state bread like smells. To avoid oxidation inert gases are used. CO_2 (Carbon-di-oxide) N_2 (Nitrogen) Ar (Argon) are used for this purpose. The best one is Ar. It is heavier than air, but does not absorb into wine. CO_2 is soluble while N_2 has the same density as air. So it does not blanket a tank as well.

There are some yeast and bacteria which grow in the presence of oxygen at high pH like Acetobacter. (Aerobic bacteria). It converts ethanol to acetic acid and ethyl acetate which in turns produce vinegar aroma(acetic acid) and nail polish remover aroma. (Ethyl acetate). *Pediococcus* is an undesirable malo lactic bacteria that can give a vegetal or dirty sock aroma. *Loctobacillus* is a very vigorous malolactic bacteria, some strains of this can produce an earthy aroma. When the wine goes through ML *lactobacillus* can out complete *Saccharomyces* at the end of the primary fermentation which produce more acetic acid in wine *Zygosaccharomyces bailii* is a spoilage yeast can tolerate much higher sugar levels than *Saccharomyces* that is way sagar %age more than 24°B is avoided. To get rid of these unwanted bacteria and yeast plating test is done for wine time to time. Plating is difficult and slow result giving method, but using “genetic indentifiers”, we get fast and more accurate result but this method is expensive.

The use of unsterilized bottles or cheap corks there are some defects that occur after bottling of wine. If bottle is not sterilized those is a very big chance that yeast or ML may occur. These yeast give the wine breadly smell make it cloudy and they may produce H_2S and other bad aromas but the worst thing is that they may expose the bottle.

Cork batch should be checked otherwise it may produce corky smell in the wine.

Ultraviolet light from the sun or flourescent light react with sulphur and other compounds in wine to give plastic or smoky aroma. To avoid wine to being “light struck” champagne green, brown and amber glass are used. These champagne green, brown and amber colour have UV protection.

Vinegar

Objectives: At the end of this lesson you shall be able to

- explain the detail of vinegar process
- state the types of vinegar
- explain the production method of vinegar.

Introduction

Vinegar is the product made from the conversion of ethyl alcohol to acetic acid by a genus of bacteria, *Acetobacter*. Therefore, vinegar can be produced from any alcoholic material from alcohol-water mixtures to various fruit wines (Peppler and Beaman 1967). Its color and aroma are greatly dependent on the material from which it is made (Kehrer 1921). Vinegar is a liquid produced from the fermentation of ethanol in a process that yields its key ingredient, acetic acid. The acetic acid concentration ranges typically from 4 to 8 percent by volume for table vinegar [1] (typically 5%) and higher concentrations for pickling (up to 18%). Natural vinegars also contain smaller amounts of tartaric acid, citric acid, and other acids.

Vinegar may be defined as a condiment made from various sugary and starchy materials by alcoholic and subsequent acetic fermentation (Cruess 1958) by a genus of bacteria, *Acetobacter*.

Vinegar can be produced by different methods and from various raw materials.

Wine (white, red, and sherry wine), cider, fruit musts, malted barley, or pure alcohol are used as substrates. Vinegar production ranges from traditional methods employing wood casks and surface culture to submerged fermentation in acetators (Morales et al 2001). Vinegar traditionally has been used as a food preservative. Whether naturally produced during fermentation or intentionally added, vinegar retards microbial growth and contributes sensory properties to a number of foods. The wide diversity of products containing vinegar (sauces, ketchup, mayonnaise, etc.) and the current fall in wine consumption have favored an increase in vinegar production (De Ory et al 2002).

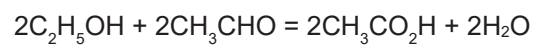
Acetic acid is the predominant flavoring and antimicrobial component in vinegar. The following review will focus on the importance of acetic acid as a direct food additive or more recently as a food processing aid, to decontaminate food prior to distribution and consumption (Marshall et al 2000). Earlier processes used for making vinegar were the Orleans process (which is also known as the slow process), the quick process (which is also called the generator process), and the submerged culture process. The quick process and submerged culture process were developed and are used for commercial vinegar production today.

Acetic acid is formed in a four-step reaction involving conversion of starch to sugar by amylases, anaerobic conversion of sugars to ethanol by yeast fermentation, conversion of ethanol to hydrated acetaldehyde, and dehydrogenation to acetic acid by aldehyde dehydrogenase (Nichol 1979; Canning 1985). The last two steps

are performed aerobically with the aid of acetic acid forming bacteria. Acetic acid yield from fermented sugar is approximately 40%, with the remaining sugar metabolites either lost to volatilization or converted into other compounds. Acid yield improvements can be achieved using high rates aeration of during continuous production (Ghommidh et al 1986).

Vinegar bacteria, also called acetic acid bacteria, are members of the genus *Acetobacter* and characterized by their ability to convert ethyl alcohol, C_2H_5OH , into acetic acid, CH_3CO_2H , by oxidation as shown below

Anaerobic Aerobic



Most bacteria strains derived from vinegar factories are able to oxidize acetic acid to CO_2 and H_2O (over-oxidation) and therefore are classified in the genus *Acetobacter* (De Ley et al 1984).

Common types of vinegar include white distilled vinegar, cider vinegar, wine vinegar, rice vinegar, and malt vinegar. Further processing of vinegar, following substrate conversion to acetic acid may include filtration, clarification distillation and pasteurization at 165.2°F (74°C) before it is bottled. Regulations in the United States require vinegar to contain at least 4% acetic acid resulting from acetic acid.

Fermentation of ethanol containing substrates. Labels identifying the diluents used to meet the listed concentration of acid are also required. Acetic acid concentration in vinegar may be expressed using the term "grain". For example, 100 grain distilled vinegar is a 10% acetic acid solution (Nickol 1979). If higher concentration of acetic acid is required, the dilute solution of acetic acid maybe heat distilled or frozen to slush. The slush is centrifuged to isolate the liquid portion (Nickol 1979; Ebner 1982).

Concentration from 10-30% may be achieved using this technique (Chukwu and Cheryan 1996). Vinegar plays an important role in salad dressings, ketchup, hot sauce and other sauces. This need demands industrial fermentation systems capable of producing a large amount of vinegar. These systems must maintain reliable controls and optimum conditions for acetic acid bacteria fermentation (De Ory et al 1999). Many techniques have been developed to improve industrial production of vinegar. Most try to increase the speed of the transformation of ethanol into acetic acid in the presence of the acetic acid bacteria (Tesfaye et al 2002). Today, the most common technology for the vinegar industry is based on the submerged culture (Hormatka and Ebner 1951) with diverse technical modifications which try to improve the general fermentation conditions (aeration, stirring, heating, etc.) The overall aim in the present study is to identify the

quality and microbial differences between the generator process and submerged acetification. Specific goals were to achieve 10-12% acidity using constructed lab scale production facilities and to characterize the species of vinegar bacteria used in acetification.

Types of vinegar

The predominant type of vinegar in the United States is white or distilled vinegar. Vinegar is usually described in terms of grain strength, the grain being ten times the acid percentage. For example 10% acid is referred to as 100 grain (Cruess 1958). According to the Crisco Company, vinegar varieties vary greatly from country to country. Some of the most popular vinegars and their characteristics are shown below (Crisco Company 2005):

- 1 **Balsamic vinegar** is brown in color with a sweet-sour flavor. It is made from the white Trebbiano grape and aged in barrels of various woods. Some gourmet Balsamic vinegars are over 100 years old.
- 2 **Cane vinegar** is made from fermented sugarcane and has a very mild, rich-sweet flavor. It is most commonly used in Philippine cooking.
- 3 **Champagne vinegar** has no bubbles. It's made from a still, dry white wine made from Chardonnay or Pinot Noir grapes (both of which are used to make Champagne).
- 4 **Cider vinegar** is made from apples and is the most popular vinegar used for cooking in the United States.
- 5 **Coconut vinegar** is low in acidity, with a musty flavor and a unique aftertaste. It is used in many Thai dishes.
- 6 **Distilled vinegar** is harsh vinegar made from grains and is usually colorless. It is best used only for pickling.
- 7 **Malt vinegar** is very popular in England. It's made from fermented barley and grain mash, and flavored with woods such as beech or birch. It has a hearty flavor and is often served with fish and chips.
- 8 **Rice wine vinegar** has been made by the Chinese for over 5,000 years. There are three kinds of rice wine vinegar: red (used as a dip for foods and as a condiment in soups), white (used mostly in sweet and sour dishes), and black (common in stir-fries and dressings).
- 9 **Sherry vinegar** is aged under the full heat of the sun in wooden barrels and has a nutty-sweet taste.
- 10 **Wine vinegar** can be made from white, red, or rose wine. These vinegars make the best salad dressings.

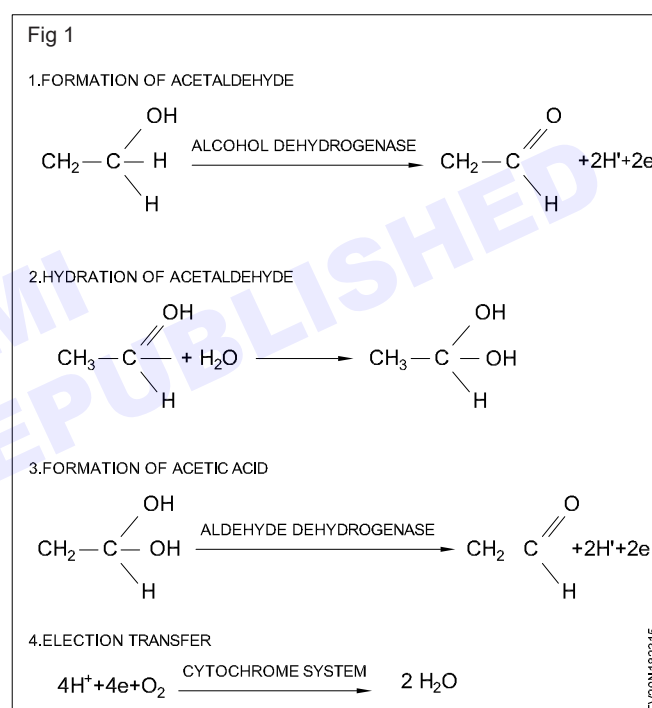
Black berry (jamun) vinegar is a great source of iron, used as a real medicine for diabetes, live trouble and heart problems. This Jamun vinegar is considered to be remedially valuable for spleen, stomach and diabetic problems.

Production Method

Vinegar production methods can range from traditional methods employing wood casks (Orleans Process) and surface culture (Generator Process) to submerged fermentation (Morales et al 2001). Vinegar is an important ingredient in many food products. The need for large amounts of the vinegar demands industrial fermentation systems that are capable of producing volumes that are reliably controlled (De Ory et al 1999). Many technical devices have been developed to improve the industrial production of vinegar. Generally, these improvements increase the speed of the transformation of ethanol into acetic acid in the presence of acetic acid bacteria (Tessfaye et al 2002).

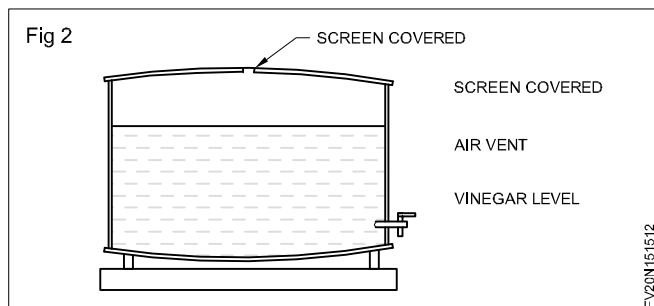
Chemical Reaction and Formulation(Fig 1)

In 1822, Dobereiner established the theory of producing acetic acid from alcohol (Kehrer 1921) and the equation of the process is shown below from Kehrer 1921:



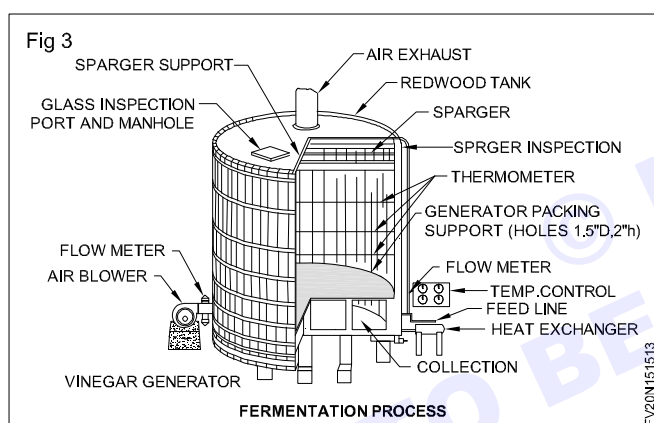
Orleans process (Fig 2)

The slow method of acetifying wine which has been used in France since 1670 is called the French or Orleans process. In this process, alcohol solutions less than 5% in wine can not be acetified easily. Below this strength, phosphates and nitrogenous substances must be added to the mash and the products have to be sold under the name of "spirit vinegar". The Orleans process was the only method to make pure wine vinegar (Mitchell 1916), and was reported to be the best process to produce fine quality table vinegar (Hickey and Vaughn 1954). In this process, wood barrels (Fig 1) from (Cruess 1958) are used and filled with alcohol fermenting liquid to approximately ¾ full. First, holes are drilled at the ends of the barrel a few inches above of the liquid surface. The holes are left open and covered with a fine screen.



Secondly approximately 20-25% of fresh vinegar is added into the barrel (Muspratt 1871). The function of adding the fresh vinegar is acidifying the liquid to the point of optimum growth for the vinegar bacteria (Cruess 1958). Vinegar bacteria settle into the liquid from the air and form a gelatinous slime layer on top of the liquid (Peppler and Beaman 1967). The liquid is fermented for about 1 to 3 months at 70°F to 85°F (Hickey and Vaughn 1954). After this time, 1/4 to 1/3 of the vinegar may then be drawn off for bottling purposes and an equivalent amount of alcoholic liquid added (Cruess 1958). Alcohol sources must constantly be added to the vinegar or the acetic acid might begin to oxidize (Cruess 1958).

Generator Fermentation (Fig 3)



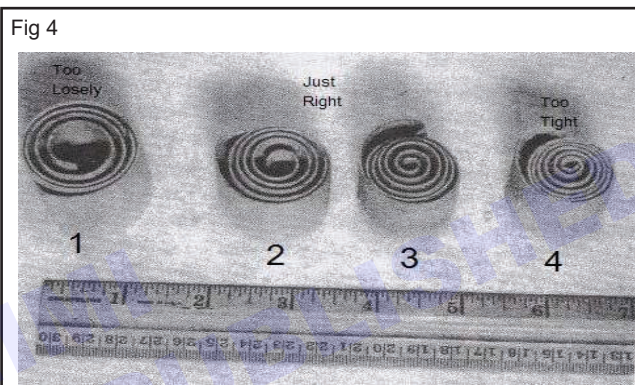
Early in the nineteenth century, a vinegar-making system called the **trickle method** [now called generator fermentation or quick process (Schnellessig)] was developed by German chemist Schutzenbach in 1832 (Hickey and Vaughn 1954).

According to this process, the bacteria were grown and formed a thick slime coating around a non-compacting material like beech wood shavings, charcoal or coke (Peppler and Beaman 1967). The non-compacting material was packed into large upright wood tanks (Fig 3) from (Cruess 1958) of 2000 cubic feet capacity above a perforated wood grating floor.

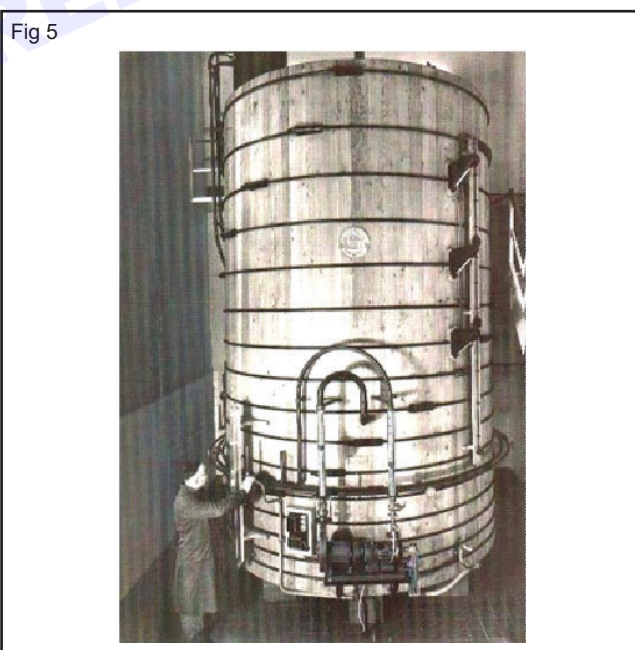
The wood shavings (Fig 4) from (Peppler and Beaman 1967) are generally made of air-dried beech wood sliced to form a coil about 2 inches long and 1¼ inches in diameter.

Re-circulated fermenting liquid or mash trickles over the packing material toward the bottom while air moves from the bottom through inlets toward the top. The rate of acetification is dependent upon oxygen concentration (Cruess 1958). A limited air supply means limited acetic

acid production and lower generator temperatures while an overabundant air supply creates over production and higher generator temperatures. The generators must be closely monitored to prevent over oxidation or unacceptable temperatures (Hassack 1922). The process takes about 3 to 7 days. Two thirds of the final vinegar product is withdrawn from the tank and fresh mash added (Cruess 1958). Replacement mash is slowly poured into the tank until the working level for acetification of the solution and a beginning temperature of 70°F (21.1°C) are reached. The optimum temperature for generator operation is 85 to 90°F (30 to 32.2°C) (Hickey and Vaughn 1954). Each gallon of 190 proof alcohol oxidized to acetic acid releases about 30000 to 35000 Btu (32000000 to 37000000 Joules) (Hickey and Vaughn 1954). The optimum temperature for Acetobacter is about 86°F (30°C). A temperature control system is necessary to prevent overheating and consequent inactivation of the bacteria (Peppler and Beaman 1967).



Submerged Fermentation (Fig 5)



Today, the most common production method is submerged culture from (De Ory et al 1999) which improves the general fermentation conditions like aeration, stirring, heating, etc (Hromatka and Ebner 1951). As generator culture systems are slow and expensive, submerged culture fermentors have become widely used at industrial scales (Hromatka and Ebner 1951; Ormaechea 1991). In

this process, the mash is stirred and aerated frequently (De Ley and Swings 1984). The fermenters are usually fitted with a heat exchanger for the maintenance of the optimum temperature during the fermentation process (De Ory et al 1999). The typical operation mode in industrial submerged cultures (Adams 1985) is semi-continuous from (De Ory et al 2002). This operation consists of the development of successive discontinuous cycles of acetification. At the end of every cycle, a given volume of acetic acid is discharged and refilled with mash. (De Ory et al 2004). The best temperature for industrial production of 11 to 12% vinegar was 86°F (30°C) (Allgeier et al 1960; Adams 1985).

Damage to the bacteria may occur above 86°F. In addition, the bacteria's condition also affects the concentration of acetic acid produced (Fregapane et al 2001).

Varieties of vinegar

Malt

Malt vinegar is made by malting barley, causing the starch in the grain to turn to maltose. Then an ale is brewed from the maltose and allowed to turn into vinegar, which is then aged. It is typically light-brown in color.

In the United Kingdom, salt and malt vinegar is a traditional seasoning for chips and crisps.

Wine

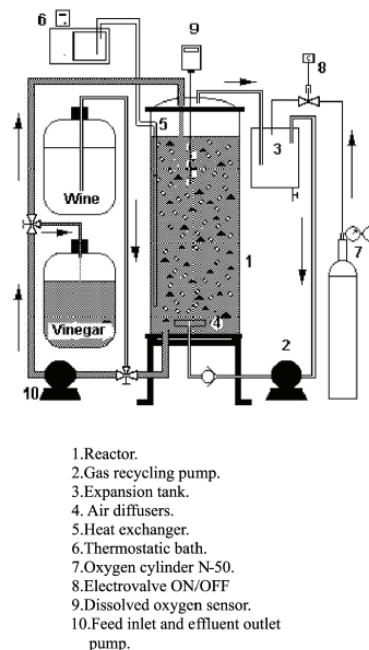
Wine vinegar is made from red or white wine, and is the most commonly used vinegar in Mediterranean countries and Central Europe. As with wine, there is a considerable range in quality. Better-quality wine vinegars are matured in wood for up to two years, and exhibit a complex, mellow flavor. Wine vinegar tends to have a lower acidity than white or cider vinegars. More expensive wine vinegars are made from individual varieties of wine, such as Champagne, sherry, or pinot grigio. It is also known as methanecarboxylic acid.

Sherry vinegar

Production of sherry vinegar is linked to the production of wines of Jerez. The vinegar is made exclusively from the acetic fermentation of Sherry wines; the taste of this vinegar is stronger than that of wine. The resulting color of this vinegar is dark-mahogany; it is concentrated and has generous aromas; the nose will notice the hue of wood. Sherry vinegar is ideal for vinaigrettes and salad dressings and for flavoring various foods.

There is evidence of its existence back in the first century after Christ, in the writings of Cadiz wiseman Columella. It is currently presented with quality products certified by the government of Andalusia and its production is regulated by the Consejo Regular del Vino y Brandy de Jerez (Council regulating the production of Jerez wine and brandy). Two types are found: Vinagre de Jerez, which is aged for six months or Vinagre de Jerez Reserva, which is aged for a minimum of two years (although the Council allows to specify the age if this is greater, and vinegar 20 or 30 years can old be found).

Fig 6



Apple cider

Apple cider vinegar, otherwise known simply as cider vinegar or ACV, is made from cider or apple must, and has a brownish-yellow color. It often is sold unfiltered and unpasteurized with the mother of vinegar present, as a natural product. Because of its acidity, apple cider vinegar may be very harsh, even burning, to the throat. If taken straight, (as opposed to used in cooking), it can be diluted (e.g., with fruit juice or water) before drinking. It is also sometimes sweetened with sugar or honey. There have been reports of acid chemical burns of the throat from apple cider vinegar tablets, but doubt remains as to whether apple cider vinegar was in fact an ingredient in the evaluated products. The pH of apple cider vinegar is typically between pH 4.25 and 5.00 if undiluted.

Fruit

Fruit vinegars are made from fruit wines, usually without any additional flavoring. Common flavors of fruit vinegar include apple, blackcurrant, raspberry, quince, and tomato. Typically, the flavors of the original fruits remain in the final product. In India "jamun" blackberry vinegar is commonly prepared. It is considered to be medicinally valuable for stomach, spleen and diabetic ailments.

Jamun sirka, a vinegar produced from the jamun (or rose apple) fruit in India, is considered to be medicinally valuable for stomach, spleen and diabetic ailments.

Balsamic

Balsamic vinegar is an aromatic, aged type of vinegar traditionally crafted in the Modena and Reggio Emilia provinces of Italy from the concentrated juice, or must, of white grapes (typically of the Trebbiano variety). It is very dark brown in color, and its flavor is rich, sweet, and complex, with the finest grades being the product of years of aging in a successive number of casks made of various types of wood (including oak, mulberry, chestnut, cherry, juniper, ash, and acacia). Originally a product available to

only the Italian upper classes, a cheaper form of balsamic vinegar became widely known and available around the world in the late 20th century. True balsamic vinegar (which has Protected Designation of Origin status) is aged for 12 to 25 years. Balsamic vinegars that have been aged for up to 100 years are available, though they are usually very expensive. The commercial balsamic sold in supermarkets is typically made with concentrated grape juice mixed with a strong vinegar, which is laced with caramel and sugar. Regardless of how it is produced, balsamic vinegar must be made from a grape product.

Balsamic vinegar has a high acidity level, but the tart flavor is usually hidden by the sweetness of the other ingredients, making it very mellow.

Rice

Rice vinegar is most popular in the cuisines of East and Southeast Asia. It is available in “white” (light yellow), red, and black varieties. The Japanese prefer a light rice vinegar for the preparation of sushi rice and salad dressings. Red rice vinegar traditionally is colored with red yeast rice. Black rice vinegar (made with black glutinous rice) is most popular in China, and it is also widely used in other East Asian countries.

White rice vinegar has a mild acidity with a somewhat “flat” and uncomplex flavor. Some varieties of rice vinegar are sweetened or otherwise seasoned with spices or other added flavorings.

Coconut

Coconut vinegar, made from fermented coconut water, is used extensively in Southeast Asian cuisine (particularly in the Philippines and Sri Lanka, major producers, where it is called *suka ng niyog* or *vinakiri*), as well as in some cuisines of India. A cloudy white liquid, it has a particularly sharp, acidic taste with a slightly yeasty note.

Palm

Palm vinegar, made from the fermented sap from flower clusters of the nipa palm (also called *attap palm*), is used most often in the Philippines, where it is produced, and where it is called *sukang paombong*. Its pH is between five and six.

Cane

Cane vinegar, made from sugarcane juice, is most popular in the Philippines, in particular, the Ilocos Region of the northern Philippines (where it is called *sukang iloko*), although it also is produced in France and the United States. It ranges from dark yellow to golden brown in color, and has a mellow flavor, similar in some respects, to rice vinegar, though with a somewhat “fresher” taste. Contrary to expectation, containing no residual sugar, it is not sweeter than other vinegars. In the Philippines, it often is labeled *assukang maasim* (Tagalog for “sour vinegar”).

Cane vinegars from Ilocos also varies in two different types: *basi* (sweet) and *suka* (sour). The sweet vinegar is used as a wine in Ilocanos, while the other type of vinegar is used as a seasoning and preservative.

A white variation has become quite popular in Brazil in recent years, where it is the cheapest type of vinegar sold. It is now common for other types of vinegar (made from wine, rice and apple cider) to be sold mixed with cane vinegar to lower the costs.

Beer

Vinegar made from beer is produced in the United Kingdom, Germany, Austria, and the Netherlands. Although its flavour depends on the particular type of beer from which it is made, it is often described as having a malty taste. That produced in Bavaria is a light golden colour with a very sharp and not-overly-complex flavour.

East Asian black

Chinese black vinegar is an aged product made from rice, wheat, millet, sorghum, or a combination thereof. It has an inky black colour and a complex, malty flavour. There is no fixed recipe, so some Chinese black vinegar may contain added sugar, spices, or caramel colour. The most popular variety, *Zhenjiang* vinegar, originated in the city of *Zhenjiang*, in the eastern coastal province of Jiangsu, China and also is produced in Tianjin and Hong Kong.

Distilled vinegar

Any type of vinegar may be distilled to produce a colorless solution of about 5% to 8% acetic acid in water. This is variously known as distilled spirit or “virgin” vinegar, or white vinegar, and is used for medicinal, laboratory, and cleaning purposes, as well as in cooking, baking, meat preservation, and pickling. The most common starting material, because of its low cost, is malt vinegar.

Spirit vinegar

The term ‘spirit vinegar’ is sometimes reserved for the stronger variety (5% to 20% acetic acid) made from sugar cane or from chemically produced acetic acid.

Synthetic vinegar

Synthetic vinegar is nothing but a mixture of pure drinking water and acetic acid in a proper ratio. When we say pure drinking water it means the water that have certain specification.

In drinking water, there should be no harmful m.o. or chemicals. *E.coli* and *salmonella*, coliform bacteria faecal streptococci *staphylococcus aureus*, *pseudomonas aeruginosa* are very harmful for us they should not be present in drinking water.

The other things that we check in drinking water are its colour taste and odour; they should be agreeable. The pH of drinking water lies between 6.5 to 8.5. For vinegar preparation harness of the water should be less than 300 otherwise there will be a sedimentation when we add glacial acetic acid to it. More over the taste of the vinegar made from hard water is not as agreeable as that made from soft water.

When we prepare vinegar we should keep in mind that there is no phenols residues iron content should not be more than 0.3 ppm otherwise blackening may occur.

When we take 9.6 litres that means 9600 ml of water and we add 600g of glacial acetic acid this will make a vinegar of strength 5% to 5.75%. The final %age depends upon the purity of glacial acetic acid. The Anhydrous(water free)acetic acid is called glacial acetic acid.

In market we have bottles of various size like 300ml, 600ml, 700ml, 750ml, 900ml. But standard size for vinegar production is 700ml. Fresh bottles should be used for vinegar filling, but if due to some reasons. If it necessary to use "used bottles" then the bottles should be neat, clean and sterilized.

For filling and corking we have various machinery. In market there are automatic filling machine, vacuum filling machines are available. We have to set one quantity we want to pour in the bottle. After filling the vinegar in bottle corking them properly.

Uses of vinegar

Vinegar is commonly used in food preparation, in particular in pickling processes, vinaigrettes, and other salad dressings. It is an ingredient in sauces such as mustard, ketchup, and mayonnaise. Vinegar is sometimes used while making chutneys. It is often used as a condiment. Marinades often contain vinegar.

- 1 Condiment for beetroot - cold, cooked beetroot is commonly eaten with vinegar.
- 2 Condiment for fish and chips - in the Britain and Ireland, salt and malt vinegar (or non-brewed condiment) is sprinkled on chips.
- 3 Flavoring for potato chips - many American, Canadian and British manufacturers of packaged potato chips and crisps feature a variety flavored with vinegar and salt.
- 4 Vinegar pie - a North American variant on the dessert called chess pie. It is flavored with a small amount of cider vinegar and some versions also contain raisins, spices and sour cream.
- 5 Pickling - any vinegar can be used to pickle foods.
- 6 Cider vinegar and sauces - cider vinegar usually is not suitable for use in delicate sauces.
- 7 Apple cider vinegar - Usually placed on the table in small bowls or cups so that people can dip their crab meat into it. Also mixed with water and used to steam crabs.

- 8 Substitute for fresh lemon juice - cider vinegar can usually be substituted for fresh lemon juice in recipes and obtain a pleasing effect although it lacks the vitamin C.
- 9 Saucing roast lamb - pouring cider vinegar over the meat when roasting lamb, especially when combined with honey or when sliced onions have been added to the roasting pan, produces a sauce.
- 10 Sweetened vinegar is used in the dish of pork knuckles and ginger stew, which is made among Chinese people of Cantonese backgrounds to celebrate the arrival of a new child.
- 11 Sushi rice - Japanese use rice vinegar as an essential ingredient for sushi rice.
- 12 Red vinegar - Sometimes used in Chinese soups
- 13 Flavoring - used in the Southern U.S. to flavor collard greens, green beans, black-eyed peas, or cabbage to taste.
- 14 Commonly put into mint sauce, for general palate preference.
- 15 Vinegar - especially the coconut, cane, or palm variety - is one of the principal ingredients of Philippine cuisine.
- 16 White vinegar can be used as flavoring in ham and beans.

Medical uses

Many remedies and treatments have been ascribed to vinegar over millennia and in many different cultures; however, few have been verifiable using controlled medical trials and many that are effective to some degree have significant side-effects and carry the possibility of serious health risks.

Soothing for sunburns

Possible cholesterol and triacylglycerol effects

Blood glucose control and diabetic management

Diet control

Antimicrobial use

Cleaning uses

Vinegar is useful to clean strains from carpet, Electronic devices, strains of wax, glassware and strains of rustroom too.

Indian Standard Specifications For Drinking Water Is: 10500

S. No	Parameter	Requirement	Desirable Limit
1	Colour	5	May be extended upto 50 if toxic substances are suspected.
2	Turbidity	10	May be relaxed up to 25 in the absence of alternate.
3	pH	6.5 to 8.5	May be relaxed up to 9.2 in the absence.

4	Total Hardness	300	May be extended up to 600
5	Calcium as Ca	75	May be extended up to 200
6	Magnesium as Mg	30	May be extended up to 100
7	Copper as Cu	0.05	May be relaxed up to 1.5
8	Iron	0.3	May be extended up to 1
9	Manganese	0.1	May be extended up to 0.5
10	Chlorides	250	May be extended up to 1000
11	Sulphates	150	May be extended up to 400
12	Nitrates	45	No relaxation.
13	Fluoride	0.6 to 1.2	If the limit is below 0.6 water should be rejected, Max. Limit is extended to 1.5
14	Phenols	0.001	May be relaxed up to 0.002
15	Mercury	0.001	No relaxation
16	Cadmium	0.001	No relaxation
17	Selenium	0.001	No relaxation
18	Arsenic	0.05	No relaxation
19	Cyanide	0.05	No relaxation
20	Lead	0.1	No relaxation
21	Zinc	5.0	May be extended up to 10.0
22	Anionic detergents(MBAS)	0.2	May be relaxed up to 1
23	Chromium as Cr+6	0.05	No relaxation
24	Poly nuclear aromatic	-	-----
25	Mineral	0.01	May be relaxed up to 0.03
26	Residual free Chlorine	0.2	Applicable only when water is chlorinated.
27	Pesticides Absent	-	-----
28	Radio active	-	-----

Provided that sea water, before being subjected to the above treatments, shall be subjected to desalination and related processes

The related packaging and labelling requirements are provided in regulation 2.1.2 , 2.2.1 and 2.4.5 of Food

Safety and Standards (Packaging and Labeling) Regulations, 2011.

It shall conform to the following standards namely :

S. No.	Characteristic	Requirements
1	Colour not more than 2	Hazen Units/ True Colour Units
2	Odour	Agreeable
3	Taste	Agreeable
4	Turbidity nephelometric turbidity unit (NTU)	Not more than 2
5	Total Dissolved Solids	Not more than 500 mg/litre

S. No.	Characteristic	Requirements
6	pH	6.5 - 8.5
7	Nitrates (as NO ₃)	Not more than 45 mg/litre
8	Nitrites (as NO ₂)	Not more than 0.02 mg/litre
9	Sulphide (as H ₂ S)	Not more than 0.05 mg/litre
10	Mineral Oil	Absent
11	Phenolic (as C ₆ H ₅ OH) compounds	Absent
12	Manganese (as Mn)	Not more than 0.1 mg/litre
13	Copper (as Cu)	Not more than 0.05 mg/litre
14	Zinc (as Zn)	Not more than 5 mg/litre
15	Fluoride (as F)	Not more than 1.0 mg/litre
16	Barium (as Ba)	Not more than 1.0 mg/litre
17	Antimony (as Sb)	Not more than 0.005 mg/litre
18	Nickel (as Ni)	Not more than 0.02 mg/litre
19	Borate (as B)	Not more than 5 mg/litre
20	Anionic surface active agents (as MBAS)	Not more than 0.2 mg/litre
21	Silver (as Ag)	Not more than 0.01 mg/litre
22	Chlorides (as Cl)	Not more than 200 mg/litre
23	Sulphate (as SO ₄)	Not more than 200 mg/litre
24	Magnesium (as Mg)	Not more than 30 mg/litre
25	Calcium (as Ca)	Not more than 75 mg/litre
26	Sodium (as Na)	Not more than 200 mg/litre
27	Alkalinity (as HCO ₃)	Not more than 200 mg/litre
28	Arsenic (as As)	Not more than 0.05 mg/litre
29	Cadmium (as Cd)	Not more than 0.01 mg/litre
30	Cyanide (as Cn)	Absent
31	Chromium (as Cr)	Not more than 0.05 mg/litre
32	Mercury (as Hg)	Not more than 0.001 mg/litre
33	Lead (as Pb)	Not more than 0.01 mg/litre ¹ Hkx III-[k.M 4° Hkkjr dk jkti=k% vIk/kj.k 413
34	Selenium (as Se)	Not more than 0.01 mg/litre
35	Iron (as Fe)	Not more than 0.1 mg/litre
36	Poly nuclear aromatic Hydrocarbons	Not detectable
37	Polychlorinated biphenyle (PCB)	Not detectable
38	Aluminium (as Al)	Not more than 0.03 mg/litre
39	Residual free chlorine	Not more than 0.2 mg/litre
40	i) Pesticide residues considered individually(The analysis shall be conducted by using Internationally established test methods meeting the residue limits specified herein). ii) Total pesticide residue (The analysis shall be conducted by Using Internationally established test methods meeting the residue limits specified herein).	Not more than 0.0001 mg/ litre Not more than 0.0005 mg/litre

S. No.	Characteristic	Requirements
41	"Alpha" activity	Not more than 0.1 picocurie/Litre (Bq)
42	"Beta" activity	Not more than 1 Bacquerel/Litre (Bq)
43	Yeast and mould counts 1 x 250 ml	Absent
44	Salmonella and Shigella 1 x 250 ml	Absent
45	E.Coli or thermotolerant bacteria 1 x 250 ml	Absent
46	Coliform bacteria 1 x 250 ml	Absent
47	Faecal streptococci & Staphylococcus aureus 1 x 250 ml	Absent
48	Pseudomonas aeruginosa 1 x 50 ml	Absent
49	Sulphite reducing anaerobes 1x 50	Absent
50	Vibrio cholera and V. parahaemolyticus 1 x 250 ml	Absent
51	Aerobic Microbial Count The total viable colony count at 200C to 220C in 72 h on agar- agar or on agar - gelatin mixture, and 20 per ml at 370C in 24 h on agar-agar.	Shall not exceed 100 per ml

Preserve, candies and crystallized

Objectives: At the end of this lesson you shall be able to

- perform the process of preserve, candy, crystallized and glazed.

Introduction

Cooking of fruit in syrup is difficult because the syrup has to be maintained at a proper consistency so that it can permeate the whole fruit without causing it to shrink or toughen. Cooking directly in syrup causes shrinking of fruit and reduces absorption of sugar. Highly juicy fruit may be cooked directly.

Preserve are made from mature fruit by treating it in sugar syrup of high concentration till it become tender and translucent in appearance. Preserve can also be made from whole fruit and large pieces of fruit and are and packed in glass bottle covered with sugar syrup for ex:- Amla, apple, pear, mango, Kaonde, papaya, pear, pine - apple, cherry.

Fruit are given different pre-treatment before the preparation of preserve, candies & crystallized depending on the fruit quality. The objective of the pre treatment are to soften the tissue enhance the sugar impregnation, harden the tissue in case of soft fruit, reduce bitterness and improve fruit texture.

Specification (as per F.P.O)

No	Name of product	T.S.S (°Brix)	Fruit content (Minimum %)
1	Preserve	68	55
2	Candies	70	55
3	Glazed fruit	70	55
4	Crystallized fruit	70	55

Definition

Preserve - preserve are made from mature fruit by sugar syrup preserve can also be made from whole fruit and large pieces of fruit. Its pack in glass jars and covered with sugar syrup. The preserve should contain 70°B T.S.S.

Candy - The fruit impregnated with cane sugar and dried its called candy. In candy preparation cane sugar is replaced partly by glucose. The candy should contain 70° brix T.S.S and 25% of the sugar must be invert sugar.

Glazed candy - The dried candy are dipped into syrup followed by dipping into 1% pectin solution. The process of glazing is done to make the candy shine. The sugar water ratio 2:1 is boiled into a syrup. The syrup is filtered and cooled at 93°C.

Crystallized candy - Crystallized candy can also be prepared by dipping the candies in a syrup of 72°Brix for 12-16 hrs. The candied fruits and vegetables is covered

or coated with crystals of sugar is called Crystallized candy.

Pretreatment

The treatments commonly used in the preserve manufacture are brine treatment, calcium treatment, blanching, pricking, etc.

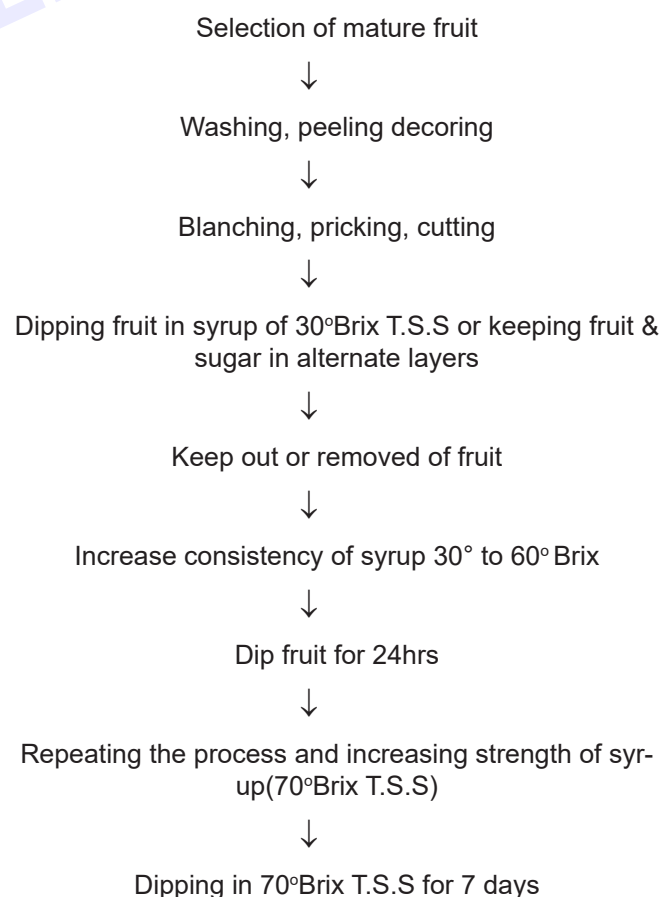
Brine treatment - The fruit are preserved in 10-15% salt solution. The concentration of the brine is monitored regularly to prevent fermentation and spoilage is called brine treatment

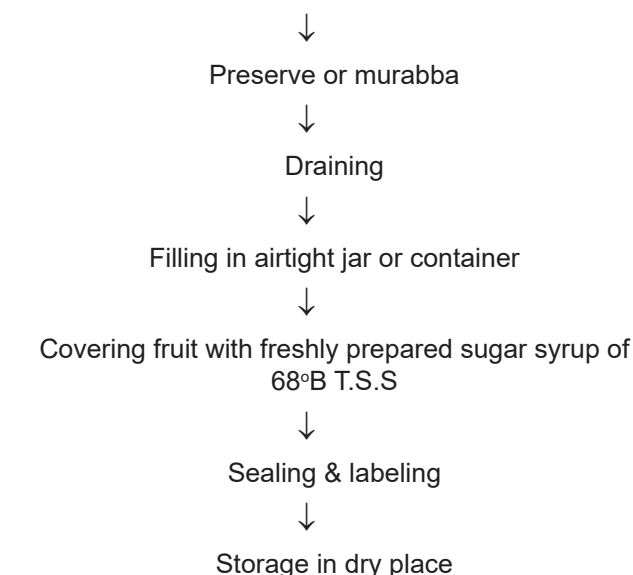
Calcium treatment - By using calcium salt given to soft fruit to harden the tissue is called calcium treatment

Blanching - Blanching is done to soften the tissue it also inactivates enzymes and help in retaining the colour of fruit

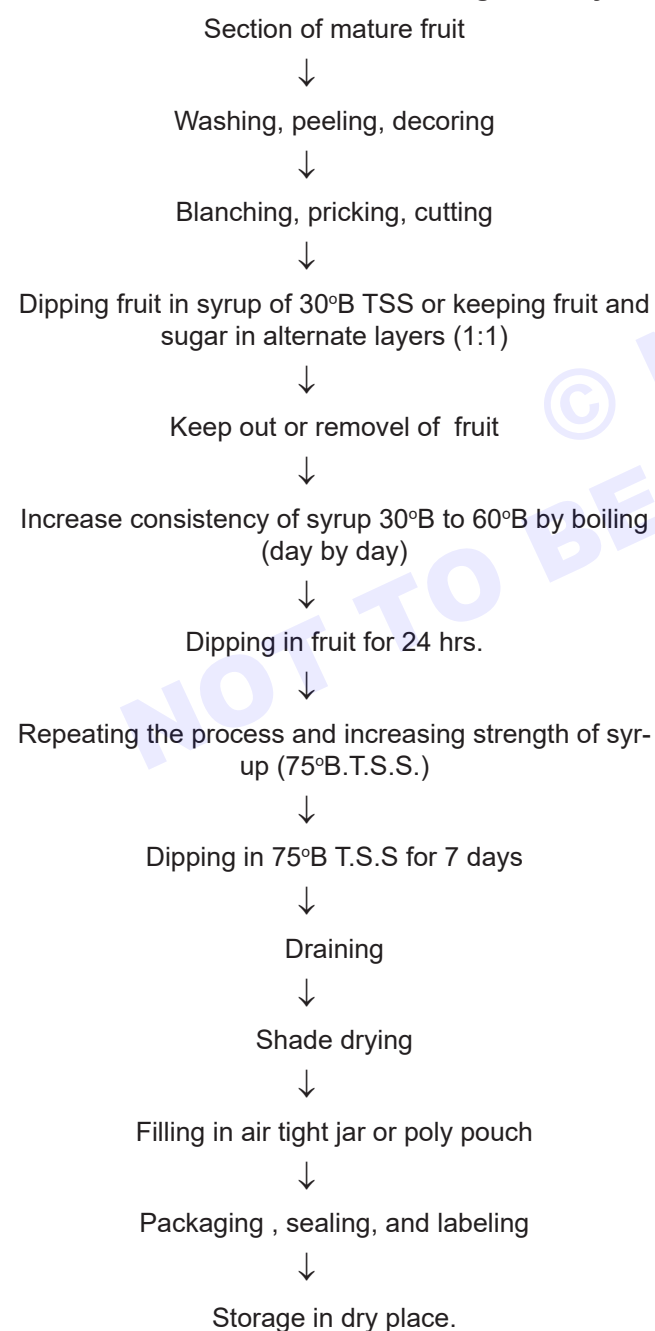
Pricking - Pricking helps in incorporation of sugar syrup to the core the fruit pricking is done so as to affect sugar penetration it is done by stainless steels fork or needless

Common flow sheet for manufacturing of preserve or murabba.

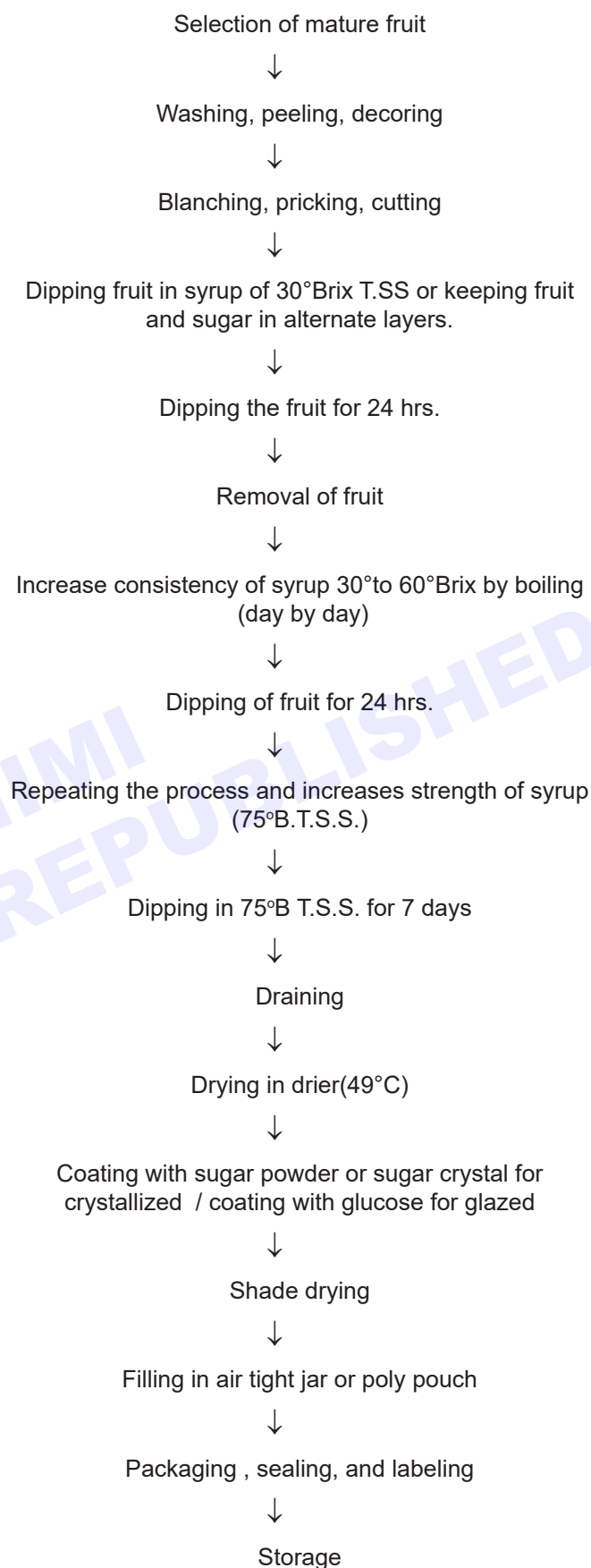




Common flowsheet for manufacturing of candy:



Common flow sheet for manufacturing of glazed and crystallized fruit



Preparation of preserve candy & crystallized

Fruit are washed, peeled, cut, blanched in water to soften the tissue. The fruit pricked & kept in a sugar syrup.

The syrup thin down to the osmosis the fruit are drained, the same syrup is reboiled & added back the process is repeated until the sugar quantity become equal to fruit the preserve is filled in glass container & add with fresh hot syrup of 70°B and sealed.

Fruit may be cooked in syrup by 3 process

- 1 **Rapid process** - Boiling is continued with gentle heating until the syrup become sufficiently thick. Soft fruits such as strawberries & raspberries, which require very little boiling for softening, hard fruit like apple, pears & peaches which require prolonged heating, can be safely cooked in heavy syrup. The final concentrations of sugar should not be less than 68% which corresponds to a boiling point of 106° C. This is a simple & cheap process but the flavour & colour of the product are lost considerably during boiling.
- 2 **Slow process** - The fruit are washed properly & prick hole are seen all over the fruit dissolve alum or salt in water. Dip fruit into alum or salt solution for 24 hrs its depend upon the quality of fruit. After the fruit wash with water thoroughly to remove the traces of salt & alum. Then fruit is blanched until it become tender prepare sugar syrup of one third or 30°B T.S.S. Prepared fruit dip in sugar syrup for 24 hrs. Then removed fruit from sugar syrup boil the sugar syrup until its T.S.S. become 40°B.

Add citric acid and remove scum. Repeat the process for 4 day or one week and every day increase T.S.S. 10°B.

- 3 **Vacuum process** - The fruit is first softened by boiling and then placed in the syrup which should have 30-35°B total soluble solid. The fruit syrup blend is then transferred to vacuum pan and concentrate under reduce pressure to 70°B total soluble solids. This process is better than other two methods.

The preserve made by this process retain the flavour and colour of the fruit is better than other two methods.

Problems in preparation of preserve and candied fruits

- 1 **Fermentation** - It is due to low concentration of sugar used in the initial stage of preparation of preserve Some time fermentation also occurs during storage due to low concentration of sugar and insufficient cooking. This can be prevented by boiling the product

at suitable intervals, by adding the required quantity of sugar and by storage and by storage in cool and place.

- 2 **Floating of fruit in jar** - It is mainly due to filling the preserve without cooling and can be avoided by cooling the preserve prior to filling .
- 3 **Toughening of fruit skin or peel**- It may be due to inadequate blanching or cooking of fruit hence blanching till tender is necessary. Toughness may develop when cooking is done in a large shallow pan with only a small quantity of syrup.
- 4 **Fruit shrinkage**- Cooking of in heavy syrup greatly reduces absorption of sugar and causes shrinkage. Therefore, fruit should be blanched first or cooked in low sugar syrup .
- 5 **Stickiness**:- It may develop after drying or during storage due to insufficient consistency of the syrup, poor quality packing and damp storage condition.

If crystallized and candied are stored under humid conditions, they lose some of their sugar due to absorption of moisture from the air. After that they become mouldy.

These product are hygroscopic water proof packing like metal and glass container which are impermeable to water vapor should be used.

Organisms responsible for food fermentation

The most common group of microorganism involved in food fermentation are.

- 1 Bacteria
- 2 Mould
- 3 Yeast

Major factors influenced of microbial growth and activity

- 1 Moisture
- 2 Oxidation reduction potential
- 3 Temperature
- 4 Ingredients
- 5 pH
- 6 Inhibitors

Fruit bar

Objectives: At the end of this lesson you shall be able to

- prepare fruit bar.

The fruit bar also called as fruit leather or fruit slabs are confectionery products prepared from fruits pulps like, mango, papaya, guava, etc. Mango fruit bar is the most successful traditional product because of its unique flavour, colour and texture.

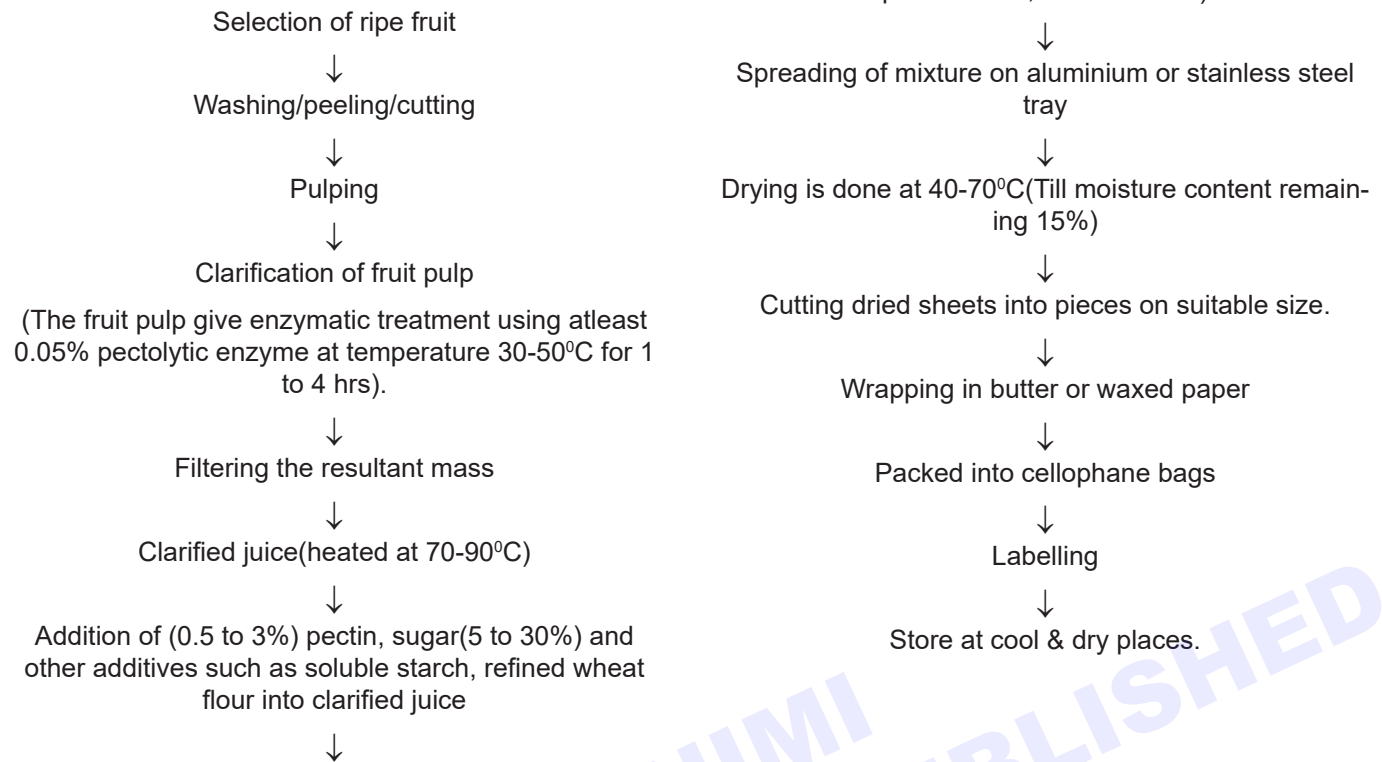
The traditional method of preparation of mango bar are called as tandra.

It involves extraction of pulp than mixing with jaggery in the ratio of 1:2 to 1:4.

After that sun drying the material on bamboo mats adding layer by layer after the previous mats adding layer by layer after the previous one is dried. These slabs of sundried product are cut into slices of uniform sizes, wrapped in cellophane paper and marketed.

Now a days to improve the traditional process with respect to preparation of pulp and mechanization of drying to improve the sensory and microbiological quality of bars from diverse fruits such as banana, guava and papaya.

Flow diagram of preparation of fruit bar.



Fruits and Vegetables Processing - Canning and Preservation of Fruits and Vegetables

Canning of fruits & vegetables

Objectives: At the end of this lesson you shall be able to

- perform canning of fruits/vegetables.

Introduction

The process sealing prepare fruits and vegetable with liquid medium in container and sterilizing them by heat for long storage is known as canning. The process sealing prepare fruits and vegetable with liquid medium in bottle and sterilizing them by heat for long storage is known as bottling.

Nicolas Appert is known as the father of canning. In 1804 Appert in France invented a process of sealing foods hermetically in containers and sterilizing them by heat.

In 1920 establish canning industry in india.

Principle

Destruction of spoilage organism in the sealed container by heat.

1 Destruction of micro-organism by high temperature:

By high temperature inactivate organism and co-aggregate protein of enzymes specially those enzyme which is helps in metabolism.

Factor affecting resistance power of micro-organism to heat:-

- 1 **Water:** Increasing water level of micro-organism decreasing resistance power.
- 2 **Fat :** - Presence of fat increasing resistant power of micro-organisms.
- 3 **pH :** - Increasing of pH decreasing resistance power of micro-organism.
- 4 **Time and Temperature :** - when micro-organism occur contact of high temperature they destruct in short time.
- 5 **Used container for sterilization :** - In large size of container take more time than small size of containers for sterilization.
- 6 **Inhibitory compound :** - If antibiotic or sulphur dioxide are used in product resistance power of organism are decrease.

2 Airtight packaging material:

Airtight packaging material improve shelf life of food product. Air is driven from the jar during heating and as it cools, a vacuum seal is formed. The vacuum seal prevents air from getting back into the product, bringing with it micro-organisms that would recontaminate the food. Generally tin and glass container are used for canning process.

Tin container: Tin container are made of thin steel plate of low carbon content, lightly coated on both sides with tin metal.

Characteristics should be in tin container:

- 1 Tin containers should be airtight, its prevent air to enter inside.
- 2 Tin container should be good conductor of heat its bear 250°F temperature.
- 3 Tin container should be light in weight.
- 4 Tin container should be non toxic.
- 5 Tin container should be free from effect of acidity and alkalinity.

Glass container:

Glass container are preferred for packing baby food because its does not contaminate the contents.

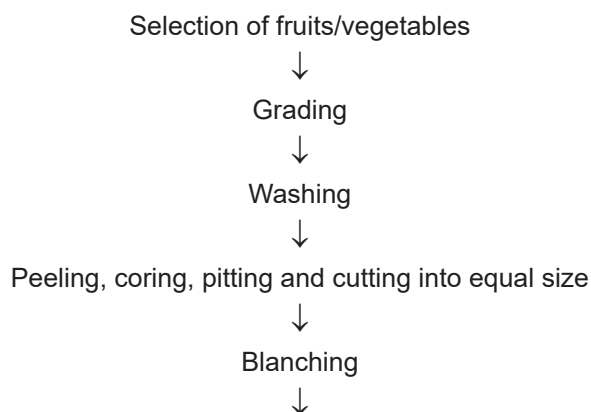
Advantages of glass container:

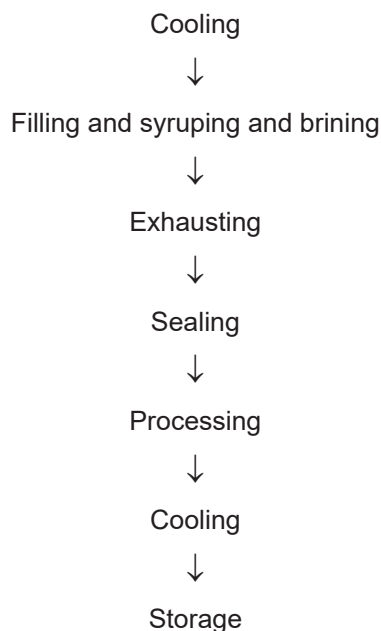
- 1 Its can be reused and recycled.
- 2 Impermeable to gases.
- 3 Its protect aroma and moisture of food.
- 4 Its barrier to micro-organisms.
- 5 Good protection against insects.
- 6 No reaction with food material.
- 7 Its not damaging to the environment.
- 8 Contents can be easily display.

Disadvantage of glass container:

- 1 Its fragile, poor shock resistance.
- 2 Its heavy.

Flow sheet for canning process





Selection of fruits/vegetables: Fruits should be ripe firm and uniformly mature. All vegetables should be tender. Fruits and vegetables should be free from dirt, blemishes, insect damage.

Grading: This is done by hand or by machines such as screw grader and roller grader. Some fruits such as berries, plum cherries etc. are graded whole but mangoes, pineapple, peaches etc. are graded after cutting into pieces or slices.

Washing: washed by soaking in water containing 25 to 30ppm chlorine. Aim of washing are remove dirt, dust and other foreign material on the fruits and vegetables. Vegetables are washed to remove not only field soil and surface microorganisms but also fungicides, insecticide and other pesticides.

3 Peeling, coring, pitting and cutting: Removing of outer layer is called peeling.

Type of peeling:

a Hand peeling:

Irregular shape fruits and vegetables are peeled by hand.

b Mechanical peeling:

Apple, peaches, pineapple, carrots, potatoes, turnip etc. are peeled by machines.

c Steam peeling:

Potatoes and tomatoes are peeled by steam or boiling water.

d Flame peeling:

It is used only for garlic and onion which have a papery outer covering. This is just burnt off.

e Lye peeling:

Fruits and vegetables are dipping in 1 to 2 % boiling caustic soda solution (lye) for 30 seconds to 2 minutes depending on there nature and maturity, Hot lye loosens the skin from the flesh by dissolving the Pectin, The peel

is then removed easily by hand, Any trace of alkali is removed by washing the fruit or vegetable thoroughly in running cold water or dipping it for a few seconds in 0.5 % citric acid solution.

Peas are shelled, carrots are scraped and beans are snapped or trimmed.

Coring - Removing hard portion in centre by coring knife from fruits.

Pitting - Removing of pit by pitting knife.

Cutting into equal size - Pieces of the size required for canning are cut but some fruits such as plum are canned whole.

Blanching - Before filling in can fruits and vegetables are dip in boiling water for 2-5 min and immediately cool in cold water is called blanching.

Aim of blanching :- By blanching process inactivate enzyme that cause the development of off flavour and colour in product and modifying texture of product.

Advantage of Blanching:

- 1 Remove tissues gas.
- 2 Remove saponin in Peas.
- 3 To stable green colour in vegetables such as - Spinach, Peas.
- 4 To reduce microbial load present fruit and vegetable.
- 5 Removes undesirable acids and taste and enhance flavor.
- 6 Inactivates phenolase and oxidase enzyme which cause toughness, discoloration, mustiness, off-flavour softening and test lose of nutritive value.
- 7 Improve texture.

Disadvantages

- 1 Fruits lose their colour, flavor and sugar.
- 2 Water soluble pigment and sugar are dissolve in boiling water.

There are two methods of blanching:

- 1 Boiling in water.
- 2 Steam blanching.

1 Boiling in water:

This method of blanching is good at destroying the enzymes to reduce spoilage but many water soluble vitamins and minerals will be lost if the blanching time is too long.

In this method dipping the fruits or vegetable into a boiling water bath at from 180°F to 200°F for 2 to 5 minutes after the boiling water bath the fruits and vegetable dipped in ice water bath to stop the cooking process.

2 Steam blanching:

Fruits and vegetables are passed on steam through belt.

Blanching by boiling water are popular than steam blanching.

Filling:

Before filling cans are washed with hot water and sterilized to remove dust and foreign material. Fruits are normally filled by hand. After filling, covering, with syrup or brine etc.

Syruping:

Syrup means a solution of sugar in water syruping is done only for fruits. Normally sucrose syrup is used in canning. Syrup is added to improve the flavor. Syrup should be filled at about 79-82°C, leaving a head space of 0.3-0.5 c.m.

Brining:

Brine means a solution of salt in water. Brining is done only for vegetables. Common salt of good quality free from iron should be used. Brine should be filled at about 79-82°C leaving a head space 0.3-0.5 cm Hot brine of 1-3 percent concentration is used for covering vegetables.

Exhausting:

After brining or syruping the cans are loosely covered with lids and exhausted by heating or mechanically.

Aim of exhausting:

- 1 To create vacuum in head space of tin can.
- 2 To prevent corrosion of tin can.
- 3 To reduce air which present in filled fruits and vegetable.
- 4 To stable nature of filled fruits and vegetable.
- 5 Protect from micro-organism.

Method of exhausting:

- 1 By heating.
- 2 By mechanically.

1 By heating:

The heat treatment method is generally used. In this method cans are passed through a tank of hot water. Cans are heated till the temperature of water reached 82-100°C and the centre of the can shows a temperature of about 79°C for 6-10 minutes. Generally exhaust the cans at a lower temperature for a longer period to ensure uniform heating of the contents so that desirable water vapour formed and sufficient vacuum produce in the can because higher temperature produce more water vapour resulting greater the vacuum produce in the can.

For glass jar and bottles vacuum closing machines are generally used, jars and bottles are placed in a closed chamber in which a high vacuum is maintained.

Advantage of exhausting:

- 1 Reduce chance of chemical reaction between the container and product.
- 2 Prevents bulging of cans.
- 3 Minimize discolouration by preventing oxidation.

4 Prevent corrosion of the tin plate.

5 To remove air and gases from cans.

6 Protect from micro-organism which present in air.

Sealing:

After exhausting the cans are sealed by can sealer. During sealing the temperature should not fall below 74°C. In case of glass jars a rubber ring should be placed between the mouth of the jar and the lid, so that it can be sealed airtight.

Processing:

Heating of foods for preserving. The sealed cans are placed in the cookers, keeping the level of water 2.5 to 5.0 cm. above the top of the cans. Cooker heated to the desired temperature after heating for the required period the cooker is removed from the fire. Time and temperature of processing vary with the size of cans and the nature of the foods. Large can take more time than small can.

Factor affecting of processing:

- 1 Thermal conductivity of can.
- 2 Concentration of sugar and salt solution.
- 3 Colloidal matter.
- 4 Quantity of fruits and vegetable filled in can.
- 5 Size of can.
- 6 Initially temperature of filled fruits and vegetable.
- 7 Temperature of retort.

1 Thermal conductivity of can:

Thermal conductivity of tin container is better than glass container but fruits and vegetable are perishable, water are barrier to heat penetration so sugar syrup or brine solution are used as a canning medium. In the presence of canning medium heat penetration process become fast.

2 Concentration of sugar and salt solution:

Salt percentage of canning medium are very low so it does not affect processing time. If sugar concentration is high processing time is long.

3 Colloidal matter:

Starch barrier to heat penetration in can so potato or other starch material take long processing time.

4 Size of can:

Large size of can take long time of processing.

5 Temperature of retort:

If retort temperature is high processing time is short.

Cooling:

After processing the cans are cooled rapidly to about 39°C to stop the cooling process and to prevent stack - burning.

Types of cooling:

- 1 Dipping the heat cans in tanks containing cold water.
- 2 Exposing the cans to air.
- 3 Spraying cold water on cans.

Cans are properly dry other wise cans containing rust during storage.

Storage : - Cans are store cool and dry place.

Given table for sugar syrup.

Sugar(gm)	Water((litre)	Brix(%)
0.818	1	45
1.000	1	50
1.222	1	55

Given table for brine solution.

Salt(gm)	Water((litre)	Brix(%)
10.00	1	1
20.40	1	2
30.92	1	3

Corrosion on can: Cans having external rust, removing the rust if the walls show a pitted appearance.

Removing of corrosion: Rust remove on the cans by these type of method.

- 1 Use white vinegar
- 2 Use a lime and salt
- 3 Use baking soda
- 4 Use potato and dish soap
- 5 Use oxalic acid

1 Use white vinegar: The vinegar reacts with the rust to dissolve it off of the metal. To use, soak the metal in white vinegar for a few hours and then scrub the rusty paste off. Dipping aluminium foil in the vinegar and using it as a brush to scrub off the rust. It is less abrasive than steel wool, but will still do the trick in removing the rust.

2 Use a lime and salt: Sprinkle salt over the rusted area so that it is thoroughly coated and then juice a lime over the top use as much juice as you can get, and allow the mixture to set for 2-3 hours before scrubbing off.

Use the rind from the lime to scrub remove the rust without further damaging the metal.

A lemon can also be used instead of a lime.

3 Use baking soda: Mix baking soda with water until it is thick enough to spread on the metal. Allow time for it to set and then scrub off. Use a toothbrush to scrub the baking soda off, and rinse with water.

4 Use Potato and dish soap: Cut the potato in half and cover the cut end in dish soap. This will make a chemical reaction with the rust, making it easier to remove. Place the potato on the metal and leave it for a few hours. To reapply, simply cut off the used end of the potato and add more soap, setting it soak into the metal for more time.

5 Use oxalic acid: Take protective precautions with this method use rubber gloves, goggles and protective clothing. Do not smoke or directly inhale the fumes of the acid. Wash the rusted item with washing-up liquid rinse and carefully dry.

Soak the item for approx 20 minutes or clean down the item with a cloth or brass brush, wash fully and dry the item when rust removed is finished.

Defects in canned products:

There are two types of defects in canned food product.

- 1 External symptom.
- 2 Internal symptom.

1 External symptom:

This type of spoilage occure on the can.

a Flipper: Cans have some external pressure this symptom is called flipper. Its primary stage of spoilage.

b Springer: Cans lid swell one or both side is called springer. There are minor difference between springer and bulging when can lid clinch with finger its go inside and remove the finger lid again go to original shape its calling springer.

c Bulging of cans: When flipper and springer condition increase in can this condition called bulging.

Bulging(swelling) of can due to-

1 Swelling by carbon-di-oxide: When carbon di-oxide gas produce in cans,cans are swell.carbon di-oxide gas produce due to micro-organism.when CO₂ produce product be odourous and soury in taste and some times its be poisonous.

2 Swelling by Hydrogen gas: Hydrogen gas produce inside in can when acid and tin plate react with each other.Reaction of tin plate and acid is called corrosion.

3 Leaker and Breather: when hole become in can if visual are leaker and if not visual are breather.

4 Bursting of can: When producing of gas in can are so high that lid can not bear it and it burst to joint.

5 Rusting: presence of moisture creating rusting on can its decrease market value of canned product. Rusting become some times due to leaker and breather or cooling of cans more than desirable.

2 Internal symptom:

This type of changes inside in can or canned food such as

- a Shrinkage
- b Odourous
- c Sourness
- d Discolouration

Internal defects in canned products occur by two reasons

- 1 Chemical reaction.
- 2 Microbial attack.

1 Chemical reaction: By chemical reaction canned food become discoloured or tin corrosion.

a Tin corrosion: Tin container made from steel and coated with tin layer.

Tin layer dissolves in acids of canned product when steel comes in direct contact with canned product, it produces hydrogen gas. This hydrogen gas produces corrosion and corrosion produces holes in cans.

Precaution:

- 1 Cans are stored in cool and dry places.
- 2 Plain cans are used for red and pink colour juices.
- 3 Lids are clinched before exhausting.
- 4 Exhausting should be done proper time and period.
- 5 When cans are sealed, its temperature should be not less than 165° F.
- 6 Leave proper head space during preparation of material fill in cans.
- 7 Lid of cans should be clinched before exhausting because it improves shelf life of canned product.

Discolouration:

Discolouration becomes due to biological causes like enzymatic and non-enzymatic browning or metallic contamination.

Non-enzymatic browning: Non-enzymatic browning affects colour and nutritive value of canned food.

Types of non enzymatic browning reaction:

- 1 Maillard reaction:** Maillard reactions caused by reaction between amine, amino acid, protein, sugar, aldehydes, ketone.
- 2 Caramelization:** Degradation of sugar in absence of amino acid is called caramelization. When sugar is heated above melting point it becomes brown colour is called caramel.

Microbial Attack:

In the following changes occur due to micro-organism.

Sl.no.	Micro-organism	Defect	Causes
1	1. Bacillus coagulans	Sour, odours, haze, cloudy	Insufficient processing, hole in containers

Decomposition of ascorbic acid in presence of oxygen or absence of oxygen is called oxidation of ascorbic acid.

Prevention of non-enzymatic browning:

- 1 Store in low relative humidity and temperature.
- 2 Decreasing pH value in products.

Metallic Discolouration :- Ferrous and copper react with canned food and make salt compound. This compound discolours canned product.

Some compounds which discolour canned product:

- 1 Ferric tannate:** When tannin of fruits and vegetables reacts with ferrous of cans, it makes ferric tannate compound and produces black layer on canned fruits and vegetables.
- 2 Iron Sulphide:** Sulphur-dioxide (SO₂) enters in can by liquid filling medium. SO₂ reacts with hydrogen gas and produces hydrogen sulphide. This compound reacts with iron and produces iron sulphide. This compound makes black layer on fruits and vegetables.
- 3 Copper Sulphide:** Copper enters in can by machinery. When copper reacts with hydrogen sulphide, it produces copper sulphide compound. This compound makes black layer on canned fruits and vegetables.

Enzymatic browning: Enzymatic browning due to the polyphenol oxidase enzyme present in fruit and vegetables. This type of enzymatic browning reaction is avoided by placing the peeled and cut pieces in 2% salt solution. Chlorogenic acid is responsible for browning of apple, peach etc.

Prevention of enzymatic browning reaction:

- 1 Use of temperature.
- 2 Use of SO₂ or sulphite.
- 3 Use of salt
- 4 Keep out air.
- 5 Use of acid.
- 6 Use of Boric acid and Borate.
- 7 Packaging should be free from acidity and alkalinity.
- 8 Packaging material such as can or bottle should be airtight.
- 9 Packaging material should be not toxic and non reactive with products.
- 10 Packaging should be material light in weight.

Sl.no.	Micro-organism	Defect	Causes
2	B.subtilis	Sour	Low pH, Insufficient processing
3	B.macerans	Odourous like decomposed egg	Produce iron sulphide
4	Clostridium thermosaccharolyticum	Purification, Sour, Butyric odours	Insufficient processing
5	Bacillus polymyxa	low pH	Insufficient processing
6	Lactobacillus brevis	Sourness	Insufficient processing
7	Clostridium thermosaccharobutyricum	Purification, foggy, odours, low pH, produce hydrogen and O ₂	Insufficient processing
8	Clostridium butyricum	Foggy appearance	Insufficient processing

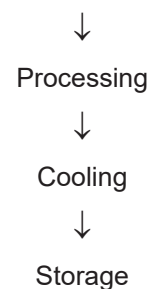
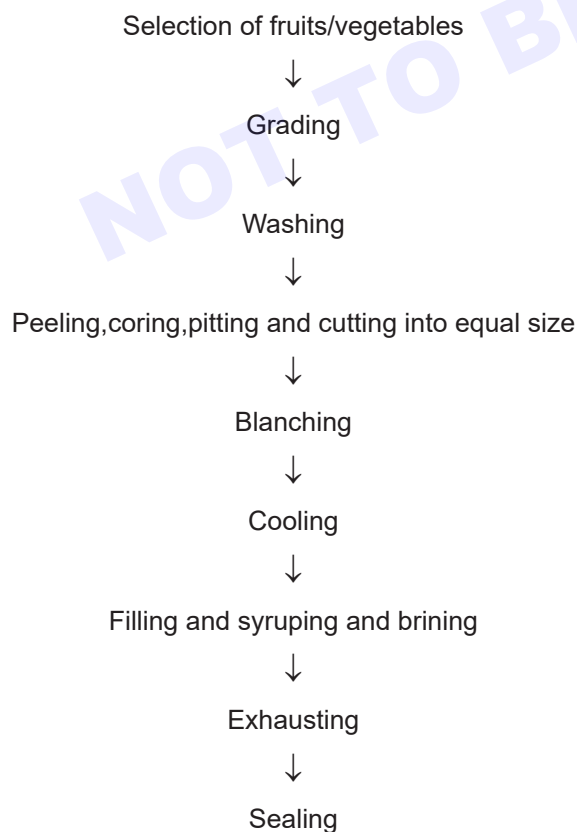
Lacquers:

The contents of the can may react with these uncoated spots resulting in discolouration of the product or corrosion of the tin plate. When the corrosion is severe, black stains of iron sulphide are produced, it is necessary can coated with those material (lacquer) which prevents discolouration but does not affect the flavour of product.

There are two types of lacquers:

- 1 Acid-resistance:** This is a golden colour enamel when cans are coated with this type of enamel is called R-enamel or A.R. cans.
- 2 Sulphur-resistant:** This lacquer is a golden colour when cans coated with it are called C-enamel or S.R. cans. This type of lacquer is used for non acidic foods.

Flow sheet for canning process



Selection of fruits/vegetables: Fruits should be ripe firm and uniformly mature. All vegetables should be tender. Fruits and vegetables should be free from dirt, blemishes, insect damage.

Grading: This is done by hand or by machines such as screw grader and roller grader. Some fruits such as berries, plum cherries etc. are graded whole but mangoes, pineapple, peaches etc. are graded after cutting into pieces or slices.

Washing: washed by soaking in water containing 25 to 30ppm chlorine.

3 Peeling, coring, pitting and cutting: Removing of outer layer is called peeling.

Type of peeling:

- a Hand peeling:** Irregular shape fruits and vegetables are peeled by hand.
- b Mechanical Peeling:** Apple, peaches, pineapple, carrots, potatoes, turnip, etc. are peeled by machines.
- c Steam peeling:** Potatoes and tomatoes are peeled by steam or boiling water.
- d Flame peeling:** It is used only for garlic and onion which have a papery outer covering. This is just burnt off.
- e Lye peeling:** Fruits and vegetables are dipping in 1 to 2 % boiling caustic soda solution (lye) for 30 seconds to 2 minutes depending on there nature and maturity, Hot lye loosens the skin from the flesh by dissolving the Pectin, The peel is then removed easily by hand,

Any trace of alkali is removed by washing the fruit or vegetable thoroughly in running cold water or dipping it for a few seconds in 0.5% citric acid solution.

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Pitting - Removing of pit by pitting knife.

Cutting into equal size - Pieces of the size required for canning are cut but some fruits such as plum are canned whole.

Blanching - Before filling in can fruits and vegetables are dip in boiling water for 2-5 min and immediately cool in cold water is called Blanching.

Advantage of Blanching :

- 1 Remove tissues gas.
- 2 Remove saponin in Peas.
- 3 To stable green colour in vegetables such as- Spinach, Peas.
- 4 To reduce microbial load present fruit and vegetable.
- 5 Removes undesirable acids and taste and enhance flavor.
- 6 Inactivates phenolase and oxidase enzyme which cause toughness, discoloration, mustiness, off-flavour softening and lose of nutritive value.
- 7 Improve texture.

Disadvantages

- 1 Fruits lose their colour, flavor and sugar.
- 2 Water soluble pigment and sugar are dissolve in boiling water.

Method

Fruits are dip into water at from 180°F to 200°F for 5 minutes, and then immediately cooled by immersion in cold water. Improve keeping quality of fruits and vegetable.

Filling - Before filling cans are washed with hot water and sterilized to remove dust and foreign material. Fruits are normally filled by hand. After filling, covering, with syrup or brine, etc.

Syruping : Syrup means a solution of sugar in water syruping is done only for fruits. Normally sucrose syrup is used in canning. Syrup is added to improve the flavor. Syrup should be filled at about 79-82°C, leaving a head space of 0.3-0.5 cm.

Brining : Brine means a solution of salt in water. Brining is done only for vegetables. Common salt of good quality free from iron should be used. Brine should be filled at about 79-82°C leaving a head space 0.3-0.5 cm Hot brine of 1-3 percent concentration is used for covering vegetables.

After brining or syruping the cans are loosely covered with lids and exhausted by heating or mechanically. Generally heat treatment method is used. The cans are

passed through a tank of water. Cans are heated till the temperature of water reached 82-100°C and the centre of the can shows a temperature of about 79°C for 6-10 minutes.

Sealing - After exhausting the can are sealed by can sealer. During sealing the temperature should not fall below 74°C. In case of glass jars a rubber ring should be placed between the mouth of the jar and the lid, so that it can be sealed airtight.

Processing: Heating of foods for preserving. The sealed cans are placed in the cookers, keeping the level of water 2.5 to 5.0cm. above the top of the cans. Cooker heated to the desired temperature after heating for the required period the cooker is removed from the fire. Time and temperature of processing vary with the size of cans and the nature of the foods. Large can take more time than small can.

Cooling: After processing the cans are cooled rapidly to about 39°C to stop the cooking process and to prevent stack - burning.

Types of cooling:

- 1 Dipping the heat cans in tanks containing cold water.
- 2 Exposing the cans to air.
- 3 Spraying cold water on cans.

Cans are properly dry other wise cans containing rust during storage.

Storage: Cans are store cool and dry place.

Given table for sugar syrup.

Sugar(gm)	Water(litre)	Brix(%)
0.818	1	45
1.000	1	50
1.222	1	55

Given table for brine solution.

Salt(gm)	Water(litre)	Brix(%)
10.00	1	1
20.40	1	2
30.92	1	3

Advantage of exhausting :

- 1 Reduce the chance of chemical reaction between the container and product.
- 2 Prevents building of cans. When it store in hot climate or at high altitude.
- 3 Minimize discolouration by preventing oxidation.
- 4 Prevent corrosion of the tin plate.
- 5 To remove air and gases from cans.

Scheme and layout of canning industry

Objectives: At the end of this lesson you shall be able to

- explain points to be consider before setup a canning industry
 - explain layout of canning industry.
-

The various important factors that have to be taken into consideration before setting up a fruits & vegetables processing industry are given below:

1 Investment

- The capital, investment on land, factory building and machinery.
- The running or operational expenses like cost of raw material, labour, processing, storage, transport & distribution.
- The type and size of production unit should plan carefully which would be most advantageous.

2 Factory site

- The site for factory is finalize as per the quantities of the right type of fruit & vegetable should be readily available in this area. Because fruits & vegetables are highly perishable in nature and spoiled during long distance transport.
- The site environment should be clean & free from dust. The site should be at a considerable distance from other industrial factories spreading smoke and disagreeable odour which effect the quality of products.
- The proper facilities should be there for disposal of the wastage.
- The proper facilities for the movement of raw material & finished product & should be there, proper facility of water supply.
- The land for future expansion of the factory.

3 Factory building

After selecting the site. The type of building is to be considered. The factory building may be single storied and multi storied its depends upon the work periods of the plant. If smaller plant and work for short period during year a single storied building is to be prefer. If larger plants that have to run almost throughout the year than multi storied construction is desirable. Generally ventilation and lighting are also better in single storied building.

Generally fruit & vegetable canneries are single storied.

In cannery the organization cover space as per the type of product to be canned and scale of operation.

- The space of plant is divided according to the steps of the canning process.
 - a Receiving and storage section for raw material and finished product.
 - b Pre processing section for preparation of fruits & vegetable for processing.
 - c Processing section like filling, exhausting, sealing etc.
 - d Laboratory.

5 Availability of labour

The availability of labour should be there in peak season.

6 Water supply

Any good drinking water supply is suitable for canning industry. The water should be free from contamination. The water play an important role in canning industry. The water is used for

- Cleaning of equipment Floor, Wall etc.
- Washing and preparation of fruits and vegetables.
- Preparation of brine and syrup solution.
- It is also used for blanching & cooling of the product.
- Water is used in boiler for steam generation.

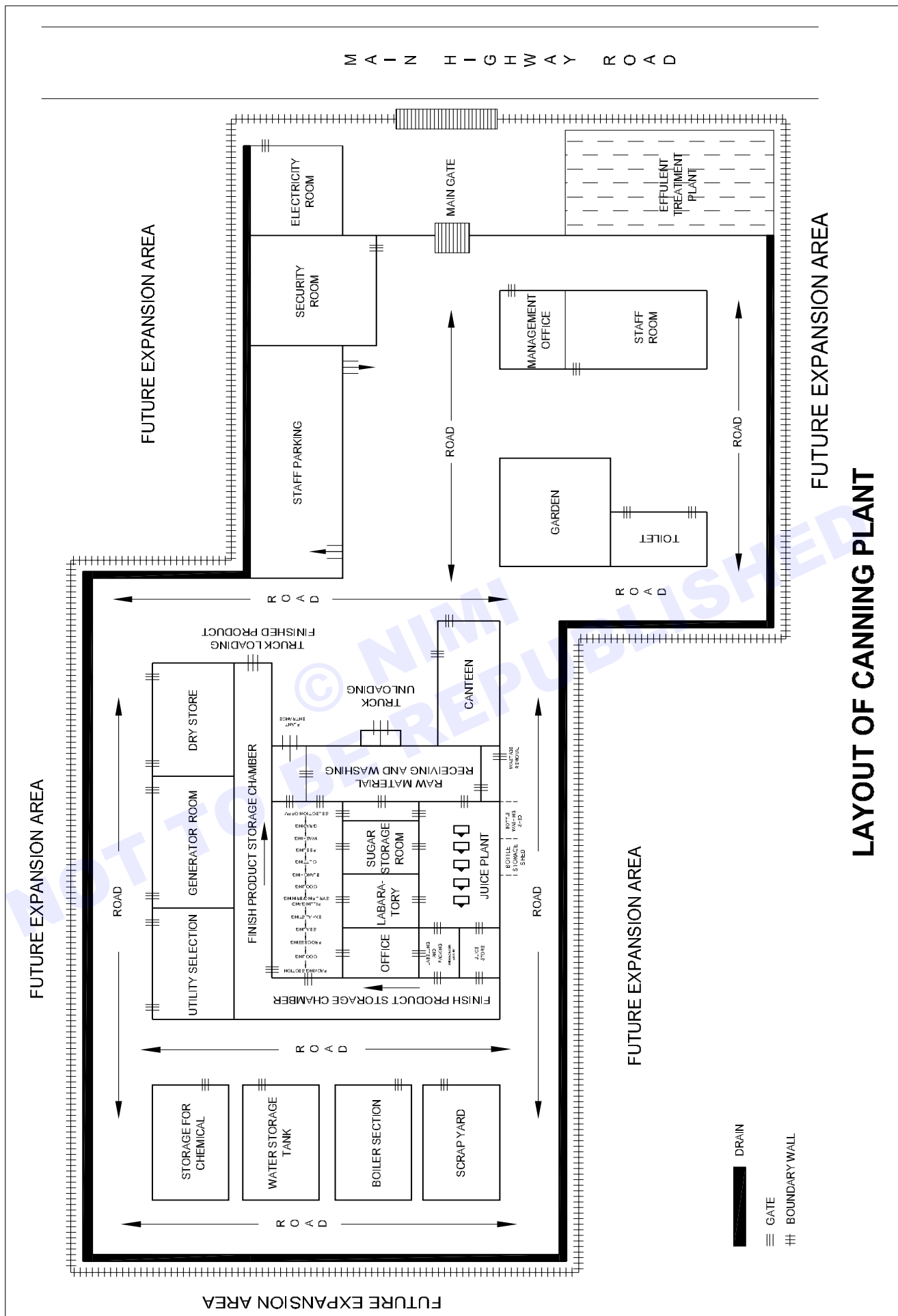
7 Disposal of cannery waste

During canning process a very large quantity of waste is produced such as skins peels and starchy material. Hence the canning industry should be situated at a place where waste could be profitably utilized to make by-products.

8 Transport facilities

The transport plays a very important for raw material in canning and finished product outgoing from canning industry.

- The canning industry should be situated on road, near a road which connects with local town and cities.



Identification defects of cans

Objectives: At the end of this lesson you shall be able to

- defects in canned products.

Defects in canned products :

Defects canned products occur by two reasons

- 1 Chemical reaction.
- 2 Microbial attack.

1 Chemical reaction: By chemical reaction canned food become discolourate or tin corrosion.

a Tin corrosion: Tin container made from steel and coated with tin layer

Tin layer dissolve in acids of canned product when steel become direct contact with canned product produce hydrogen gas. This hydrogen gas produce corrosion and corrosion produce hole in cans.

Precaution :

- 1 Cans are store in cool and dry places.
- 2 Plain cans are used for red and pink colour juices.
- 3 Lids are clinch before exhausting.
- 4 Exhausting should be done proper time and period.

Discolouration: Discolouration become due to biological causes like enzymatic and non-enzymatic browning or metallic contamination.

Enzymatic browning due to the polyphenol oxidase enzyme present in fruit and vegetables this type of enzymatic browning reaction avoided by placing the peeled and cut pieces in 2% salt solution.

Non-enzymatic browning/maillard reactions caused by reaction between amine, amino acid, protein, sugar, aldehydes, ketone.

Degradation of sugar in absence of amino acid is called caramelization. When sugar is heated above melting point it become brown colour is called caramel.

Decomposition of ascorbic acid in presence of oxygen or absence of oxygen (oxidation of ascorbic acid)

Prevention of non-enzymatic browning:

- 1 Store in low relative humidity and temperature.
- 2 Decreasing pH value in products.

Metallic Discolouration : Ferrous and copper react with canned food and make salt compound. This compound discolourate canned products.

Prevention of enzymatic browning reaction:

- 1 Use of temperature.
- 2 Use of SO₂ or sulphite.
- 3 Use of salt
- 4 Keep out air.

5 Use of acid.

6 Use of Boric acid and Borate.

Microbial Attack:

In the following changes occur due to micro-organism.

Micro-organism	Defect	Causes
Bacillus coagulans	Sour, Odours, Haze, Cloudy	insufficient processing, hole in containers
B. subtilis	Sour	Low pH, insufficient processing.
B. macerans	Odourous like decomposed egg	produce iron sulphide
Clostridium thermo-saccharolyticum	Purification, Sour, Butyric odours	insufficient processing.
Clostridium butyricum	Foggy appearance	insufficient processing.
Bacillus polymyxa	Low pH	insufficient processing.
Lactobacillus brevis	Sourness	insufficient processing.
Clostridium thermo-saccharolyticum	Purification, Foggy, Odours, Low pH, Produce hydrogen & O ₂	insufficient processing.

Lacquers : The contents of the can may react with these uncoated spots resulting in discolouration of the product or corrosion of the tin plate. When the corrosion is severe, black stains of iron sulphide are produced, it is necessary can coated with those material (lacquer) which prevents discolouration but does not affect the flavour of product.

There are two types of lacquers :

- 1 Acid-resistance:** This is a golden colour enamel when cans are coated with this type of enamel is called R-enamel or A.R. cans.
- 2 Sulphur-resistant:** This lacquer is a golden colour when cans coated with it are called C-enamel or S.R. cans. This type of lacquer is used for non acidic foods.

Fruits and Vegetables Processing - Canning and Preservation of Fruits and Vegetables

Study of frozen fruits & vegetables

Objectives: At the end of this lesson you shall be able to

- detail of freezing
- types of freezing
- method and principle of freezing.

Freezing

Freezing is a method of preservation. It is one of oldest method. Which allow preservation of taste, texture and nutritional value in foods better than any other method.

Freezing processes is a combination of the beneficial effects of low temperature at which chemical reactions are reduced, microorganism cannot grow, and cellular metabolic reaction are delayed.

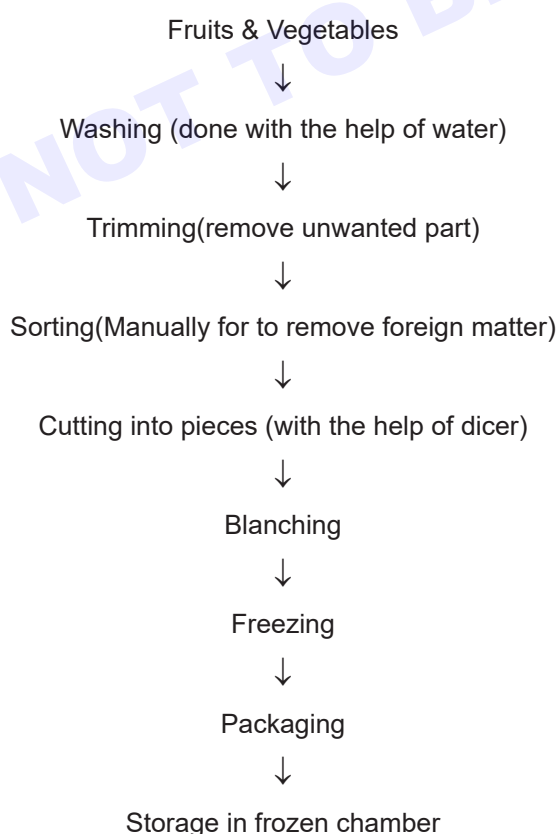
The rate of freezing of food depends upon a number of factors such as the method employed, the temperature, circulation of air & refrigerant, size and shape of package, kind of food, etc.

The freezing of fruits & vegetables is done at -18°C . The time temperature combination is depends upon the kind of fruits & vegetables.

At -18°C fruits are usually retain good quality for 12 month and vegetable for 8-12 month. Increasing the storage temperature result in decreasing shelf life.

Freezing is cheaper than canning and frozen products are of better quality than canned products.

Flow sheet of fruits and vegetable for freezing



Method of Freezing

Selection of fruits and vegetable : Select mature vegetables and ripe fruits. Avoid defected fruits and vegetables.

Grading: Fruits and vegetable are graded according size, colour, stage of ripeness by different types of grader.

Washing, peeling, trimming, decorating: Fruits and vegetables are wash with water by dipping or spray. Remove outer skin by peeler and hard portion from centre to fruits.

Re-observation: Observe fruits and vegetable so that rodent, defected, improper peel, not fully mature should be reduce again.

Blanching: Blanching process is apply only for vegetables. Vegetables are keep in boiling water for 2 to 5 minutes and immediately keep in cold water so that gases are removed from tissue, inactivate undesirable enzyme and micro-organism, stabilize colour and flavour.

It is defined as scalding, parboiling or precooking. Blanching is require in case of vegetables & some of the fruits having spoilage due to enzyme activity. Enzyme responsible for their spoilage are "Peroxidase & Catalase". In case of vegetable the enzyme involved is 'peroxidase' which is required to be inactivated during blanching to have better shelf life of the product.

The blanching is done in case of vegetables and some fruits by exposing them into boiling water or steam for 2 to 5 minutes at 82°C to 93°C than immediately cooled by immersion in cold water (5°C).

Packaging: Two types packaging material are used for packaging.

1 Primary packet.

2 Secondary packet.

1 Primary packet: Fruits and vegetable are fill in primary packet. Primary packet direct contact of fruits and vegetables such as

a Box: Its capacity 454 kg.

b Paper board: Folding box are more popular.

c Pouch: Craft paper pouches are more popular. Its is suitable for those product which is separate to each other after freezing like pea.

d Tin can: Its made from tin or alluminium plate. Its is useful for strawberry and other small fruits.

e Plastic film: Generally poly vinylidene chloride, cellophanes, polyesters are used for packaging.

f Slab packing: It is suitable for spinach.

- 2 External packet:** Fibre board and foam polyesterin are used as external packet. External packet should be wrinkled and flexible. External packet protect of packaging material to external damage.

Process of packing:

- 1 Filling:** Prepare fruits and vegetables are fill in packaging material then freeze it but some prepare fruits and vegetables are freeze then fill it.
- 2 Sealing:** Fill packaging material are properly sealed. Paper made packet are sealed by gummy substance and tin container are air tight seal.
- 3 Primary packet are fill in secondary packet:** After freezing when its kept to another place its covered by external packet. After external packaging freeze fruits and vegetables are ready to transport.

Freezing:

There are three method of freezing .

- 1 Air contact freezing.
 - 2 Immersion freezing.
 - 3 Indirect contact freezing.
- 1 Air contact freezing:** Freezing is done by contact of cool and high velocity air etc.
- 2 Immersion freezing:** Fruits and vegetables are dip in solution, chloride brine solution at low temperature or dip in other solution.
- 3 Indirect contact freezing:** Fruits and vegetables are freezed when it come contact of cooled medium.

Freezing: Store fruits and vegetable in freeze condition at 0°C or below is called freezing.

Principle of Freezing:

- 1 Principle of producing low temperature.
- 2 To inactivate micro-organism and enzyme by low temperature.
- 3 Principle of producing low temperature : Heat and temperature those type of energy which transfer to one medium to another medium due to difference of temperature. This properties are used for freezing.

Control of thermodynamic property of heat is called freezing

- 5 To inactivate micro-organism and enzyme by low temperature.
- 6 Thermophilis and mesophilis organism are killed in low temperature.
- 7 Metabolic injury occure in some micro-organism such as pseudomonas species by freezing.
- 8 Micro-organism growth are inhibited in low temperature.

Types of freezing:

- I Slow freezing:** Fruits and vegetables are freeze at -15° to -29°C for 3 to 72 hours but in this method ice crystals formed are large and rupture the cells and thawed tissue can not reconstitute its original size, shape and water content. In this method freezing is done by circulation of cool air.
- II Quick freezing:** Quick freezing is done by three methods
- a By direct immersion:** Fruits and vegetables are dip in brine or sugar solution at low temperature and store at -18°C or below. Brine solution is used for only vegetables. Syrup is used for only fruits. Cooling of brine and syrup is protect flavor of vegetables and fruits. Heat transfer should be very high when product contact with refrigeration medium.
- b By indirect contact with Refrigeration:** In this method package is kept in contact with the passage through which the refrigerant at -18 to -46°C flows.
- c Air blast freezing:** Freezing is done by placing the fruits and vegetables on trays or on a belt which are then passed slow & through an insulated tunnel containing air in it. The air temperature should be -18° to -34°C or low.

Advantage of quick freezing :

- 1 To prevent micro-organism and chemical reaction during freezing, defrosting.
 - 2 Less crystallization effect :- To minimize products inner structure membrane breakage.
 - 3 Less dripping water while defrosting and maintaining as much as possible unique flavor, taste.
- III Cryogenic freezing:** By this method fruits and vegetable are freeze by cooling refrigerants such as :- liquid nitrogen, nitrous oxide, vapour nitrogen liquid, CO₂, dry ice and dry CO₂.

Applying procedure:

- 1 Immersion in the liquid.
- 2 Spraying of liquid.
- 3 Circulation of its vapour over the product to be frozen.
- 4 Freeze by CO₂ : Liquid CO₂ spray on fruits and vegetables. Liquid CO₂ are compressed and spread like a layer on pieces of fruits and vegetables and increase speed of freezing.

Storage: Freeze fruits and vegetables are store atleast -20°F - 29°C and relative humidity should be 85 to 90 %.

General Evaluation of freeze product:

Characteristics	Fresh	Frozen
	(Fruits / Vegetables in %)	
Freshness	100	71
Nutrition value	100	51
Texture	100	62
Taste	100	56

Study of frozen fruits and vegetable

Physical aspect of freezing :- Moisture nitrogen is the principle change occurring in frozen food affecting the physical, chemical and biochemical properties including texture and palatability of the food.

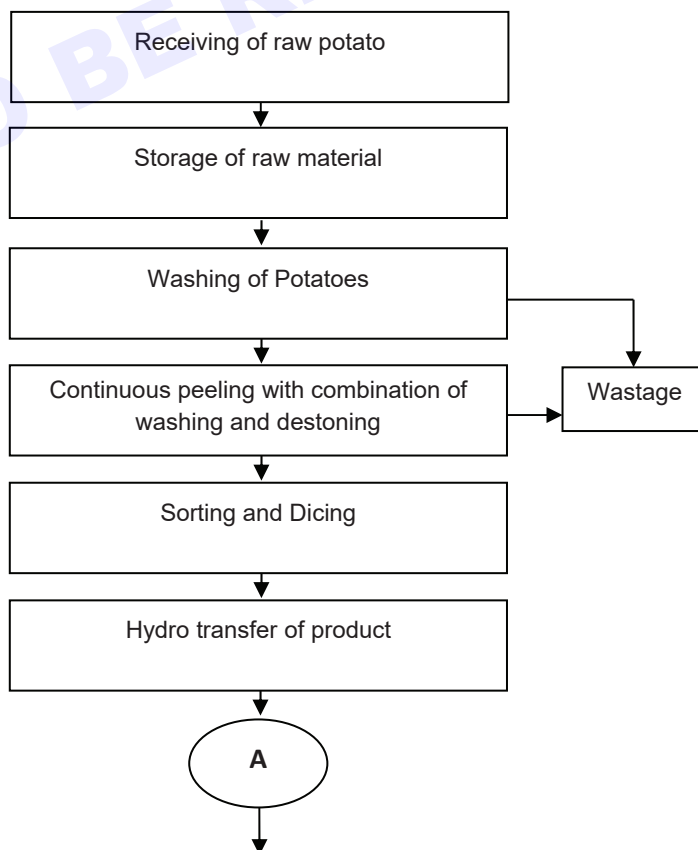
- 1 Texture:** In the process of freezing, when water in the cells freeze, an expansion occurs and ice crystals cause the cell walls to rupture consequently the texture of the produce is generally much softer after thawing when compared to non-frozen product.
- 2** The glassy appearance in some frozen products produced by ice crystals evaporating on the surface

area of a product. The grainy, brownish spots occurring on the product cause the tissue to become dry and tough, weight, moisture proof packaging during the freezing process.

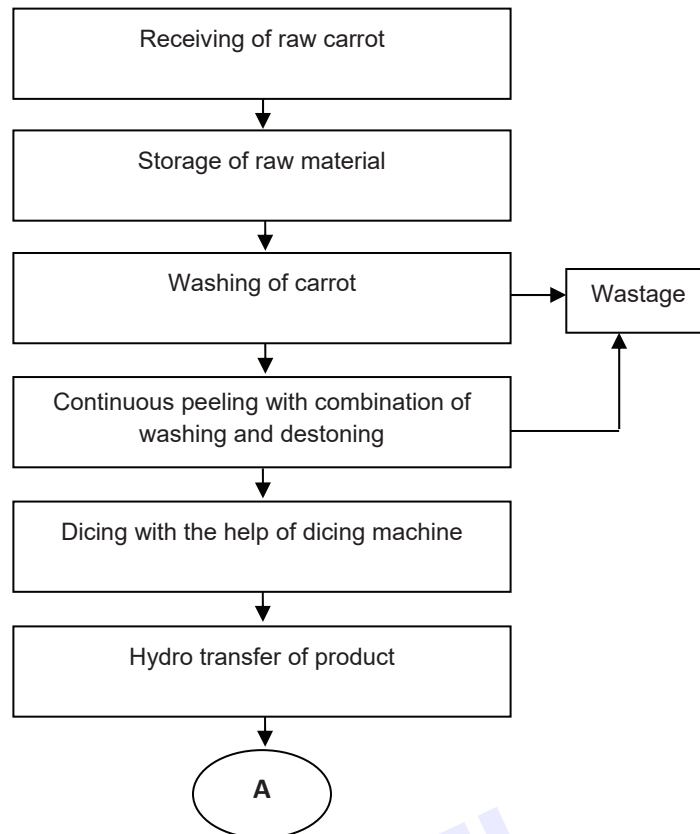
Chemical changes: Some enzymes that causes the loss of colour, loss of nutrients, flavor changes and colour changes in frozen fruits and vegetables. Generally by blanching process destroy this type of enzyme and micro-organism. Some enzymes can be controlled by using chemical compounds which interface with deteriorative chemical reactions. Ascorbic acid is an example that may be used in its pure form or in commercial mixtures with sugars for inhibition of enzymes in fruits

Peas	Shell garden peas	Water blanch 1- ½ minutes, Steam blanch 1- ½ minutes
Potatoes	Peel, cut or grate as desired	Water blanch Whole-5 minutes Pieces->2-3 minutes
Carrots	Wash, Peel and trim cut if desired	Water blanch 5 minutes
Green/Red/Yellow capsicum	Washing, coring and removal of seeds. Sorting and dicing.	Water blanch 2-5 mins at 90 - 94°C.
Sweet corn	Remove peel and removal of kernel from cobs. Washing.	Water blanch 2 - 5 minutes at 90 - 94°C.

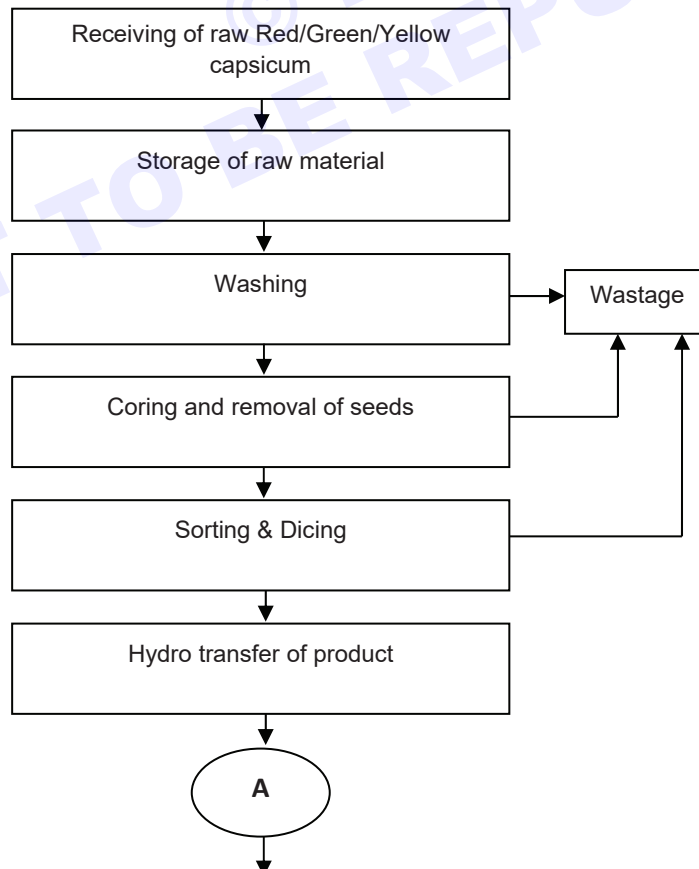
Flow Diagram of frozen diced potatoes cubes processing



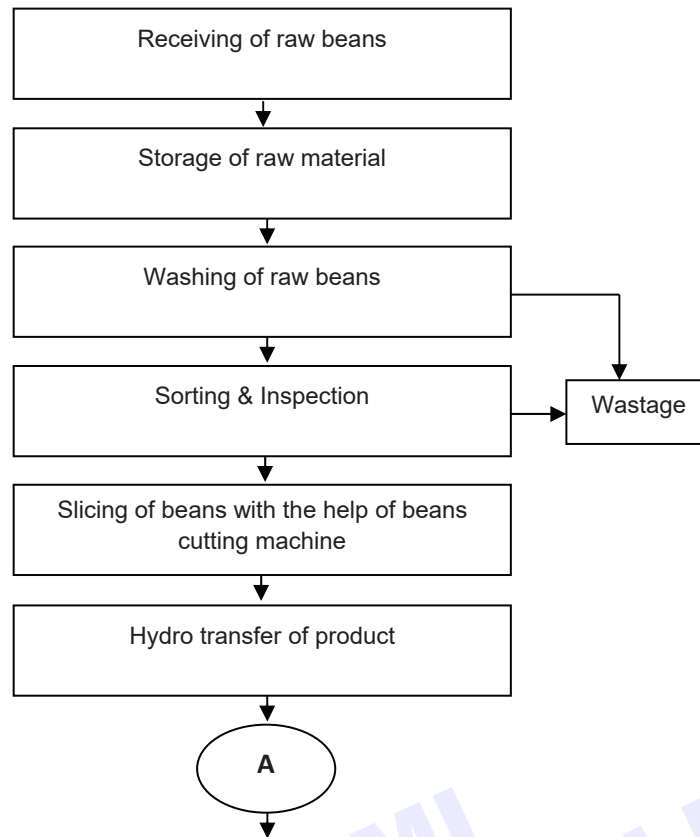
Flow Diagram of frozen diced carrot cubes processing 1



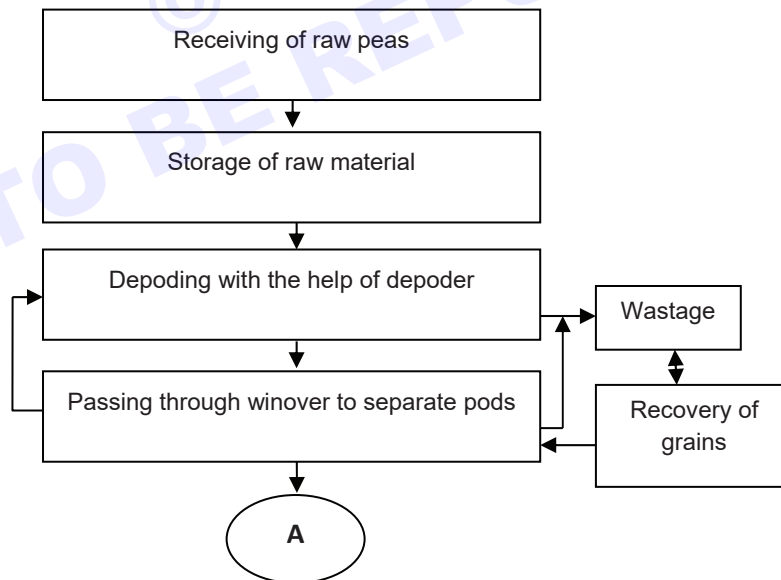
Flow diagram of frozen diced Red/Green/Yellow capsicum processing



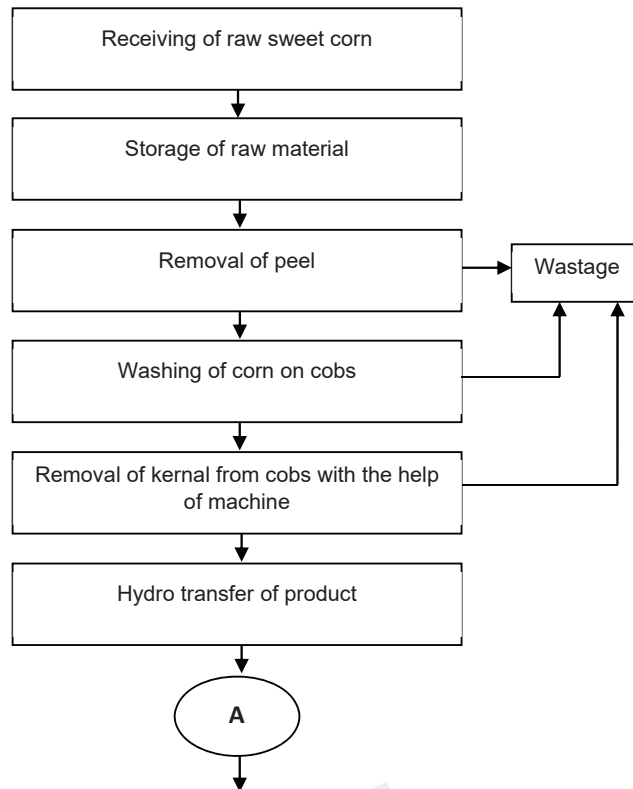
Flow diagram of frozen beans processing



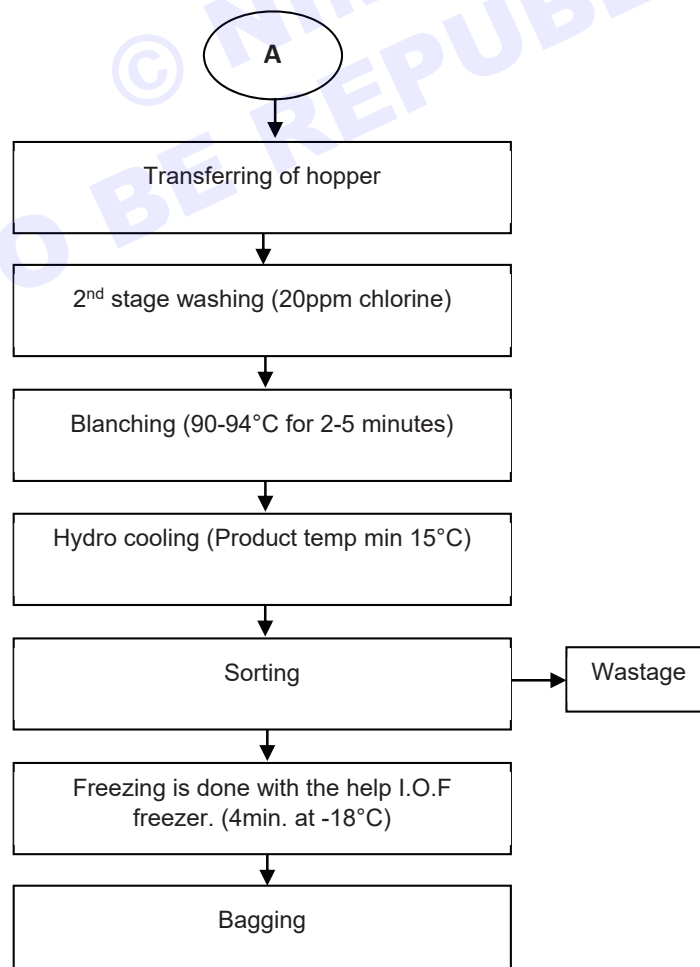
Flow diagram of peas processing

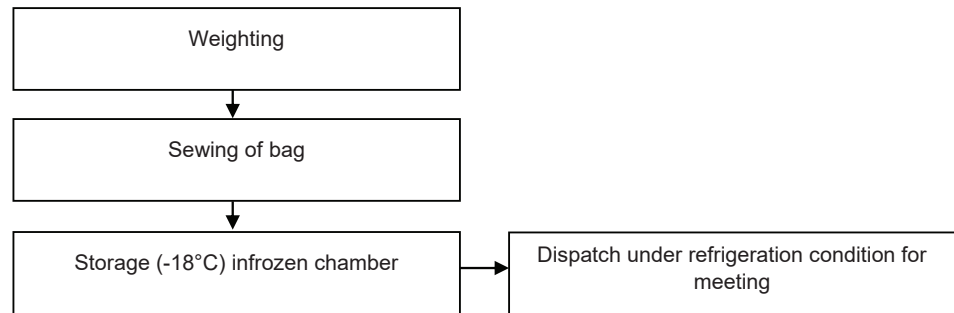


Flow diagram of sweet corn processing



Flow diagram processing and post processing





General description of IQF “peas”

Smaller, sweet should be prepared by proper time and temperature combination during blanching and freezing ensuring the stability of size, color, flavour and texture. Product should be free flowing and should free from insects, damages, blemishes, peas pods and foreign bodies. The final product temperature at outlet of IQF (Individual quick freezer) should be not less than -18°C.

Description of parameters:

- a **Pale / Yellow / Brown/:** Any peas whose colour is pale or yellow or brown fall under this category of defect.
- b **Blemish:** Any pea whose colour is not as per the characteristic colour of the peas and shows blackening in parts or in aggregate form a part of this category of defect
- c **Split & Skins:** Due to the process of mechanically removing the peas from the pods some percentage of the peas grain either split in two parts or the skin of the peas to come off. The aggregate of the split and the skins are counted in this category of defect.
- d **EVM:** Vegetable matter forms the plant or the root is called EVM.
- e **Foreign EVM:** Non toxic vegetable matter not from the plant.
- f **Shrunked:** Sometimes due to over blanching the peas grain tends to loose excessive cell fluid due to the process of excess osmosis as a result the pea tends to loose its texture visible in form of shrinkage of skin the aggregate percentage of these are called shrunked.
- g **Foreign material:** Non - Product related e.g. stones, wooden sticks, threads, plastic, paper, insects, hair, rubber pieces etc.

General product description: “Frozen diced potato shall only be prepared from good quality of raw material. The raw potato is first peeled sorted for defects and then dices as per specified sizes than washed, blanched, hydro cooled and then frozen to temperatures between -15°C to -18°C.

Description of parameters:

- a **Blemish:** Any dice whose colour is not as per the characteristic colour of the potato and shows blackening in parts or in aggregate form a part of this category of defect

- b **Unpeeled Dices:** Are those dices from which the peel has not been removed.
- c **Greening:** Green colour dice which covers an area greater than the half of the surface area of a dice, is to be considered under this category of defect.
- d **EVM:** Vegetable matter forms the plant or the root is called EVM.
- e **Under size:** Any dice whose all three sides are either less than or irregular in size in comparison to the true dice.
- f **Over size:** Any dice whose two or all three sides are more than the true dice size.
- g **True size:** All those dices whose all three dimensions match the dimensions of the true size
- h **Fines:** All those cuts, which do not form any, defined shape with dimensions of all three sides are less than under size.

Product description: Frozen diced “CARROT” should be prepared from good quality of raw material. Fresh coreless carrot, which is washed, peeled before cutting into cubes (dimensions for example : 6.4mm x 6.4mm x 6.4mm and 9.5mm x 9.5mm x 9.5mm), blanched and frozen, ensuring the stability of colour, flavor and texture. Product should be free flowing and should be free from insect, damages, blemish and foreign matter the final product temperature should be between -15° to -18°C.

Description of parameters:

- 1 **Blemish:** Any dice whose colour is not as per the characteristic colour of the carrot and shows blackening in parts or in aggregate form a part of this category of defect
- 2 **Greening:** Green colour dice which covers an area greater than the half of the surface area of a dice, is to be considered under this category of defect.
- 3 **Evm:** Vegetable matter forms the plant or the root is called EVM.
- 4 **Under size:** Any dice whose all three sides are either less than or irregular in size in comparison to the true dice size but the side is not less than 4 mm in case of 6.4 mm dice and not less than 6 mm in case of 9.5 mm dices are called under sized dices
- 5 **Over size:** Any dice whose two or all three sides are more than the true dice size but the side is not more than 10.4 mm in case of 6.4 mm dice and not more than 13.5 mm in case of 9.5 mm dices are called over sized dices.

- 6 True dices:** All those dices whose all three dimensions match the dimensions of the true size weather 6.4 mm cube or 9.5 mm cube are called true dices
- 7 Fines:** All those cuts which do not form any defined shape with dimensions of all three sides are less than 2mm in case of 6.4 mm dices and less than 4 mm in case of 9.5 mm dices are called fines.

General product description: "Frozen diced green capsicum (for example 9.5mm x 9.5mm x 9.5mm) should be prepared from good quality of raw material by removal of seed, washed, diced, blanched and frozen, ensuring the stability of Colour, flavour and texture. Product should be free flowing and should free from insects, damages, blemishes and foreign bodies and off odor. The final product temperature at outlet of IQF should be not less than -18°C.

Description of Parameters:

- 1 Blemish:** Any dice whose colour is not as per the characteristic colour of the green capsicum and shows blackening in parts or in aggregate form a part of this category of defect
- 2 Discolouration:** Reddish, or browning on the surface area of a dice, is to be considered under this category of defect.
- 3 Evm:** Vegetable matter forms the plant or the root is called EVM.
- 4 Under size:** Any dice whose all three sides are either less than or irregular in size in comparison to the true dice size but the side is not less than 4 mm in case of 9.5 mm dices are called under sized dices
- 5 Over size:** Any dice whose two or all three sides are more than the true dice size but the side is not more than 13.5 mm in case of 9.5 mm dices are called over sized dices.
- 6 True dices:** All those dices whose all three dimensions match the dimensions of the true size that is 9.5 mm dice are called true dices

General product description: "Frozen diced red capsicum (for example 9.5mm x 9.5mm x 9.5mm) shall be prepared from good quality of raw material by removal of seed, washed, diced, blanched and frozen, ensuring the stability of Colour, flavour and texture. Product should be free flowing and should free from insects, damages, blemishes, foreign matter and off odor. The final product temperature at outlet of IQF should be not less than -15°C to -18°C.

Description of parameters:

- 1 Blemish:** Any dice whose colour is not as per the characteristic colour of the green capsicum and shows blackening in parts or in aggregate form a part of this category of defect
- 2 Discoloration:** Reddish, or browning on the surface area of a dice, is to be considered under this category of defect.
- 3 Evm:** Vegetable matter forms the plant or the root is called EVM.

- 4 Under size:** Any dice whose all three sides are either less than or irregular in size in comparison to the true dice size but the side is not less than 4 mm in case of 9.5 mm dices are called under sized dices
- 5 Over size:** Any dice whose two or all three sides are more than the true dice size but the side is not more than 13.5 mm in case of 9.5 mm dices are called over sized dices.
- 6 True dices:** All those dices whose all three dimensions match the dimensions of the true size that is 9.5 mm dice are called true dices.

General product description: "FROZEN SWEET CORN" - obtained from fresh mature corn, peeled, kernel removed, blanched and frozen, ensuring the stability of Colour, flavour and texture. Product should be free flowing and should free from insects, damages, blemishes, and foreign bodies and off odor. The final product temperature at outlet of IQF should be not less than -18°C.

Description of parameters:

- a Brix:** °Brix is the rough indicator for the total soluble content in the product to be precise it indicates the percentage of sugar in the juice extracted from the kernels. This parameters is ascertains with the help of refractometer.
- b Weight of kernels:** The collective weight of the 100 frozen kernels.
- c Blemish:** Any kernel whose colour is not as per the characteristic colour of the kernels and shows blackening in parts or in aggregate form a part of this category of defect.
- d Dia of grain:** When the dia of the grain should not be less than width 6 mm to 10 mm, length 10 mm to 14 mm.
- e Splits and skins:** Due to the process of manual removing the kernels from the cobs, some percentage of the kernels grain either in two parts or the skin of the kernels to come off. The aggregate of the split and the skins are counted in this category of defect.
- f Evm:** Vegetable matter forms the plant or the root is called EVM.
- g Dented Kernels:** This is the percentage of kernels, which shows dents on the exposed area. Due to excessive moisture loss at the time of storage after harvesting.
- h Kernel in hard stage:** This is the percentages of kernels, which have very tough pericarps, and contain a heavy sticky doughy substance.
- i Kernels in creamy in stage:** In which the kernels have obtained full size, have fairly tender pericarps which breaks with moderate pressure from the thumb nail, and contain thick creamy substance which spreads or run very little when released.

Pickles

Objectives: At the end of this lesson you shall be able to

- state the types of pickle
- explain the methods of preparation of pickles.

Introduction

Several kind of pickle are sold in Indian market mango pickle ranks first follow by lime ,carrot ,cauliflowers ,mix pickle and cucumber. These are commonly made in home as well as commercially manufacture and exported. Fruit are generally preserved in sweetened and spiced vinegar. Vegetable are preserved in salt.

Pickling is the result of fermentation by lactic acid forming bacteria. which are generally present in large number on the surfaces of fresh vegetable and fruit. These bacteria can grow in acid medium and in the presence of 8 - 10% percent salt solution, but the growth of majority of undesirable organism is inhibited. Lactic acid bacteria are most active at 30°C, so this temperature must be maintained as far as possible in the early stage of pickle making.

The preservation of food with common salt or in vinegar is known as pickle. It is one of the most ancient methods of preserving fruit and vegetable. Pickle are good appetizer and add to the palatability of a meal.

When vegetables are transfer into brine solution. The brine solution penetrates into the tissues of the former and soluble material present in vegetables diffuses into the brine by osmosis. Soluble materials are fermentable sugars and minerals. The sugar serve as food for lactic acid bacteria which convert sugars into lactic and other acids. The formed acid brine acts upon vegetable tissue to produce the characteristic taste and aroma of pickle.

Definition - The process of preservation of fruit and vegetable in common salt, vinegar or in oil is called pickling.

Types of pickle

1 Preserve by salt

2 Preserve by vinegar

3 Preserve by oil

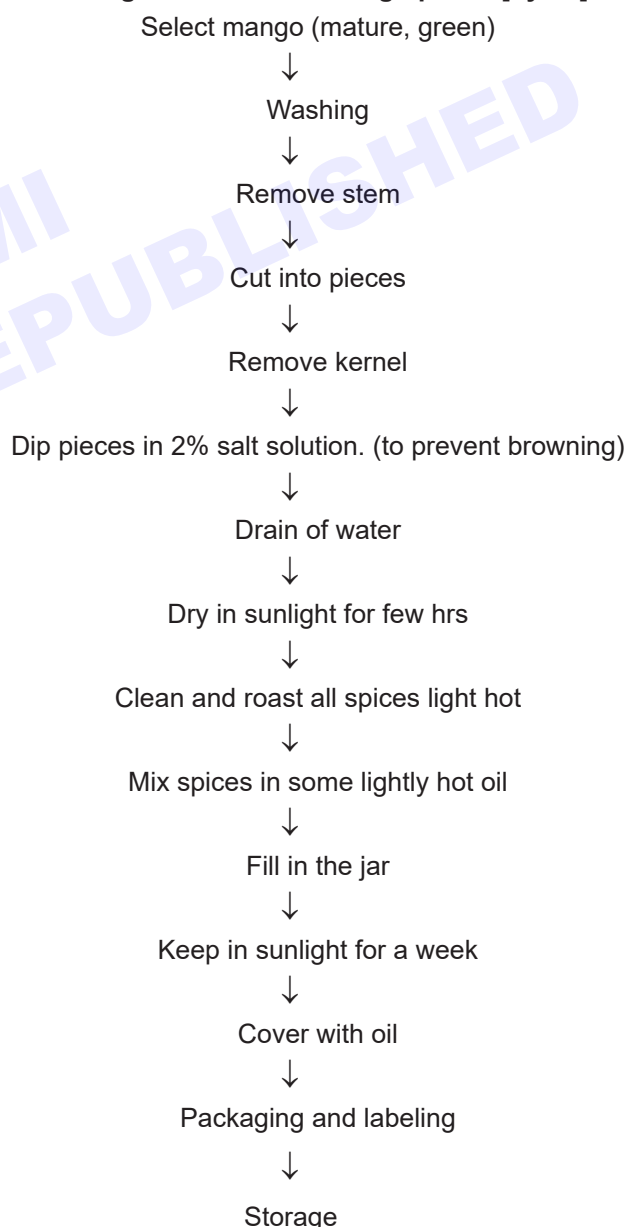
1 **Preserve by salt** - Salt improve the taste ,flavor and hardness the tissue of vegetables and control fermentation salt content of 15% percent or above prevent microbial spoilage . This method of preservation is generally used only for vegetable ex. Mango Mix vegetable, red chili, green chili.

2 **Preserve by vinegar** - Vinegar pickle are the most important pickle consumed in other countries A number of fruit and vegetables are preserved in vinegar whose final concentration in terms of acetic acid , in the finished pickle should not less than 2 percent Acetic acid present for Ex.Cucumber, cabbages, oil

3 **Preserve by oil** - The fruit or vegetable should be completely covered in the edible oil it's producing suffocating environment to inactivate micro organism ex. Mango , mix Pickle, Karonda, Amla , Bitter gourd jackfruits.

Salt, vinegar, acetic acid and spice are the import ingredient used while pickling either single or with combination in sufficient quantities to material.

Processing flow sheet for Mango pickle [by oil]



Procedure - Mango oil pickle is very pungent and hot to taste. Oil pickles are generally highly spiced. Mangoes of high quality are mono ploy of India select under ripe but fully developed tart variety of mango. Wash and slice the mango longitudinally or any other shape size and using stainless steel knife. Dip the slice in 2 to 3% salt to prevent blackening of the cut surface mix the slices with salt powder and put in a glass jar keep the glass in the sunlight for 4 to 5 days till the slices turn to pale yellow. Then mix other ingredients with the slice covered with a thin layer of mustered oil or any edible oil pack the pickle in glass jar. The pickle will be ready in 5 to 7 days.

In salt solution lactic acid fermentation of fruit and vegetable is called curing.

Processing flow sheet for Cucumber pickle [by vinegar]

Select cucumber [small size, slightly under ripe]



Method of spiced vinegar :

Preparation:

- **1st Method:** Soaking the spices in vinegar for 2-3 month, draining and using again spices are boiled with vinegar till the flavours are extracted, using essential oil of spices.

- **2nd Method:** By heating the sugar is dissolved in vinegar spices bag or linen bag and are suspended in the vinegar. The batter is slow heat gently for 6hrs and removed heat and spices are put in spices beg or linen allowed to cool. Remove the spice bag and the vinegar store in casks.

Procedure - Small size, slightly under ripe cucumbers are select carefully taking care to see that they are not injured cucumber for pickle are first fermented in salt and then put in special vinegar to make it a pickle. First about 40° salinometer brine is filled in to big jar and cucumber are added. Then 40° salino meter brine is covered on the material up to the brine, since cucumber have 90% moisture the brine gradually gets diluted. To prevent the growth of organism, salt concentration should be maintained at 10 % level. It should not increase above 10 % as it would prevent the activity of lactic acid bacteria. Fermentation would be over in 4-6 weeks. After fermentation raise the salt concentration to 60° salinometer. Further stored as salt stack During fermentation cucumber changes in colour from bright green to olive green or yellowish green colour Brine attains an acidity of 0.6 to 0.8% as lactic [up to 2.5%]. The product should be preserved without air. Otherwise pickle scum due to growth of wild yeast on the surface and destroy the lactic acid.

Benefits of fermentation of fruits and vegetable

- 1 Improving the nutrition
- 2 Improve digestibility
- 3 Removal of anti nutritional factors
- 4 Preservation of food
- 5 Having medicinal benefits
- 6 Increasing employment and income

Note: Salometer - It is a small instrument which used to detect salt present in brine. Salt present in a brine is expressed as degrees "salometer" which is a percent saturation of sodium chloride by weight.

Action of preservative

Salt vinegar acetic acid and spices are the important ingredients used while pickling, either single or with combination in sufficient quantities to preserve food material.

Action of salt

In food material, if the salt content is more than 15 to 20% the microorganisms including mold yeast, and lactic acid bacteria do not grow or multiplied. So it can be applied in preserving vegetable, which contains little sugar and the lactic acid cannot be formed sufficiently. However, there are some organism called "Halodunic" which can survive in high salt solution e.g., micrococcus, pseudomonas, leuconostoc, sarcinia.

Role of salt

- 1 Salt is one of the most important food adjuncts in food preparation.
- 2 In fermentation, salt can exert a role in sorting the organism permitted to grow.

- 3 Amount of salt added determines whether or not any organism can grow and what type of organisms can grow .
- 4 In food, it exerts growth repressing action on certain microorganisms, can dehydrate protoplasm cause plasmolysis.
- 5 Proteolytic and organisms also inhibited by salt and acid solution . These are more sensitive to acid than salt.
- 6 Salt, vinegar and spices have complimentary action against microorganisms.
- 4 Solubility of oxygen gets required. so organisms growth is inhibited.
- 5 **Carbon dioxide- poisoning** - In presence of salt, cells of organism are sensitized against presence of carbon dioxide. Microorganism produce carbon dioxide for its metabolism, which is poisonous to themselves.
- 6 **NaCl** - Inhibits the growth on the activity of proteases and proteolytic organism the die for want of nutrients.
- 7 **Vinegar** - Two percent acetic acid is necessary for the preservation of vegetable. To avoid dilution, keep the vegetable in 10% acetic acid solution for several days before pickling. This also helps in expelling occluded gases.
- 8 **Lactic acid** - Lactic acid bacteria can grow even in 8-10% salt solution. Most effective at 30°C. When sufficient acid is formed 1.5% the bacteria cease to function. This is carried out only in anaerobic condition. In presence of air, lactic acid is destroyed by putrefactive bacteria, which result in spoilage.

Mode of action

- 1 **By osmotic pressure** - hypotonic solution - cell bursts, osmotic pressure is higher than inside the cell. Cell shrinks as a result. Water drains out, dehydration effect cell dies plasmolysis.
- 2 **Dehydration** - NaCl sodium ion has a tendency to collect water around it this is called ion hydration . available water is in bound water , subsequently growth related by water.
- 3 **Poisonous material** - Organism require minute quantities of certain minerals, such as Na, Mg, K etc, and if they are in excess, inhibit the growth. Here sodium ion becomes deleterious to organism.

In finished product (pickle)

Parameter	Pickle in oil	Pickle in brine	Pickle in citrus	Pickle in vinegar
	(%)	(%)	(%)	(%)
Moisture	55-65	55-65	55-65	55-65
Salt	10-12	18-20	12-15	01-02
Acidity	1.8-2.0	1.2-2.0	1.2-3.0	2.0-3.0

Finished product (pickle) specification

Fruit content	40%
T.S.S. (total soluble solid)	50%
Acidity	2%
Ash	5%
Mould count (fields examined)	40%
Picklies & chutuney (max)	
Benzoic acid	250ppm
Sulphur-di-oxide	100ppm

Food safety standard authority of India(FSSAI)

Objectives: At the end of this lesson you shall be able to

- state HACCP
- state ISO 22000
- state GMP,GHP
- state personal hygiene.

The Food Safety and Standards Authority of India (FSSAI)**Introduction**

The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.

Highlights of the Food safety and standard act, 2006

Various central Acts like Prevention of Food Adulteration Act, 1954 , Fruit Products Order , 1955, Meat Food Products Order , 1973,

Vegetable Oil Products (Control) Order, 1947, Edible Oils Packaging (Regulation) Order 1988, Solvent Extracted Oil, De- Oiled Meal and Edible Flour (Control) Order, 1967, Milk and Milk Products Order, 1992 etc will be repealed after commencement of FSS Act, 2006.

The Act also aims to establish a single reference point for all matters relating to food safety and standards, by moving from multi- level, multi- departmental control to a single line of command. To this effect, the Act establishes an independent statutory Authority - the Food Safety and Standards Authority of India with head office at Delhi. Food Safety and Standards Authority of India (FSSAI) and the State Food Safety Authorities shall enforce various provisions of the Act.

Establishment of the authority

Ministry of Health & Family Welfare, Government of India is the Administrative Ministry for the implementation of FSSAI. The Chairperson and Chief Executive Officer of Food Safety and Standards Authority of India (FSSAI) have already been appointed by Government of India. The Chairperson is in the rank of Secretary to Government of India.

FSSAI has been mandated by the FSS Act, 2006 for performing the following functions:

- Framing of Regulations to lay down the Standards and guidelines in relation to articles of food and specifying appropriate system of enforcing various standards thus notified.

- Laying down mechanisms and guidelines for accreditation of certification bodies engaged in certification of food safety management system for food businesses.
- Laying down procedure and guidelines for accreditation of laboratories and notification of the accredited laboratories.
- To provide scientific advice and technical support to Central Government and State Governments in the matters of framing the policy and rules in areas which have a direct or indirect bearing of food safety and nutrition .
- Collect and collate data regarding food consumption, incidence and prevalence of biological risk, contaminants in food, residues of various, contaminants in foods products, identification of emerging risks and introduction of rapid alert system.
- Creating an information network across the country so that the public, consumers, Panchayats etc receive rapid, reliable and objective information about food safety and issues of concern.
- Provide training programmes for persons who are involved or intend to get involved in food businesses.
- Contribute to the development of international technical standards for food, sanitary and phyto-sanitary standards.
- Promote general awareness about food safety and food standards.

Salient features of FSS ACT, 2006

The Act provides for consolidation of laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption. Some of the salient features of the Act are:

- Movement from multi-level and multi-department control to a single line of command.
- FSSAI as a single reference point for all matters relating to Food Safety and Standards, Regulations and Enforcement.
- Integrated response to strategic issues like Novel foods, Health Foods, Nutraceuticals, GM foods, international trade etc.

- Decentralisation of licensing for manufacture of food products.
- Achieve high degree of consumer confidence in quality & safety of food.
- Effective, transparent and accountable regulatory framework within which the industry can work efficiently.
- Investors friendly regulatory mechanism with emphasis on self regulations and capacity building.
- Emphasis on gradual shift from regulatory regime to self compliance.
- Consistency between domestic and international food policy measures without reducing safeguards to public health and consumer protection.
- Adequate information dissemination on food to enable consumer to make informed choices.
- Compounding and Adjudication of cases - to reduce Court's workload and expedite the disposal of cases.
- Graded penalty depending upon the gravity of offences.
- A dequate representation of government, industry organizations, consumers, farmers, technical experts, retailers etc.
- Enforcement of the legislation by the State Governments/ UTs through the state Commissioner for Food Safety, his officers and Panchayati Raj /Municipal bodies.

The Act, inter alia, incorporates the salient provisions of the Prevention of Food Adulteration Act, 1954 and is based on international legislations and instrumentalities. In a nutshell, the Act takes care of international practices and envisages a overreaching policy framework and provision of single window to guide and regulate persons engaged in manufacture, marketing, processing, handling, transportation, import and sale of food. The Act is contemporary, comprehensive and intends to ensure better consumer safety through Food Safety Management Systems and setting standards based on science and transparency as also to meet the dynamic requirements of Indian Food Trade and Industry and International trade.

New provisions in the act

- Covering Health Foods, supplements, nutraceuticals.
- Issuing Licenses within a time frame of 2 months.
- Provision of Improvement Notice by Designated Officers.
- Prosecution, if to be launched, should be within 1 year time frame.
- Special Courts for summary trials.
- Compensation to Victims (for any case of Injury/ Grievous injury/ Death)

- Reward to informer (informing about the violators - adulteration etc.) by State Govt.
- One composite license for unit(s) falling under one area
- Training and Awareness programmes for Food Business Operators as well as Regulators
- Encouraging Self regulation through introduction of Food Recall Procedures
- No License for small food business operators; only registration is mandatory.
- Central licensing from Authority.

The Major deviations from the existing regulations and the implications of Change

A Changes in definitions

a FSSAI- Adulterant

Any material which is or could be employed for making the food unsafe or sub-standard or mis-branded or containing extraneous matter;

Misbranded

Means an article of food with

- False, misbranding or deceptive claims either on the label of the package, or through advertisement,
- If the article is sold as an imitation of, or is a substitute for, or is likely to deceive, or
- The package bears statement, design or device regarding the ingredients or the substances contained therein, which is false or misleading or
- Manufacturers name and address is false or
- Contains any artificial flavouring, colouring or chemical preservative and is not labelled properly as per the requirements of the law or

Substandard

An article of food shall be deemed to be sub-standard if it does not meet the specified standards but does not render the food unsafe.

Unsafe

Means an article of food which is injurious to health:-

- By the article itself, or its package thereof, or
- Consists wholly or in part, any filthy, putrid, rotten, decomposed or diseased animal substance or vegetable substance; or
- Is processed unhygienically or the article of food has harmful substance in it or is infected or infested with worms, weevils or insects; or
- Has been substituted by inferior or cheaper substance whether wholly or in part; or
- Uses a substance directly or as an ingredient or as additive which is not allowed under the law; or

- vi By virtue of its being prepared, packed or kept under unsanitary conditions; or
- vii By virtue of its being mis-branded or sub-standard or food containing extraneous matter; or
- viii By virtue of containing pesticides and other contaminants in excess of quantities specified by regulations.

b Advertisement

Any audio or visual publicity, representation or pronouncement made by means of any light, sound, smoke, gas, print, electronic media, internet or website and includes any notice, circular, label, wrapper, invoice or other documents;

c Food

Any substance, whether processed, partially processed or unprocessed, which is intended for human consumption and includes primary food i.e. all raw produce except those in hands of the grower, farmer, fisherman etc., genetically modified or engineered food or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum, and any substance, including water used into the food during its manufacture, preparation or treatment but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants prior to harvesting, drugs and medical products, cosmetics, narcotic or psychotropic substances: Provided that the Central Government may declare, by notification in the Official Gazette, any other article as food for the purposes of this Act having regards to its use, nature, substance or quality

d Food business

Means any undertaking, whether for profit or not and whether public or private, carrying out any of the activities related to any stage of manufacture, processing, packaging, storage, transportation, distribution of food, import and includes food services, catering services, sale of food or food ingredients

e Food business operator

Means a person by whom the business is carried on or owned and is responsible for ensuring the compliance of this Act, rules and regulations made there-under

f Manufacture

Means a process or adoption or any treatment for conversion of ingredients into an article of food, which includes any sub-process, incidental or ancillary to the manufacture of an article of food

g Manufacturer - FSSAI

Means a person engaged in the business of manufacturing any article of food for sale and includes any person who obtains such article from another person and packs and labels it for sale or only labels it for such purposes.

B Changes in provisions

1 Sampling and analysis (Section 47)

When a Food Safety Officer takes a sample of food for analysis, he shall-

- a Give notice in writing of his intention to have it analysed to the person from whom he has taken the sample and to the person, if any, whose name, address and other particulars have been disclosed;
- b Except in special cases as may be provided by rules divide the sample into four parts and mark and seal or fasten up each part in such a manner as its nature permits and take the signature or thumb impression of the person from whom the sample has been taken. If such person refuses to sign or put this thumb impression, the Food Safety Officer shall call upon one or more witnesses and take his signature or thumb impression, in lieu of the signature or thumb impression of such person;
 - i send one of the part for analysis to the Food Analyst under intimation to the Designated Officer;
 - ii send two parts of the Designated officer for keeping this in safe custody; and
 - iii send the remaining part for analysis to an accredited laboratory, if so requested by the food business operator, under intimation to the Designated Officer.

Provided that if the rests reports received under sub-clauses (i) and (ii) are found to be at variance, then the Designated Officer shall send one part of the sample in his custody, to referral laboratory for analysis if he feels, whose decision thereon shall be final.

- 2 When a sample of any article of food or adulterant is taken, the Food Safety officer shall, by the immediate succeeding working day, send the sample to the Food Analyst for the area concerned for analysis and report.
- 3 Where the part of the sample sent to the Food Analyst is lost or damaged, the Designated Officer shall, on a requisition made to him, by the Food Analyst or the Food Safety Officer dispatch one of the parts of the sample sent to him, to the food Analysis for analysis.
- 4 In case of imported articles of food, the authorised officer of the Food Authority shall take its sample and send to the Food Analyst of notified laboratory for analysis who shall send the report within a period of five days to the authorised officer.
- 5 The Designated Officer, the Food Safety Officer, the authorised officer and the Food Analyst shall follow such procedure as may be specified by regulations.

Administration at the central government level

- 1 22 Members Authority representing various stakeholders.
- 2 Chairperson and Chief Executive Officer
- 3 8 Scientific Panels and Scientific Committee.
- 4 Central Advisory Committee.
- 5 Separate Scientific Division
- 6 Surveillance, Regulatory and Quality Assurance Divisions

- 7 Codex cell to handle international matters
- 8 Import Safety
- 9 Novel Foods, Nutraceuticals, GM Foods approval
- 10 Fixation of Standards and guidelines for food
- 11 Labeling and Advertising norms

New concepts and their legal implications

A General principles to be followed in administration of the act (section 18)

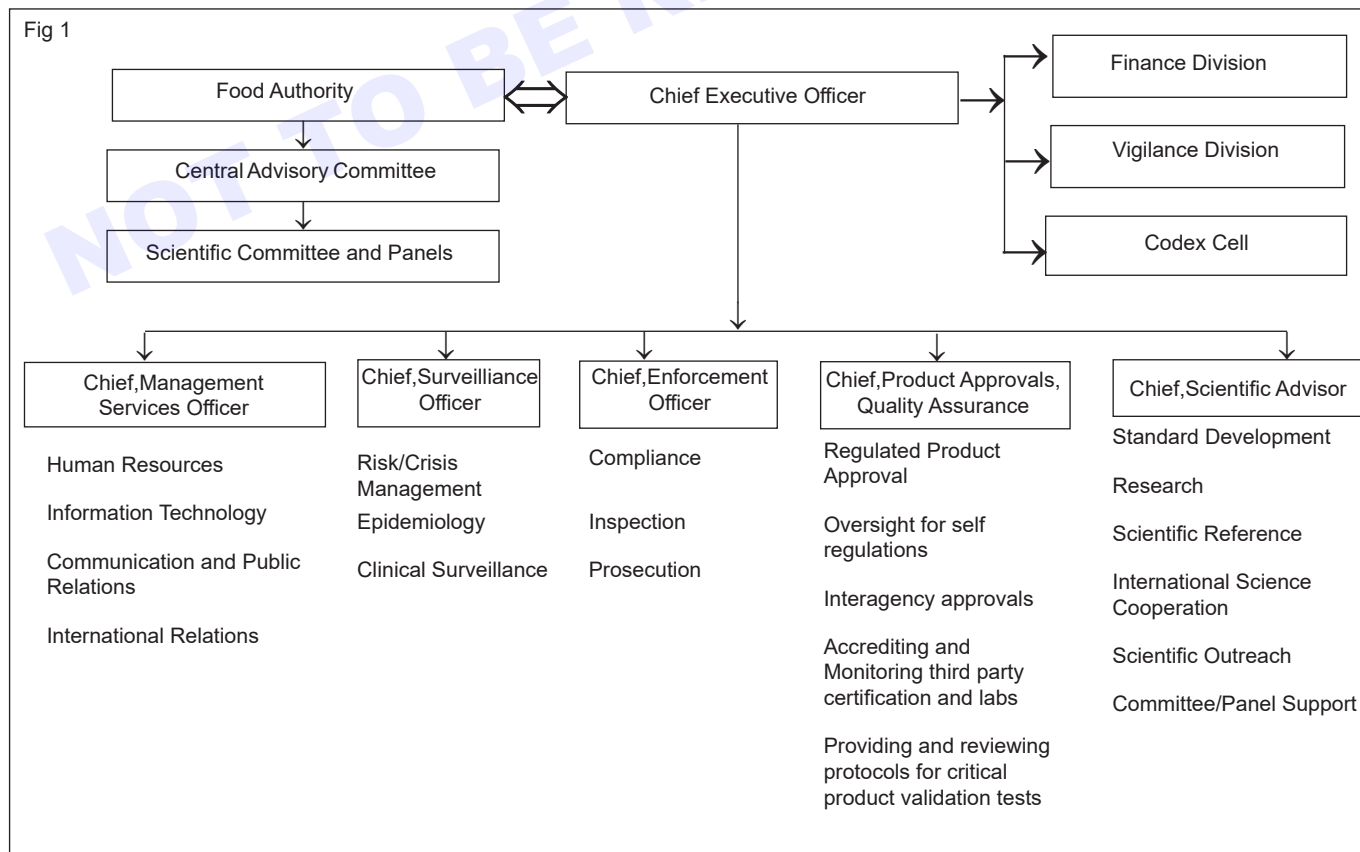
The Central Government, the State Governments, the Food Authority and other agencies, as the case may be, while implementing the provisions of this Act shall be guided by the following principles, namely:-

- 1 Endeavour to achieve an appropriate level of protection of human life and health and the protection of consumer's interests, including fair practices in all kinds of food trade with reference to food safety standards and practices.
- 2 Carry out risk management which shall include taking into account the results of risk assessment, and other factors which in the opinion of the Food Authority are relevant to the matter under consideration and where the conditions are relevant, in order to achieve the general objectives of regulations.
- 3 Where in any specific circumstances, on the basis of assessment of available information, the Designated Officer shall, on a requisition made to him, by the Food Analyst or the Food Safety Officer dispatch one of the parts of the sample sent to him, to the food Analysis for analysis.

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- c Where in any specific circumstances, on the basis of assessment of available information, the possibility of harmful effects on health is identified but scientific uncertainty persists, provisional risk management measures necessary to ensure appropriate level of health protection may be adopted, pending further scientific information for a more comprehensive risk assessment;
- d The measures adopted on the basis of clause (c) shall be proportionate and no more restrictive of trade than is required to achieve appropriate level of health protection, regard being had to technical and economical feasibility and other factors regarded as reasonable and proper in the matter under consideration;
- e The measures adopted shall be reviewed within a reasonable period of time, depending on the nature of the risk to life or health being identified and the type of scientific information needed to clarify the scientific uncertainty and to conduct a more comprehensive risk assessment;
- f In case where there are reasonable grounds to suspect that a food may present a risk for human health, then, depending on the nature, seriousness and extent of that risk, the Food Authority and the Commissioner of Food Safety shall take appropriate steps to inform the general public of the nature of the risk to health, identifying to the fullest extent possible the food or type of food, the risk that it may present, and the measures which are taken or about to be taken to prevent, reduce or eliminate that risk; and
- g Where any food which fails to comply with food safety requirements is part of a batch, lot or consignment of food of the same class or description, it shall be presumed until the contrary is proved, that all of the food in that batch, lot or consignment fails to comply with those requirements.

The Food Authority shall, while framing regulations or specifying standards under this Act.

- a Take into account prevalent practices and conditions in the country including agricultural practices and handling, storage and transport conditions;
- b Ensure that there is open and transparent public consultation, directly or through representative bodies including all levels of panchayats, except where it is of opinion that there is an urgency concerning food safety or public health to make or amend the regulations in which case such consultation may be dispensed with:

Provided that such regulations shall be in force for not more than six months;

- c Ensure protection of the interests of consumer and shall provide a basis for consumers to make informed choices in relation to the foods they consume;
- d Ensure prevention of
 - i Fraudulent, deceptive or unfair trade practices which may mislead or harm the consumer; and
 - ii Unsafe or contaminated or sub-standard food.

B The new provisions

1 Special purpose foods (Section 22)

Save as otherwise provided under this Act and regulations made there under, no person shall manufacture, distribute, sell or import any novel food, genetically modified articles of food, irradiated food, organic foods, foods for special dietary uses, functional foods, nutraceuticals, health supplements, proprietary foods and such other articles of food which the Central Government may notify in this behalf. Separate regulations for each of them are being framed for this category.

2 Provisions relating to import (Section 25)

All imports of articles of food to be subjected to this Act.

- 1 No person shall import into India.
 - i Any unsafe or misbranded or sub-standard food or food containing extraneous matter;
 - ii Any article of food for the import of which a license is required under any Act or rules or regulations, except in accordance with the conditions of license; and
 - iii Any article of food in contravention of any other provision of this Act or of any rule or regulation made there under or any other Act.
- 2 The Central Government shall, while prohibiting, restricting or otherwise regulating import of articles of food under the Foreign Trade (Development and Regulation) Act, 1992, follow the standards laid down by the Food Authority under the provisions of this Act and the rules and regulations made there under.
- 3 All imports will come under central licensing and an existing importer also needs to be registered under the central authority and all imported products will be screened for safety parameters by an IT enabled food safety system as a new initiative under FSSA.

3 Responsibility of authorities for enforcement of the act (Section 29)

Enforcement of the act will be done through commissioner, designated officer and food safety officers.

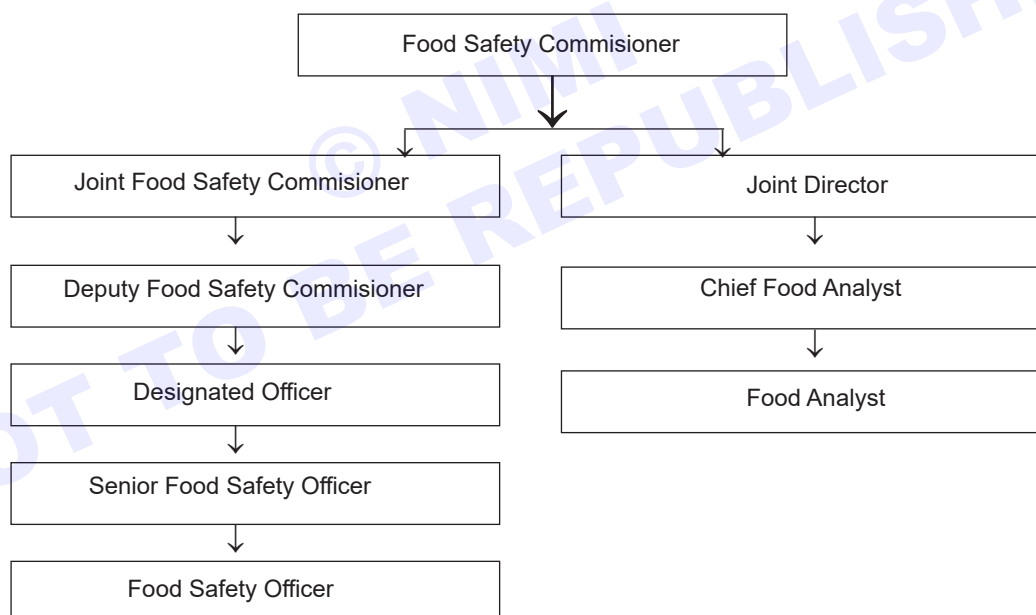
- The food authority and the state food safety authorities shall be responsible for the enforcement. They shall monitor and verify that the requirements of law being fulfilled by the FBO at all stages of food business.
- Authorities shall maintain a system of control and other activities as appropriate to the circumstances including public communication on food safety and risk. Food safety surveillance and monitoring covering all stages of food business.
- FSOs shall enforce and execute within their area the provisions of this act with respect to which the duty is not imposed expressly or by necessary implication on some other authority.
- The regulations under this act shall also specify which of the food safety officers are to enforce and execute them generally or in relation to cases of a particular description or particular area.

Administrative set up at state level

The enforcement of the act would be through the state commissioner of food safety (CFS) and his officers (viz. designated officer, food safety officer) and panchayati raj / municipal bodies.

It is also proposed that Food Analysts, Chief Food Analyst, and Joint Director may be posted at District Level, Zonal Level, and State Level Offices in rotation with their posting in the laboratory. These officers will act as co-ordinators between Enforcement Officers and Laboratory. These officers will assist Food Safety Commissioner in identification food laboratories and research institutions for testing and calibration or any other accreditation agency to be notified by the Food Authority for the purpose of carrying out analysis of samples. These officers will also play a role in policy making, formation of schemes related to development of laboratories including infrastructure, well qualified staff, training of existing staff and may be entrusted with any other work related to food safety management viz. Food surveillance, Food recall/ incident reporting, Food Terrorism and Rapid Alert System as directed by Food Safety Commissioner.

Fig 2



Proposed set up at state level

Functions, duties & responsibilities of food safety regulators

• Functions of the commissioner (Section 30):

The commissioner of the food safety shall not be below the rank of the commissioner and secretary to the state government.

- Prohibit in public health interest the manufacture, storage, distribution or sale of any article of food in the whole of the state within a maximum time of one year.

- Survey of the industrial units engaged in the process of manufacture of food in that state for compliance.
- Organise and conduct training programmes for the personnel of the office of the commissioner and on a wider scale, different segments of food chain for generating awareness on food safety.
- Ensure an efficient and uniform implementation of the standard and the other requirements and also ensure a high degree of objectivity, accountability, practicability, transparency and credibility.
- Sanction prosecution for offences punishable with imprisonment and also.

- vi Perform other functions as the state government may in consultation with the food authority prescribed.

• **Functions of the designated officer (Section 36):**

- i Shall be a whole time officer, not below the rank of Sub divisional officer or equivalent.
- ii Appointment shall be done by commissioner of food safety and each district will have at least one designated officer who has the power to issue or cancel license.
- iii Prohibit sale of any article of food in contravention with the provisions of the act and the rules.
- iv Receive report and samples of articles from food safety officer under his jurisdiction and get them analyzed.
- v Recommended cases to commissioner for sanction to launch prosecution, in case the contravention is punishable with imprisonment.
- vi Sanction or launch prosecution in case of contravention punishable with fine or recommended the case to commissioner for punishment with imprisonment.
- vii Maintain record of all inspections made by food safety officer and the actions taken by them, etc.

• **Functions of Food Safety officer (Section 38):**

A full time officer having a degree in food or dairy technology or agricultural science or veterinary sciences or bio chemistry or microbiology or degree in science or chemistry as one of the subjects from a recognized university or possess any other qualification notified by the central government or is a graduate in medicine and has received training in Food Safety, sampling and surveillance or

Has successfully completed the training, for a specified period in Food Safety, Food Inspection and Sampling under an institute or institution approved for the purpose by the Food Authority.

Appointment shall be done by Commissioner according to the need and through issuance of notification. The State Government may authorize any officer of the State Government having the prescribed qualifications to perform the functions of a Food Safety Officer.

Major functions are as follows:

- i Take sample of food or other substances intended for human consumption for analysis purpose.
- ii Article of food or substance to be produced as evidence.
 - a Seize any article of food in contravention of the Act or rules and may keep the same in the safe custody of the FBO after taking the sample and send the same to Food Analyst of the local area for analysis and report generation. He may require the FBO to execute a bond for a sum of money equal to the value of the article seized with one or more sureties as he deems fit.

- b Enter and inspect any place of food manufacturing, storing for sale or storing for manufacture of any other article of food or exhibited for sale and where any adulterant is manufactured or stored and take samples for analysis. If the article is of perishable nature and the FSO feels that it is unfit for human consumption, he can, after giving notice in writing to the FBO destroy the same.
- c Inspection of a premise shall follow as far as possible the provisions of code of criminal procedure, 1973, relating to search or inspection by a police officer executing a search warrant issued under the code.
- d To inspect as frequently as prescribed by the designated officer all food establishments for having license for manufacture, handling, packing or selling of foods within area of his jurisdiction.
- e Maintain a data base of FBO in the area assigned to him and check compliance with the conditions of license and report to the designated officer.
- f Investigate complaints in respect to any contravention of the provisions, if any.
- g Issue improvement notices and record all inspections including taking of samples and seizure of stocks.
- h Stop and inspect any suspected vehicle and recommend to designated officer giving specific grounds the violence done by the licensee.
- i Carry out food safety surveillance, respond to food poisoning and facilitate food safety plans for Panchayats/ Municipalities as per the guidelines.

• **Functions of the food analyst (Section 45)**

He would be responsible for carrying out the required analysis of the sample as instructed by the Food Safety Officer along with the test method. The various steps to be taken are as follows:

- i Compare and note down the conditions of the seal of the container and the outer cover containing the sample.
- ii He may ask for the second sample if the first sample is found to be in broken condition or unfit for analysis and inform the DO about the same within seven days time and also send a requisition for the second part of the sample retained by DO.
 - a He will then analyze, prepare report and send to DO for copies of report indicating the method of sampling and analysis within 14 days time.
 - b Where the purchaser wants the food to be analyzed, then the report shall be sent to that purchaser with a copy to the DO.

Appeal against reports from food analyst shall be done before the DO and if he feels refer the matter to the Referral laboratory as may be notified by the food safety authority.

Adjudicating officer: The State Government will notify adjudicating officer for adjudication of food related cases. He will perform all or any of the following functions:

- The Adjudicating Officer will have the powers of a civil court and all the proceedings before him shall be deemed to be judicial proceedings within the meaning of sections 193 and 228 of the Indian Penal Code.
- The Adjudicating Officer while adjudging the quantum of penalty shall have due regard to the following
 - a The amount of gain or unfair advantage (wherever possible to quantify) due to contravention
 - b The amount of loss caused or likely to cause to any person due to contravention
 - c The repetitive nature of contravention
 - d Whether contravention is knowingly or unknowingly.
- May issue direction to person found guilty of an offence, for taking corrective action to rectify the mistake or destruction of such article of food.
- May direct offender to pay compensation to victim or representative of victim in case of injury or death of consumer.
- May order for cancellation of license, re-call of food from market, forfeiture of establishment and property.
- Issue prohibition orders.

Synergizing consumers, industry and local bodies:

Multiplicity of food laws, standard setting and enforcement agencies for different sectors of food has created a state of confusion in the minds of consumers, traders, manufacturers and investors. Standards are rigid and non-responsive to scientific advancements and modernization and varied Quality/Safety standards were proving restrictive in innovative food products. Thin spread of manpower, poor laboratories infrastructure and other resources were conducive to effective fixation of standards and their enforcement. Regulatory Mechanism was investor adversary and there was poor Information dissemination level to consumer level.

The Food Safety and Standards Act, 2006 has kept all the above factors into consideration and is an attempt to have single reference point for all matters relating to food safety and standards, regulations and enforcement. suggested for effective, transparent and accountable regulatory framework with investors friendly regulatory mechanism with emphasis on self regulations and capacity building. More responsibility has been left on the part of Food Businesses to ensure safe and quality food for the consumers. The Act has empowered the consumers by more emphasis on adequate information dissemination on food to enable consumer to make informed choices and achieve high degree of consumer confidence in quality & safety of food. Local Panchayat and Municipalities are also considered to be involved in the implementation of Act to have the spread of concept of food safety up to grass root level.

Food regulations are mandatory and must be complied with by the processor and enforced by the food safety

regulatory authorities in all cases, because violations constitute offences. Failure by the food safety officers or other food safety authorities to enforce regulations at all times, besides being illegal, defeats the purpose of having a food safety system and promotes non-compliance across the industry by example. It would be unfair to demand compliance from one processor and not from others. The food safety regulator's primary responsibility is to protect the consumer by ensuring compliance with food safety laws and regulations, given that the public's well-being is the ultimate objective of a national food safety system. Producers and processors, in contrast, are in business to make a profit and that priority may well impair their perception of accountability to society. Therefore, it is also the food safety regulators duty to remind producers and processors of their responsibility to produce safe foods. This message can be made more relevant by explaining to food producers and processors that the safety of their products not only fulfils their responsibility towards society . something that may seem idealistic and ethereal . but may also be determinant in developing their business. For example, the adverse effect of bad publicity and the use of favourable publicity as a marketing tool could be described. Compliance with guidelines and voluntary standards, on the other hand, depends on the good will and disposition of the processor and should be strongly encouraged by the food safety regulatory authorities.

Special responsibilities of food business operator (Section 26)

- Every food business operator shall ensure that the articles of food satisfy the requirements of this Act and the rules and regulations made there under at all stages of production, processing, import, distribution and sale within the businesses under his control.
- No food business operator shall employ any person who is suffering from infectious, contagious or loathsome disease.
- No food business operator shall sell or offer for sale any article of food to any vendor unless he also gives a guarantee in writing in the form specified by regulations about the nature the nature and quality of such article to the vendor: Provided that a bill, cash memo, or invoice in respect of the sale of any article of food given by a food business operator to the vendor shall be deemed to be a guarantee replacing the provision of warranty under PFA
- Where any food which is unsafe is part of a batch, lot or consignment of food of the same class or description, it shall be presumed that all the food in that batch, lot or consignment is also unsafe, unless following a detailed assessment within a specified time, it is found that the rest of the batch, lot or consignment is unsafe: Provided that any conformity of a food with specific provisions applicable to that food shall be without prejudice to the competent authorities taking appropriate measures to impose restrictions on that food being placed on the market or to require

its withdrawal from the market for the reasons to be recorded in writing where such authorities suspect that, despite the conformity, the food is unsafe.

Prerequisite programmes - Good hygienic practices(GHP)

The foundation for food safety is infrastructure and hygiene. Quality and food safety improvement and maintenance is a continuous process. It can be achieved if primary production measures, production operations, storage and packaging are monitored properly with care. Food Regulations have substantial influence on the manufacturer.

Adoption of Good Hygienic Practice (GHP), Good Manufacturing Practice (GMP), food safety management systems based on HACCP/ISO 22000 and quality management systems based on ISO 9001 help food processing industries to maintain food quality and safety. In India, quality of export consignments is certified by several Government Agencies. The Quality and food safety inspection is carried out by conducting physical, chemical and microbiological examinations and monitoring of levels of various toxic contaminants like

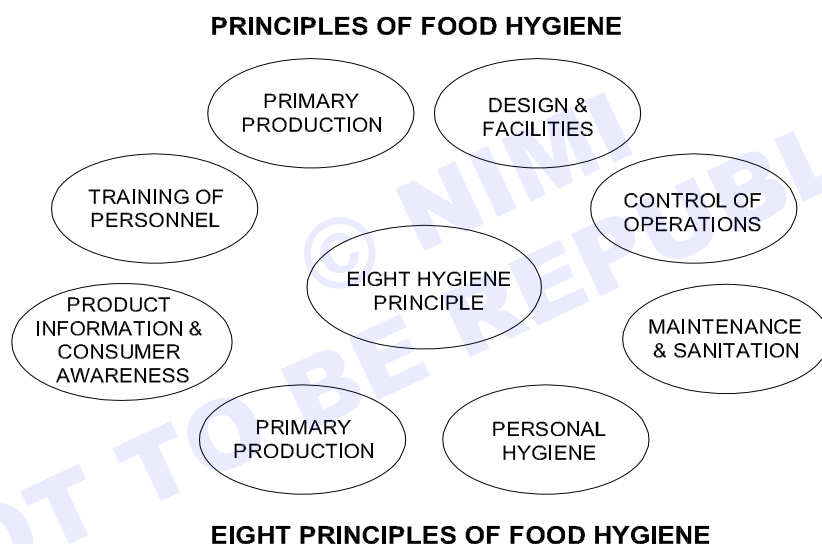
aflatoxins, heavy metals and pesticide and drug residues in various foods. Since most of food poisoning cases arise out of microbiological contamination, therefore, stringent measures are taken to control these contaminants during the manufacture of food products.

International basis for GHP

The codex alimentarius commission brought out the recommended international code of practice-general principles of food hygiene in 1969 which has undergone four revisions and current version is (CAC/RCP1(1969) rev.4 20030. This has enunciated 8 principles of food hygiene.

International food trade, and foreign travel, are increasing, bringing important social and economic changes. But this also makes the spread of illness around the world easier. Effective hygiene control, therefore, is vital to avoid the adverse human health and economic consequences of foodborne illness, foodborne injury, and food spoilage. The General Principles are commended to Governments, industry (including individual primary producers, manufacturers, processors, food service operators and retailers) and consumers alike.

Fig 3



Objectives of GHP

- Identify the essential principles of food hygiene applicable throughout the food chain (including primary production through to the final consumer), to achieve the goal of ensuring that food is safe and suitable for human consumption;
- Recommend a HACCP-based approach as a means to enhance food safety;
- Indicate how to implement those principles.

Scope and use

Governments can consider the contents of this document and decide how best they should encourage the implementation of these general principles to:

- Protect consumers adequately from illness or injury caused by food; policies need to consider the vulnerability of different groups within the population.

- Provide assurance that food is suitable for human consumption.
- Maintain confidence in internationally traded food.
- Provide health education programs which effectively communicate the principles of food hygiene to industry and consumers.

1 Primary production

Objective: Primary production should be managed in a way that ensures that food is safe and suitable for its intended use. Where necessary, this will include:

- Avoiding use of areas where the environment poses a threat to food safety
- Controlling contaminants/diseases of animals/plants to safeguard food safety;
- Adopting practices to ensure food is produced under hygienic conditions.

Rationale: To reduce likelihood of introducing a hazard which may adversely affect food safety, or its suitability for consumption, at later stages of food chain.

1.1 Environmental hygiene

Consider potential sources of contamination from the environment. Primary food production should not be carried on in areas where presence of potentially harmful substances may lead to unacceptable level of such substances in food.

1.2 Hygienic production of food sources

The potential effects of primary production activities on the safety and suitability of food should be considered at all times. In particular, this includes identifying points where a high probability of contamination may exist and taking specific measures to minimize that probability producers should implement measures to:

- Control contamination from air, soil, water, feedstuffs, fertilizers, pesticides, veterinary drugs or any other agent used in primary production;
- Control plant and animal health so that it does not pose a threat to human health through food consumption, or adversely affect product suitability.
- Protect food sources from faecal and other contamination.

1.3 Handling, storage and transport

Procedures should be in place to:

- Sort food and food ingredients to segregate material which is evidently unfit for human consumption;
- Dispose of any rejected material in a hygienic manner; and
- Protect food and food ingredients from contamination by pests, or by chemical, physical or microbiological contaminants or other objectionable substances during handling, storage and transport.

Care should be taken to prevent deterioration and spoilage through measures which may include controlling temperature, humidity, and/or other controls.

Cleaning, maintenance and personnel hygiene

Appropriate facilities and procedures should be in place to ensure that:

- Any necessary cleaning and maintenance is carried out effectively; and
- An appropriate degree of personal hygiene is maintained.

2 Establishment, design and facilities

Objectives: Depending on nature of operations, and associated risks, premises, equipment and facilities should be located, designed and constructed to ensure:

- Contamination is minimized.
- Design and layout permit appropriate maintenance,

cleaning and disinfections and minimize air-borne contamination.

- Surfaces and materials, in particular those in contact with food, are non-toxic in intended use, suitably durable, and easy to maintain and clean.
- Where appropriate, suitable facilities are available for temperature, humidity and other controls.
- There is effective protection against pest access and harborage

Rationale: Attention to good hygienic design and construction, appropriate location, and provision of adequate facilities, is necessary to control hazards.

2.1 Location and Establishment

Potential sources of contamination need to be considered when deciding where to locate food establishments and effectiveness of any reasonable measures that might be taken to protect food.

Establishments should be located away from:

- Environmentally polluted areas and industrial activities which pose a serious threat of contaminating food;
- Areas subject to flooding unless sufficient safeguards are provided;
- Areas prone to infestations of pests;
- Areas where wastes, either solid or liquid, cannot be removed effectively.

Equipment should be located so that it:

- Permits adequate maintenance and cleaning;
- Functions in accordance with its intended use; and
- Facilitates good hygiene practices, including monitoring.

2.2 Premises and rooms

2.2.1 Design and layout

The internal design and layout of food establishments should permit good food hygiene practices appropriately, including protection against cross contamination between and during operations by foodstuffs.

2.2.2 Internal structures and fittings

Structures within food establishments should be soundly built of durable materials and be easy to maintain, clean and where appropriate, able to be disinfected.

- The surfaces of walls, partitions and floors should be made of impervious materials with no toxic effect in intended use.
- Walls and partitions should have a smooth surface up to a height appropriate to operation.
- Floors should be constructed to allow adequate drainage and cleaning.
- Ceilings and overhead fixtures should minimize build up of dirt and condensation, and the shedding of particles

- Windows should be easy to clean, be constructed to minimize the build up of dirt.
- Doors should have smooth, non-absorbent surfaces, and be easy to clean and, where necessary, disinfect
- Working surfaces that come into direct contact with food should be in sound condition, durable and easy to clean, maintain and disinfect.

2.2.3 Temporary/mobile premises and vending machines

Premises and structures include market stalls, mobile sales and street vending vehicles, temporary premises in which food is handled such as tents. Such premises and structures should be sited, designed and constructed to avoid, contaminating food and harboring pests.

2.3 Equipment

2.3.1 Equipment and containers coming into contact with food, should be designed and constructed to ensure that, they can be adequately cleaned, disinfected and maintained to avoid the contamination of food.

2.3.2 Food control and monitoring equipment

Equipment used to cook, heat treat, cool, store or freeze food should be designed to achieve the required food temperatures as rapidly as necessary in the interests of food safety and suitability, and maintain them effectively. These requirements are intended to ensure that:

- Harmful or undesirable micro-organisms or their toxins are eliminated or reduced to safe levels or their survival and growth are effectively controlled;
- Where appropriate, critical limits established in HAC-CP-based plans can be monitored; and
- Temperatures and other conditions necessary to food safety and suitability can be rapidly achieved and maintained.

2.3.3 Containers for waste and inedible substances

Containers for waste, by-products and inedible or dangerous substances, should be specifically identifiable, suitably constructed and, where appropriate, made of impervious material.

2.4 Facilities

2.4.1 Water supply

An adequate supply of potable water with appropriate facilities for its storage, distribution and temperature control, should be available whenever necessary to ensure the safety and suitability of food. Non-potable water shall have a separate system.

2.4.2 Drainage and waste disposal

Adequate drainage and waste disposal systems and facilities should be provided. They should be designed and constructed so that the risk of contaminating food or the potable water supply is avoided.

2.4.3 Cleaning

Provide adequate facilities for cleaning food, utensils and

equipment. Facilities should have an adequate supply of hot and cold potable water where appropriate.

2.4.4 Personnel hygiene facilities and toilets

Personnel hygiene facilities should be available to ensure that an appropriate degree of personal hygiene can be maintained and to avoid contaminating food. Where appropriate, suitably located and designated facilities should include:

- Adequate means of hygienically washing and drying hands.
- Lavatories of appropriate hygienic design.
- Adequate changing facilities for personnel.

2.4.5 Temperature control

Depending on nature of food operations undertaken, adequate facilities should be available for heating, cooling, cooking, refrigerating and freezing food, for storing refrigerated or frozen foods, monitoring food temperatures, and when necessary, controlling ambient temperatures to ensure food safety and suitability.

2.4.6 Air quality and ventilation

Provide adequate means of natural or mechanical ventilation to:

- Minimize contamination of food e.g. from aerosols/condensation droplets
- Control ambient temperatures
- Control odours which might affect the suitability of food
- Control humidity, to ensure the safety and suitability of food.

Ventilation systems should be designed and constructed so that air does not flow from contaminated areas to clean areas.

2.4.7 Lighting

Provide adequate lighting to carry out operation in a hygienic manner. Lighting should not result in misleading colour. Intensity should be adequate. Protect lighting fixtures to ensure that food is not contaminated by breakages.

2.4.8 Storage

Provide adequate facilities for storage of food, ingredients and non-food chemicals. Design and construct facilities to:

- Permit adequate maintenance and cleaning.
- Avoid pest access and harborage.
- Enable food to be effectively protected from contamination during storage.
- Provide environment (temperature and humidity) to avoid food deterioration.

- Provide secure storage facilities for cleaning materials/hazardous substances.

3. Control of operation

Objective: To produce food which is safe and suitable for human consumption by:

- Formulating design requirements with respect to raw materials,
- Composition, processing, distribution, and consumer use to be met in the manufacture and
- Handling of specific food items; and
- Designing, implementing, monitoring and reviewing effective control systems.

Rationale: To reduce the risk of unsafe food by taking preventive measures to assure the safety and suitability of food at an appropriate stage in the operation by controlling food hazards.

3.1 Control of food hazards

Control food hazards through the use of systems such as HACCP. They should:

- Identify any steps in their operations which are critical to the safety of food
- Implement effective control procedures at those steps
- Monitor control procedures to ensure their continuing effectiveness
- Review control procedures periodically, and whenever the operations change.

These systems should be applied throughout the food chain to control food hygiene throughout the shelf-life of the product through proper product and process design.

3.2 Key aspects of hygiene control systems

3.2.1 Time and temperature control

Inadequate food temperature control is one of the most common causes of food borne illness or food spoilage. Such controls include time and temperature of cooking, cooling, processing and storage. Systems should be in place to ensure that temperature is controlled effectively where it is critical to the safety and suitability of food. Temperature control systems should take into account:

- The nature of the food, e.g. its water activity (Rw factor), pH, and likely initial level and types of micro-organisms.
- The intended shelf-life of the product.
- The method of packaging and processing.
- How the product is intended to be used.

Such systems should also specify tolerable limits for time and temperature variations. Temperature recording devices should be checked at regular intervals and tested for accuracy.

3.2.3 Specific process steps

Other steps which contribute to food hygiene may include e.g. chilling, thermal processing, irradiation, drying, chemical preservation, vacuum or modified atmospheric packaging.

3.2.4 Microbiological and other specifications

Where microbiological, chemical or physical specifications are used in any food control system, such specifications should be based on sound scientific principles and state, where appropriate, monitoring procedures, analytical methods and action limits.

3.2.5 Microbiological cross-contamination

Pathogens can be transferred from one food to another, either by direct contact or by food handlers, contact surfaces or the air. Raw, unprocessed food should be effectively separated, either physically or by time, from ready-to-eat foods, with effective intermediate cleaning and where appropriate disinfection. Access to processing areas may need to be restricted or controlled.

3.2.6 Physical and chemical contamination

Systems should be in place to prevent contamination of foods by foreign bodies such as glass or metal sheards from machinery, dust, harmful fumes and unwanted chemicals. In manufacturing and processing, suitable detection or screening devices should be used where necessary.

3.2.7 Incoming material requirements

No raw material or ingredient should be accepted by an establishment if it is known to contain parasites, undesirable micro-organisms, pesticides, veterinary drugs or toxic, decomposed or extraneous substances which would not be reduced to an acceptable level by normal sorting and/or processing.

3.2.8 Packaging

Packaging design and materials should provide adequate protection for products to minimize contamination, prevent damage, and accommodate proper labeling.

3.2.9 Water

3.2.9.1 In contact with food

Only potable water, should be used in food handling and processing, with the following exceptions:

- For steam production, fire control and other similar purposes not connected with food; and
- In certain food processes, e.g. chilling, and in food handling areas, provided this does not constitute a hazard to the safety and suitability of food (e.g. the use of clean sea water).

Water re-circulated for reuse should be treated and maintained in such a condition that no risk to the safety and suitability of food results from its use.

3.2.9.2 As an ingredient

Potable water should be used wherever necessary to avoid food contamination.

3.2.9.3 Ice and steam

Ice should be made from potable. Ice and steam should be produced, handled and stored to protect them from contamination. Steam used in direct contact with food or food contact surfaces should not constitute a threat to the safety and suitability of food.

3.3 Management and supervision

The type of control and supervision needed will depend on size of business, nature of its activities and types of food involved. Managers and supervisors should have enough knowledge of food hygiene principles and practices.

3.4 Documentation and records

Appropriate records of processing, production and distribution should be retained for a period that exceeds the shelf-life of the product. Documentation can enhance the credibility and effectiveness of the food safety control system.

3.5 Recall procedures

Managers should ensure effective procedures are in place to deal with any food safety hazard and to enable complete recall of any implicated lot of finished food from market. Recalled products should be held under supervision until they are destroyed, used for purposes other than human consumption, determined to be safe for human consumption, or reprocessed in a manner to ensure their safety.

4. Establishment, Maintenance & Sanitation

4.1 Maintenance and cleaning

4.1.1 Establishments and equipment should be kept in an appropriate state of repair and condition to:

- Facilitate all sanitation procedures
- Function as intended, particularly at critical steps
- Prevent contamination of food, e.g. from metal shread, flaking plaster, debris and chemicals.

Cleaning should remove food residues and dirt which may be a source of contamination.

The necessary cleaning methods and materials will depend on the nature of the food business.

4.1.2 Cleaning procedures and methods

Cleaning can be carried out by the separate or the combined use of physical methods, such as heat, scrubbing etc. Cleaning procedures will involve, where appropriate:

- Removing gross debris from surfaces
- Applying a detergent solution to loosen soil and bacterial film and hold them in solution or suspension
- Rinsing with water to remove loosened soil and residues of detergent
- Dry cleaning or other methods for removing/collecting residues and debris

- Disinfection with subsequent rinsing unless the manufacturers' instructions indicate on scientific basis that rinsing is not required.

4.2 Cleaning programmes

Cleaning/disinfection programmes should ensure that all parts of establishment are appropriately clean, and should include the cleaning of cleaning equipment. Where written cleaning programmes are used, they should specify:

- Areas, items of equipment and utensils to be cleaned.
- Responsibility for particular tasks
- Method and frequency of cleaning
- Monitoring arrangements.

4.3 Pest control systems

4.3.1 Pests are threat to safety and suitability of food. Pest infestations can occur where there are breeding sites and a supply of food. Avoid creating an environment conducive to pests.

4.3.2 Preventing access

Buildings should be kept in good repair and condition to prevent pest access and to eliminate potential breeding sites. Holes, drains and other places where pests are likely to gain access should be kept sealed.

4.3.2 Harborage and infestation

The availability of food and water encourages pest harborage and infestation. Potential food sources should be stored in pest-proof containers and/or stacked above the ground and away from walls.

4.3.3 Monitoring and detection

Establishments and surrounding areas should be regularly examined for evidence of infestation.

4.3.4 Eradication

Pest infestations should be dealt with immediately and without adversely affecting food safety or suitability.

4.4 Waste management

Make suitable provision for removal and storage of waste. Waste must not accumulate in working areas. Waste stores must be kept clean.

4.5 Monitoring effectiveness

Sanitation systems should be monitored for effectiveness, periodically verified by means such as audit pre-operational inspections or microbiological sampling.

5 Establishment: Personal hygiene

5.1 Health status

People known, or suspected, to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through food, should not be allowed to enter any food handling area if there is a likelihood of their contaminating food. Any person so affected should immediately report illness or symptoms of illness to the management. Medical examination of a food handler should be carried out if clinically or epidemiologically indicated.

5.2 Illness and injuries

Conditions to be reported to management for medical examination and/or possible exclusion from food handling can be considered, are jaundice, diarrhoea, vomiting, fever, sore throat with fever, visibly infected skin lesions and discharges from ear, eye or nose.

5.3 Personal cleanliness

Food handlers should maintain a high degree of personal cleanliness. Personnel should always wash their hands when personal cleanliness may affect food safety, for example:

- At the start of food handling activities;
- Immediately after using the toilet; and
- After handling raw food or any contaminated material, where this could result in contamination of other food items; they should avoid handling ready-to-eat food, where appropriate.

5.4 Personal behaviour

People should avoid behaviour which could result in contamination of food.

5.5 Visitors

Visitors to food manufacturing, processing or handling areas should, wear protective clothing and adhere to personal hygiene provisions in this section.

6. Transportation

6.1 Requirements

Conveyances/bulk containers should be designed and constructed so that they:

- Do not contaminate foods or packaging;
- Can be effectively cleaned and, where necessary, disinfected
- Permit effective separation of different foods or foods from non-food items where necessary during transport
- Provide effective protection from contamination, including dust and fumes;
- Can effectively maintain the temperature, humidity, atmosphere and other conditions necessary to protect food from microbial growth.
- Allow any necessary temperature, humidity and other conditions to be checked.

6.2 Use and maintenance

Conveyances and containers for transporting food should be kept in a state of cleanliness, repair and condition.

7. Product information and consumer awareness

7.1 Lot identification

Lot identification is essential in product recall and stock rotation.

7.2 Product information

All food products should be accompanied by or bear adequate information to enable the next person in the food chain to handle, display, store and prepare and use the product safely and correctly.

7.3 Labelling

Prepackaged foods should be labeled with clear instructions to enable the next person in the food chain to handle, display, store and use the product safely.

7.4 Consumer education

Health education programs should cover general food hygiene. Such programs should enable consumers to understand the importance of any product information and to follow any instructions accompanying products, and make informed choices.

8 Training

8.1 Awareness and responsibilities

All personnel should be aware of their role in protecting food from contamination or deterioration. Food handlers should have the necessary knowledge and skills to enable them to handle food hygienically. Those who handle strong cleaning or hazardous chemicals should be instructed in safe handling techniques.

8.2 Training programmes

Level of training depends on the following factors:

- Nature of food and its ability to sustain growth of harmful micro-organisms
- Manner in which food is handled/packed
- Extent/nature of processing or further preparation before final consumption
- Conditions under which the food will be stored
- Expected length of time before consumption.

Prerequisite programme- good manufacturing practices

Good Manufacturing Practices (GMP) refers to the Practices which manufacturers, processors, and packagers should take as proactive steps to ensure that their products are safe, pure, and effective.

GMP requires a quality approach to manufacturing, enabling companies to minimize or eliminate instances of contamination, mixups, and errors. This in turn, protects the consumer from purchasing unsafe and poor quality products. Failure of firms to comply with GMP can result in very serious consequences including recall, seizure, fines, and imprisonment. It addresses issues including recordkeeping, personnel qualifications, sanitation, cleanliness, equipment verification, process validation, and complaint handling.

Most GMP requirements are very general and open-ended, allowing each manufacturer to decide individually how

to best implement the necessary controls. This provides much flexibility, but also requires that the manufacturer interpret the requirements in a manner which makes sense for each individual business.

Good Manufacturing Practice in Food Industry

Personnel

- a Disease control:** Any person who, appears to have, an illness, open lesion, including boils, sores, or infected wounds shall be excluded from any operations which may be expected to result in food contamination.
- b Cleanliness:** All persons working in direct contact with food shall conform to following hygienic practices while on duty:
- 1 Wearing garments suitable to the operation to avoid contamination of food,
 - 2 Maintaining adequate personal cleanliness,
 - 3 Washing hands thoroughly in an adequate hand-washing facility,
 - 4 Removing all unsecured jewellery and other objects that might fall into food, equipment, or containers,
 - 5 Maintaining gloves, if they are used in food handling, in an intact, clean, and sanitary condition. The gloves should be of an impermeable material,
 - 6 Wearing, where appropriate, in an effective manner, hair nets, headbands, caps, beard covers, or other effective hair restraints,
 - 7 Storing clothing or other personal belongings in areas other than where food is exposed or where equipment or utensils are washed,
 - 8 Confining the following to areas other than where food may be exposed : eating food, chewing gum, drinking beverages, or using tobacco,
 - 9 Taking any other necessary precautions to protect against contamination of food by perspiration, cosmetics, tobacco, chemicals, medicines applied to skin.
- c Education and training:** Personnel responsible for identifying sanitation failures should have a background of education or experience to provide a level of competency necessary for production of clean and safe food.
- d Supervision:** Responsibility for assuring compliance by all personnel with all requirements of this part shall be clearly assigned to competent supervisory personnel.

Plant and grounds

- a Grounds:** shall be kept in a condition that will protect against the contamination of food. The methods for maintenance of grounds are as follows

- 1 Properly storing equipment, removing litter and waste, and cutting weeds or grass within the immediate vicinity of the plant buildings or structures that may constitute an attractant, breeding place, or harborage for pests,
- 2 Maintaining roads, yards, and parking lots so that they do not constitute a source of contamination in areas where food is exposed,
- 3 Adequately draining areas that may contribute to contamination to food by seepage, foot-borne filth, or providing a breeding place for pests,
- 4 Operating systems for waste treatment and disposal so that they do not constitute a source of contamination in areas where food is exposed.

- b Plant construction and design:** The plant and facilities shall:

- 1 Provide sufficient space for such placement of equipment and storage of materials as is necessary for the maintenance of sanitary operations.
- 2 Permit the taking of proper precautions to reduce the potential for contamination of food, food-contact surfaces, or food-packaging materials.
- 3 Permit the taking of proper precautions to protect food in outdoor bulk fermentation vessels.
- 4 Be constructed in such a manner that floors, walls, and ceilings may be adequately cleaned and kept clean and kept in good repair.
- 5 Provide adequate lighting in hand-washing areas, dressing and locker rooms, and toilet rooms and in all areas where food is examined, processed, or stored.
- 6 Provide adequate ventilation or control equipment to minimize odors and vapors in areas where they may contaminate food.
- 7 Provide, where necessary, adequate screening or other protection against pests.

Sanitary operations

- a General maintenance:** Buildings, fixtures, and other physical facilities of the plant shall be maintained in a sanitary condition.
- b Substances used in cleaning and sanitizing:** storage of toxic materials:
- 1 Cleaning compounds and sanitizing agents used in cleaning and sanitizing procedures shall be free from undesirable microorganisms.
 - 2 Toxic cleaning compounds, sanitizing agents shall be identified, held, and stored in a manner that protects against contamination of food.
- c Pest control:** No pests shall be allowed in any area of a food plant. The use of insecticides or rodenticides is permitted only under precautions and restrictions that will protect against the contamination of food, food-contact surfaces, and food-packaging materials.

d Sanitation of food-contact surfaces: All food-contact surfaces, including utensils and food-contact surfaces of equipment, shall be cleaned frequently to protect against contamination of food.

- 1 Food-contact surfaces used for manufacturing or holding low-moisture food shall be in a dry, sanitary condition at the time of use.
- 2 In wet processing, when cleaning is necessary to protect against the introduction of microorganisms into food, all food-contact surfaces shall be cleaned and sanitized before use and after any interruption during which the food-contact surfaces may have become contaminated.
- 3 Non-food-contact surfaces of equipment used in the operation of food plants should be cleaned frequently to protect against contamination of food.
- 4 Single-service articles should be stored in appropriate containers.
- 5 Sanitizing agents shall be adequate and safe under conditions of use.

e Storage and handling of cleaned portable equipment and utensils: Cleaned and sanitized portable equipment with food-contact surfaces and utensils should be stored so as to protect food-contact surfaces from contamination.

Sanitary facilities and controls

Each plant shall be equipped with adequate sanitary facilities and accommodations including, but not limited to:

- a Water supply. The water supply shall be sufficient for the operations intended and shall be derived from an adequate source. Any water that contacts food or food-contact surfaces shall be safe and of adequate sanitary quality.
- b Plumbing. Plumbing shall be of adequate size and design and adequately installed and maintained to:
 - 1 Carry sufficient quantities of water to required locations throughout the plant.
 - 2 Properly convey sewage and liquid disposable waste from the plant.
 - 3 Avoid constituting a source of contamination to food, water supplies, equipment, or utensils or creating an unsanitary condition.
 - 4 Provide adequate floor drainage in all areas where floors are subject to flooding-type cleaning or where normal operations release or discharge water or other liquid waste on the floor.
 - 5 Provide that there is no backflow from, or cross-connection between, piping systems that discharge waste water or sewage and piping systems that carry water for food or food manufacturing.
- c **Sewage disposal:** Sewage disposal shall be made into an adequate sewerage system or disposed off through other adequate means.

d Toilet facilities: Each plant shall provide its employees with adequate, readily accessible toilet facilities.

e Hand-washing facilities: Hand-washing facilities shall be adequate and convenient and be furnished with running water at a suitable temperature. Compliance with this requirement may be accomplished by providing:

- 1 Hand-washing facilities and, where appropriate hand-sanitizing facilities at each location in the plant where good sanitary practices require employees to wash and/or sanitize their hands.
- 2 Effective hand-cleaning and sanitizing preparations.
- 3 Suitable drying devices.
- 4 Devices or fixtures, such as water taps, so designed and constructed to protect against recontamination of clean, sanitized hands.
- 5 Readily understandable signs directing employees sanitize their hands.
- 6 Refuse receptacles that are constructed and maintained in a manner that protects against contamination of food.

f Rubbish and offal disposal: Rubbish and solid waste shall be so conveyed, stored, and disposed of as to minimize the development of odour, minimize the potential for the waste becoming so an attractant and harborage place for pests.

Equipment and utensils

- a All plant equipment and utensils shall be so designed and of such material (food grade) and workmanship as to be adequately cleanable.
- b Seams on food-contact surfaces shall be smoothly bonded or maintained so as to minimize accumulation of food particles, dirt, and organic matter.
- c Equipment that is in manufacturing area and that does not come into contact with food shall be so constructed that it can be kept in a clean condition.
- d Holding, conveying, and manufacturing systems shall be of design and construction that enables them to be maintained in sanitary condition.
- e Each freezer used to store and hold food capable of supporting growth of microorganisms shall be fitted with an indicating temperature recording device.
- f Instruments and controls shall be accurate and adequately maintained, and adequate in number for their designated uses.
- g Compressed air or other gases introduced into food shall be treated in such a way that food is not contaminated.

Processes and Controls

a Raw materials/ingredients

- 1 Raw materials shall be inspected and segregated

to ascertain that they are clean and suitable for processing into food;

- 2 Raw materials shall either not contain levels of microorganisms that may produce food poisoning or other disease in humans;
- 3 Raw materials susceptible to contamination with aflatoxin, undesirable microorganisms, or extraneous material shall comply with regulations;
- 4 Raw materials shall be held so as to protect against contamination and shall be held at such temperature and humidity as to prevent food adulteration;
- 5 Frozen raw materials shall be kept frozen. If thawing is required it shall be done in a manner that prevents the raw materials from becoming contaminated; and
- 6 Liquid or dry raw materials and other ingredients received and stored in bulk form shall be held in a manner that protects against contamination.

b Manufacturing operations

- 1 Equipment and utensils and finished food containers shall be maintained in an acceptable condition through appropriate cleaning and sanitizing.
 - 2 Manufacturing shall be conducted under such conditions and controls as are necessary to minimize the potential for the growth of microorganisms,
 - 3 Food that can support the rapid growth of undesirable microorganisms, shall be held in a manner that prevents the food from becoming adulterated.
- (i) Maintaining refrigerated foods at 5°C or below, frozen foods in a frozen state and hot foods at 60°C or above

(ii) Heat treating acid or acidified foods to destroy mesophilic microorganisms

- 4 Work-in-process shall be handled so as to protect against contamination.
- 5 Effective measures shall be taken to protect finished food from contamination by raw materials, other ingredients, or refuse.
- 6 Equipment, containers, and utensils shall be maintained during manufacturing or storage in a manner that protects against contamination.
- 7 Effective measures shall be taken to protect against the inclusion of metal or other extraneous material in food.
- 8 Mechanical manufacturing steps shall be performed so as to protect food against contamination.
- 9 Filling, assembling, packaging, and other operations shall be performed in such a way that food is protected against contamination.
- 10 Ice shall be made from water that is safe and of adequate sanitary quality.
- 11 Manufacturing areas/equipment used for manufacturing human food should not be used to manufacture nonhuman use food.

Warehousing and distribution

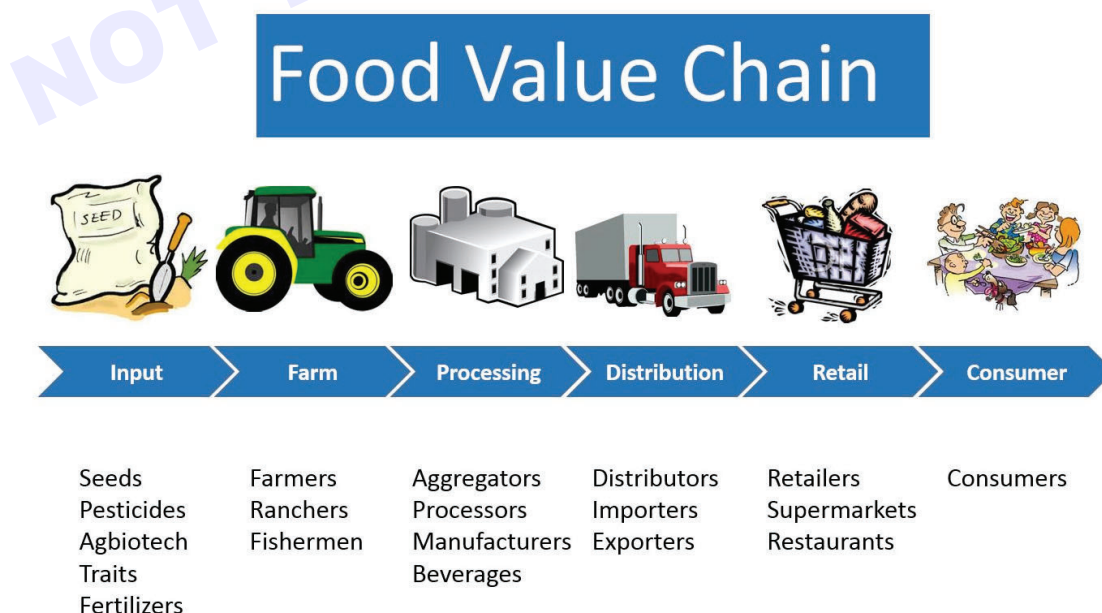
Storage and transportation of finished food shall be under conditions that will protect food against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.

Maximum Defect Action Levels

Defect action levels are established for foods whenever it is necessary and feasible to do so.

Food safety management systems - HACCP

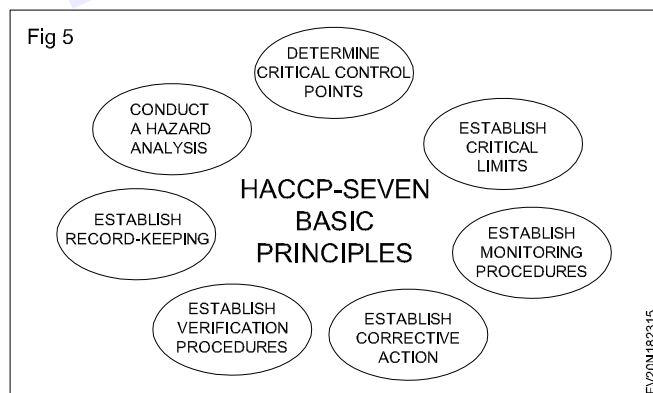
Fig 4



Codex has defined HACCP as a system which identifies, evaluates, and controls hazards which are significant for food safety. More broadly it is a scientific and rational approach to food safety which analyzes potential hazards, determines the critical control points in a food process and develops monitoring procedures to determine if the hazards identified are being effectively controlled. It enhances food safety besides better use of resources and timely response to problems. HACCP has signaled a shift in emphasis from resource intensive end-product inspection and testing to preventive control of hazards at all stages of food production. This is the reason why HACCP system is now widely embraced by the food industries and by the government regulatory agencies around the world as a most cost-effective means of minimizing the occurrence of identifiable food borne biological, chemical and physical hazards and maximizing product safety. It is a system which targets critical areas of processing and in doing so reduces the risk of manufacturing and selling unsafe products.

The primary objective of a HACCP programme is to produce reliably a safe food. This means a product which is free of microbiological, chemical or physical hazards. Industry is fairly familiar with various microbiological, chemical and physical hazards and trying to avoid various common hazards. Despite familiarity and knowledge of food poisoning from microbiological and chemical causes, or injury from glass, wire and other dangerous physical objects, their control is difficult and occasionally they result in serious consumer safety exposures and expensive product recalls and retrievals. It is therefore necessary to have technical orientation on common microbiological, chemical and physical hazards that may cause serious problems in foods.

HACCP can be applied throughout the food chain (See Fig 02) from the primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health to enhance food safety and provide other significant benefits. In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.



Guidelines for the application of HACCP system

The HACCP system, which is based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is a tool to assess

hazards and establish control systems that focus on prevention rather than relying mainly on endproduct testing. The HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments.

The successful application of HACCP requires the full commitment and involvement of management and the work force. It also requires a multidisciplinary approach; this multidisciplinary approach should include, when appropriate, expertise in agronomy, veterinary health, production, microbiology, medicine, public health, food technology, environmental health, chemistry and engineering, according to the particular study. The application of HACCP is compatible with the implementation of quality management systems, such as ISO 9001, and is the system of choice in the management of food safety within such systems.

Prior to the application of HACCP to any sector of the food chain, that sector should have in place prerequisite programmes described in previous sections and appropriate food safety requirements. These prerequisite programs to HACCP, including training, should be well established, fully operational and verified in order to facilitate the successful application and implementation of the HACCP system. For all type of food business, management awareness and commitment is necessary for implementation of an effective HACCP system. The effectiveness will also rely upon management and employees having the appropriate HACCP knowledge and skills.

During hazard identification, evaluation, and subsequent operations in designing and applying HACCP systems, consideration must be given to the impact of raw materials, ingredients, food manufacturing practices, role of manufacturing processes to control hazards, likely end-use of the product, categories of consumers of concern, and epidemiological evidence related to food safety. The intent of the HACCP system is to focus control at Critical Control Points (CCPs). Redesign of the operation should be considered if a hazard which must be controlled is identified but no preventive measures exist (See decision Tree). The efficacy of any HACCP system will nevertheless rely on management and employees having the appropriate HACCP knowledge and skills, therefore ongoing training is necessary for all levels of employees and managers, as appropriate.

Development of HACCP plan

The application of HACCP principles consists of the 12 step development as identified in the Logic Sequence for application of HACCP (See Fig 04). It has two portions- first five steps are called preliminary steps and next seven steps are based on seven principles of HACCP.

Preliminary steps

1 Establishment of a multi- disciplinary team

When a Food Industry embarks upon implementing HACCP system, it becomes necessary to gather together as much expertise and experience on the discussion table as possible including involvement of top management. As

development of HACCP based food safety management programme requires a multi-disciplinary team effort, it should include, when appropriate expertise in veterinary health, production, microbiology, toxicology, public health, food technology, environmental health, chemistry and engineering according to the particular study. This cross-functional expertise is necessary to adequately analyze all physical, chemical and biological hazards through the food chain.

2 Describe the product

The organization should describe its product(s). The description should include the major raw material, food ingredients, preservation and packing materials used and their impact on food safety. This can also include a brief description of how the process occurs and/ products are produced and stored. It would be useful if hazards that may exist either in ingredients or in packing material are identified. A description of the method of distribution includes type of transport and any special consideration to maintain product safety.

Separate HACCP plan should be made for each product. But if two or more products have the identical raw material, ingredients, process operations, packaging, storage and distribution, they can be clubbed together in one HACCP plan.

3 Identify intended use

The intended use should be based on the expected uses of the product by the end user or consumer. It should be indicated how the product is to be used including if it is to be fully cooked before consumption, what preparations will be needed, what will be serving requirements, shelf life etc. If consumer has special consideration such as infant or geriatrics it should be made clear so that necessary emphasis may be given to safeguard their special interest. For instance ice cream is consumed without further processing by general population including high risk groups but infant milk food is meant for infants and is given special consideration.

4 Construct a process flow diagram

The HACCP team constructs a detailed process flow diagram for each product indicating critical steps of control. Each step within the specified area of operation is analyzed for the particular part of the operation under consideration to produce the flow diagram. When applying HACCP system to a given operation, consideration is given to steps preceding and following the specified operation. The process flow diagram is used as the basis of the hazard analysis and should therefore contain sufficient technical detail for the study to progress.

5 On-site verification of process flow diagram

When the process flow diagram is complete, it is verified by the HACCP team at site to confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate.

Steps based on HACCP principles

6 Principle 1

Conduct a hazard analysis. When the process flow diagram is completed and verified, the HACCP team conducts a hazard analysis and lists all the biological, chemical and physical hazards that may be reasonably expected to occur at each step from primary production, processing, manufacture and distribution until the point of consumption. When conducting the hazard analysis, consideration must be given to the impact of raw materials, ingredients, manufacturing practices, role of manufacturing processes to control hazards, likely end-use of the product, consumer populations at risk and epidemiological evidence relative to food safety. Plans determine the food safety hazards and identify the preventive measures the plan can apply to control these hazards. A food safety hazard is any biological, chemical, or physical property that may cause a food to be unsafe for human consumption.

7 Principle 2

Identify critical control points. A Critical Control Point (CCP) is a point, step, or procedure in a food manufacturing process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level. The identification of a CCP in the HACCP system is facilitated by the application of a decision tree (See Fig 05). All hazards that may be reasonably expected to occur, at each step, should be considered.

8 Principle 3

Establish critical limits for each critical control point. A critical limit is the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level. Since the critical control points define the boundaries between safe and unsafe products, it is vital that they are specified at the correct levels and validated at each criteria. The HACCP team should therefore fully understand the criteria governing safety at each CCP in order to set the appropriate critical limits. Critical limits must be specified for each preventive measure.

9 Principle 4

Establish monitoring system for each critical control point. Monitoring activities are necessary to ensure that the process is under control at each critical control point. Monitoring is one of the most important aspects of the HACCP system. It is the scheduled measurement a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP and provide information in time for corrective action to regain control of the process.

10 Principle 5

Establish corrective actions. These are actions to be taken when monitoring indicates a deviation from an established critical limit. The final rule requires a plant's HACCP plan to identify the corrective actions to be taken if a critical limit is not met. Corrective actions are intended to ensure that no product injurious to health or otherwise adulterated as a result of the deviation enters commerce.

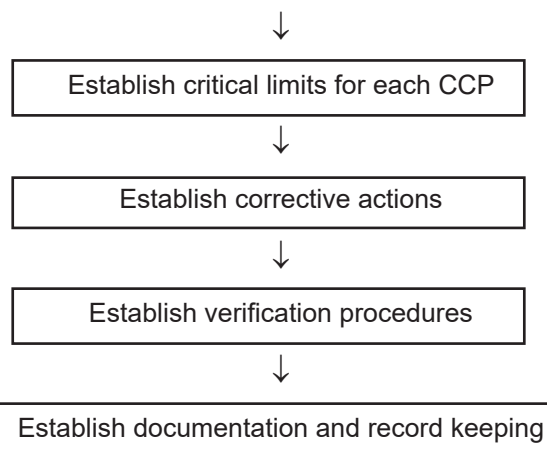
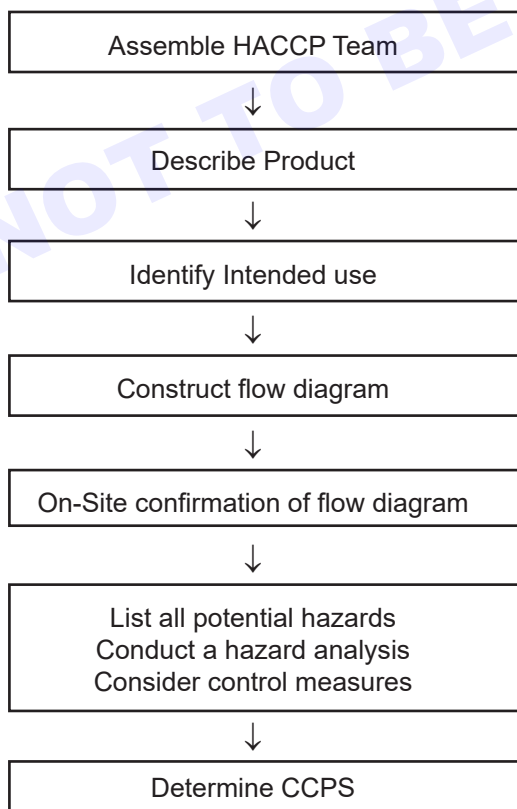
11 Principle 6

Establish verification procedures. Verification ensures the HACCP plan is adequate, that is, working as intended. Verification procedures may include such activities as review of HACCP plans, CCP records, critical limits and microbial sampling and analysis. Verification also includes 'validation' - the process of finding evidence for the accuracy of the HACCP system (e.g. scientific evidence for critical limitations). Validation ensures that the plants do what they were designed to do; that is, they are successful in ensuring the production of safe product.

12 Principle 7

Establish record keeping procedures. Efficient and accurate record keeping is essential to the application of a HACCP system. Records need to be kept of all areas which are critical to product safety to demonstrate that the HACCP system is in compliance with the documented system. The HACCP regulation requires that all plants maintain certain documents, including its hazard analysis and written HACCP plan, and records documenting the monitoring of critical control points, critical limits, verification activities, and the handling of processing deviations.

Logic Sequence for application of HACCP



Example of Decision Tree to identify CCPs

(answer question in sequence)

Food Safety Management System - ISO 22000

The Codex Alimentarius Commission brought out an International Standards on Food Safety Management System (HACCP) in 1997. The food industries keenly awaiting for such an international standards implemented it in their operations and got certification through implementation in their operations. Since this was not a requirement standard, a number of countries and regions developed their own standards based on HACCP for the supply of safe food. Thus one model developed by Codex became 20 models in its application with differing scope and uneven levels of food safety.

The international Organization for standardization stepped in and brought out ISO 22000:2005 Food safety management systems - Requirements for any organization in the food chain. This standard has been developed by the experts from the Food Industry, along with representatives of specialized international organizations and in close cooperation with the Codex Alimentarius Commission for providing a framework of internationally harmonized requirements.

The aim of this International Standard is to harmonize on a global level the requirements for food safety management for businesses within the food chain. It is particularly intended for application by organizations that seek a more focused, coherent and integrated food safety management system than is normally required by law. It requires an organization to meet any applicable food safety related statutory and regulatory requirement through its food safety management system.

Who Should Use ISO 22000: 2005?

Since ISO 22000 is a generic food safety management standard, it can be used by any organization directly or indirectly involved in the food chain. It applies to all organizations in the food chain. It doesn't matter how complex the organization is or what size it is, ISO 22000 can help ensure the safety of its food products.

The food chain consists of the entire sequence of stages and operations involved in the creation and consumption of food products. This includes every step from initial production to final consumption. More precisely, it includes

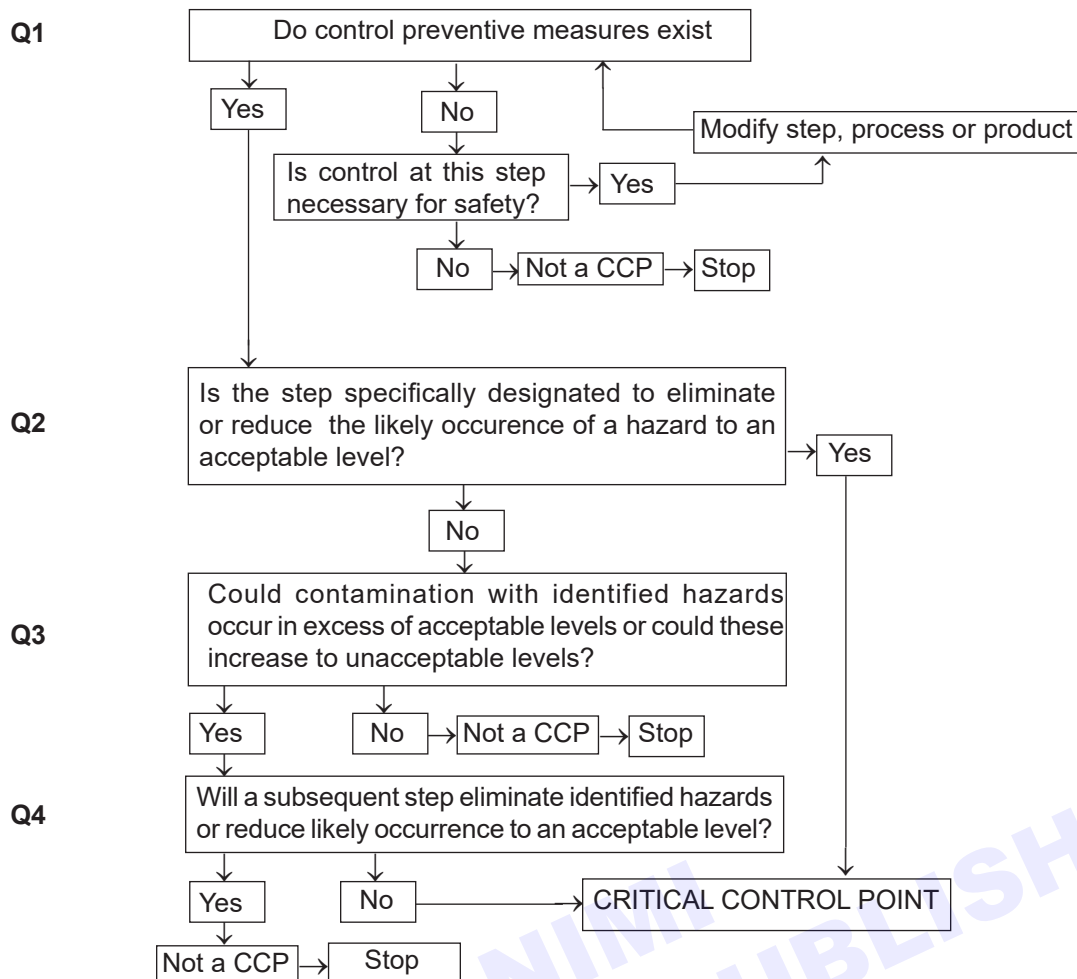
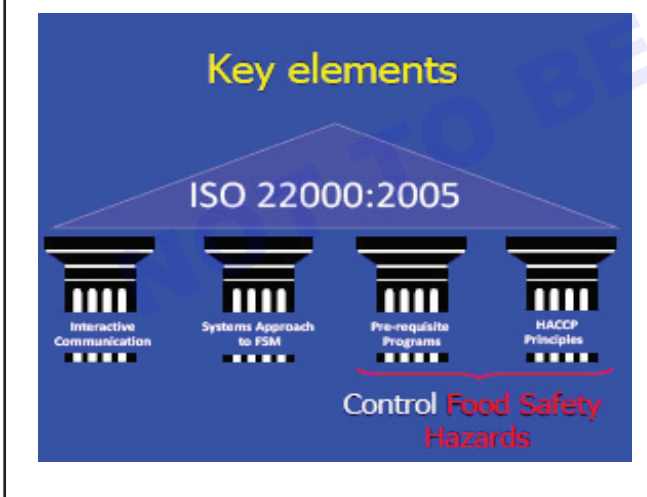


Fig 6



the production, processing, distribution, storage, and handling of all food and food ingredients.

The food chain also includes organizations that do not directly handle food. These include organizations that produce feed for animals. It also includes organizations that produce materials that will eventually come into contact with food or food ingredients.

Why to use ISO 22000: 2005

ISO 22000 will help you to achieve the following objectives:

- To establish a food safety management system (FSMS).
- To ensure that products do not cause adverse health effects.
- To demonstrate compliance with external safety requirements.
- To evaluate customers' food safety requirements.
- To provide safe products and enhance customer satisfaction.
- To export food products and penetrate international markets.
- To communicate safety issues throughout the food chain.
- To ensure compliance with company's food safety policy.

Key Elements of ISO 22000

ISO 22000 combines generally recognized key elements to ensure food safety along the food chain (See Fig 06):

Interactive Communication

ISO 22000 requires that interactive communication (i.e. proactive, open, continuous dialogue with the stake holders to ensure that:

- All relevant food safety hazards are identified and adequately controlled at each step within the food chain through communication to all parties in the food chain.

- b Communication with customers and suppliers, based on the information generated through systematic hazard analysis is maintained to establish customer and supplier requirements in terms of feasibility, need and impact on the end product.

Systems approach to Food Safety Management

The most effective food safety systems are designed, operated and updated within the framework of a structured management system and incorporated into the overall management activities of the organization. This provides maximum benefit for the organization and interested parties. The standard has taken due consideration of the provisions of ISO 9001:2008 in order to enhance compatibility of the two standards.

Prerequisite Programme

Prerequisite programs (PRPs) are the conditions that must be established throughout the food chain and the activities and practices that must be performed in order to establish and maintain a hygienic environment. PRPs must be suitable and be capable of providing food that is safe for human consumption. PRPs are also referred to as good hygienic practices, good agricultural practices, good production practices, good manufacturing practices, good distribution practices, and good trading practices.

Operational prerequisite programs (OPRPs) are prerequisite programs (PRPs) that are essential. They are essential because a hazard analysis has shown that they are necessary in order to control specific food safety hazards. OPRPs are used to reduce the likelihood that products will be exposed to hazards, that they will be contaminated, and that hazards will proliferate. OPRPs are also used to reduce the likelihood that the processing environment will be exposed to hazards.

HACCP Principles

ISO 22000 integrates the HACCP 7 principles (See Box) developed by the Codex Alimentarius Commission and dynamically combine it with PRPs necessary to control and reduce any food safety hazards identified for the end products delivered to the next step in the food chain to acceptable levels.

ISO 22000 Food Safety Management System

FSMS is a set of interrelated or interacting elements (system) to establish policy and objectives and to achieve those objectives used to direct and control an organization with regard to food safety.

An ideal food safety management system in an enterprise should be one that:

- Meets the food safety policy (overall intentions and direction of an enterprise related to food safety as formally expressed by top management), and achieve the
- Measurable objectives related to the policy meets performance of “effectiveness” (extent to which planned activities are realized and planned results achieved) and “efficiency” (relationship between

the results achieved and the resources needed).

- Applies proven management principles (comprehensive and fundamental rule or belief) for leading and operating an enterprise, aimed at continually improving performance over the long term by focusing on customers while addressing the needs of all other stakeholders.

An effective FSMS should be one that:

- Is well-established, documented, implemented, maintained and continually improved / updated
- Has its products / services that actually meet its intended usage and are safe
- Is proactive and innovative, scientific, risk-avoiding and prevention-oriented

HACCP PRINCIPLES

- 1 Conduct a hazard analysis;
- 2 Determine the Critical Control Points (CCP.s);
- 3 Establish critical limit(s);
- 4 Establish a system to monitor control of the CCP;
- 5 Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control;
- 6 Establish procedures for verification to confirm that the HACCP system is working effectively; and
- 7 Establish documentation concerning all procedures and records appropriate to these principles and their applications.

ISO 22000 Food Safety Management System

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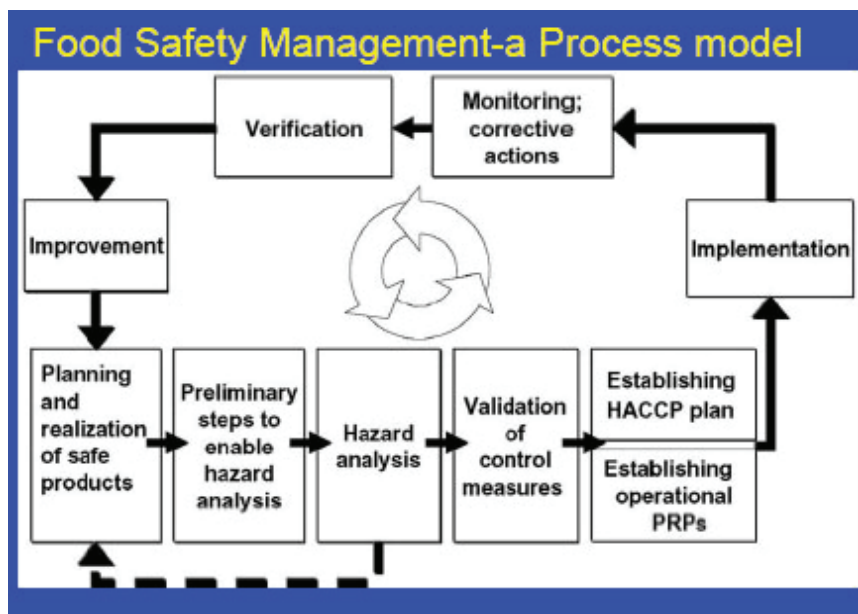
- Is well-established, documented, implemented, maintained and continually improved / updated.

- Has its products / services that actually meet its intended usage and are safe.
- Is proactive and innovative, scientific, risk-avoiding and prevention-oriented.

Model of the ISO 22000

The ISO 22000 model is a continuous improvement process-based FSMS with systematic approach to developing, planning, validating, establishing, implementing, monitoring, verifying and improving the FSMS.

Fig 7



Key Requirements of the ISO 22000: 2005

The ISO 22000 standard is a management system standard that sets requirements for results without setting requirements for resources. This standard sets out specific requirements for the five areas shown in the (Fig 8).

Fig 8



Implementation model for food safety control measures

ISO 22000 requires that organizations to plan and develop processes needed for realization of safe product, implement, operate and ensure effectiveness of planned activities. This includes PRP.s, Operational PRP.s and/or HACCP plan. The organization uses a dynamic and systematic process approach to develop the food safety management system. This is achieved through effective development, implementation, monitoring of

planned activities, maintenance and verification of control measures, updating the food processes and process environment, and through appropriate actions in the event of the production of nonconformities.

ISO 22000 groups control measures into three groups(See Fig 9):

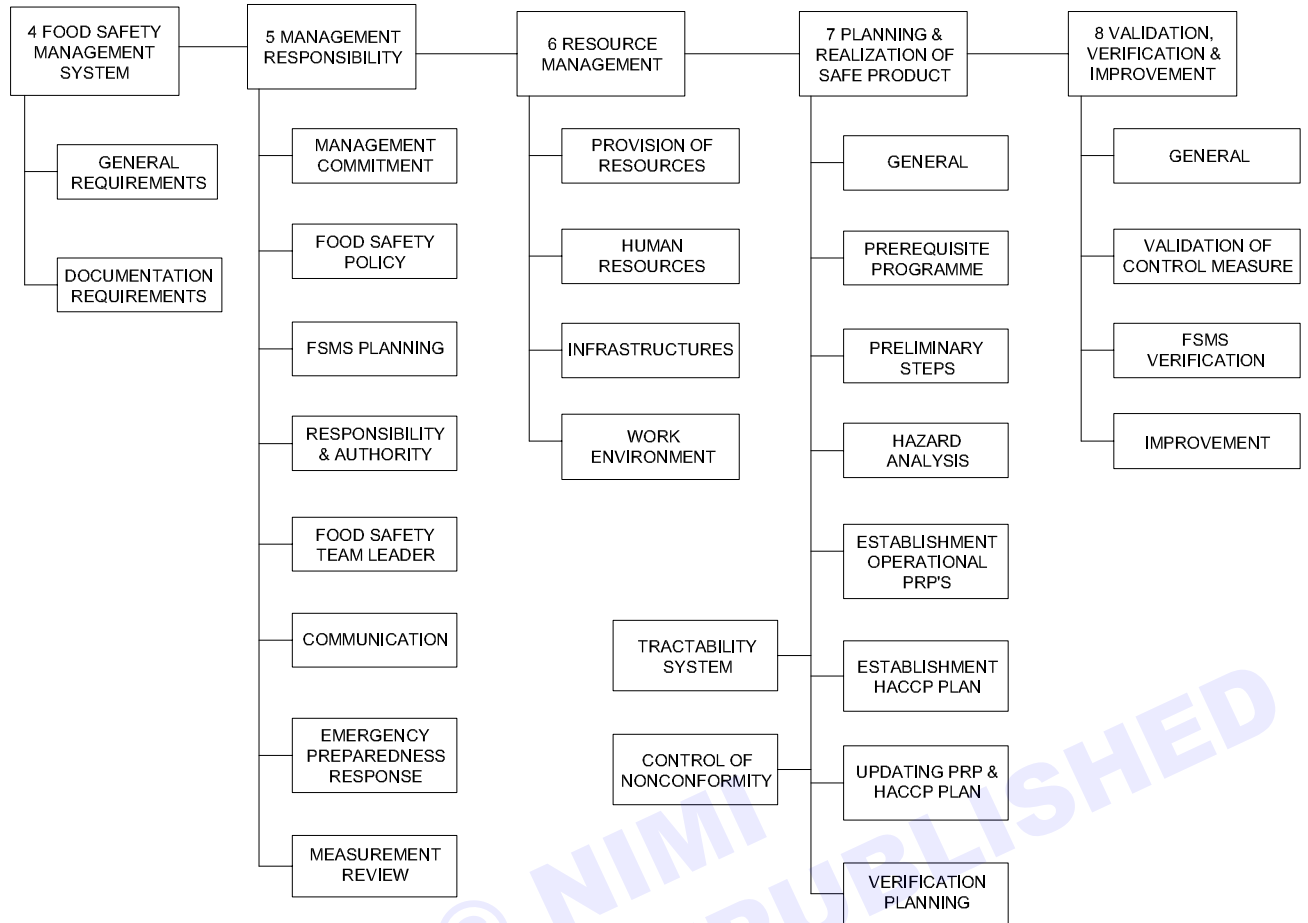
- Prerequisite programmes (PRPs) that manage the basic conditions and activities; the PRPs are not selected for the purpose of controlling specific identified hazards but for the purpose of maintaining a hygienic production, processing and/or handling environment.
- Operational prerequisite programmes (OPRPs) that manage those control measures that the hazard analysis identifies as necessary to control identified hazards to acceptable levels, and which are not otherwise managed by the HACCP plan.
- HACCP plan to manage those control measures that the hazard analysis identifies as necessary to control identified hazards to acceptable levels, and which are applied at critical control points (CCP.s)

ISO 22000 Certification

ISO 22000 is designed to be used for certification/registration purposes. In other words, once company has established a FSMS that meets ISO's requirements, it can apply for certification to a certification agency to audit the system. If certification agency find after audit that the implemented system meets the ISO 22000 requirements, it will issue an official certificate that states that company. FSMS meets the food safety requirements.

Fig 9

STRUCTURE OF ISO 22000



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Fig 10

FOOD SAFETY MANAGEMENT SYSTEM PLAN		
CONSTITUTION OF A MULTIDISCIPLINARY FOOD SAFETY TEAM		
Gathering information for prerequisites	Gathering information for hazard analysis	
1. Recommended International Code of Practice General Principles of Food Hygiene (CAC/RCP1(1969) Rev-4 (2003)	1. Product characteristics a) Raw materials, ingredients and product-contact materials b) Characteristics of end products	
2. Industry specific guidelines / codes	2. Intended use	
3. Statutory & regulatory requirements in that specific area	3. Flow diagrams, onsite verification. Process steps and control measures	
	HAZARD ASSESSMENT	
	Categorization of Hazards	
	Significant Hazards	
	OPRP's	
Prerequisite programmes (PRP's)	OPR Programme	HACCP Plan
INSTITUTION OF FOOD SAFETY CONTROL MEASURES		
PRP's	OPR Programme	HACCP Plan
VALIDATION		
IMPLEMENTATION OF CONTROL MEASURES		
Prerequisite Programme	Operational Prerequisite Programme (OPRP)	HACCP Plan
MONITORING		
	OPRP Programme	HACCP Plan
VERIFICATION OF CONTROL MEASURES		
PRP's	OPRP Programme	HACCP Plan
Ongoing verification	Ongoing verification	Ongoing verification
Internal Audit	Internal Audit	Internal Audit
Analysis of results of verification activities	Analysis of results of verification activities	Analysis of results of verification activities
PERIODIC UPDATION OF THE SYSTEM		

However, it is not mandatory to go for certification. A company can be in compliance without being formally certified by an accredited certification agency. It can self assess the system implemented and declare ISO 22000 compliant company. But company customers and business partners are not likely to accept that the company has an effective FSMS if it is not certified.

Benefits of ISO 22000 for users

Organizations implementing the standard will benefit from:

- Organized and targeted communication among trade partners ;
- Optimization of resources (internally and along the food chain);
- Improved documentation;
- Better planning, less post process verification;
- More efficient and dynamic control of food safety hazards;
- All control measures subjected to hazard analysis;
- Systematic management of prerequisite programmes;
- Wide application because it is focused on end results;
- Valid basis for taking decisions;
- Increased due diligence;
- Control focused on what is necessary, and
- Saving resources by reducing overlapping system audit.

Personal Hygiene

Health Status

- Personnel known, or suspected, to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through food, shall not be allowed to enter into any food handling area if there is a likelihood of their contaminating food. The Food Business shall develop system, whereby any person so affected, shall immediately report illness or symptoms of illness to the management and medical examination of a food handler shall be carried out apart from the periodic checkups, if clinically or epidemiologically indicated.
- Arrangements shall be made to get the food handlers / employees of the establishment medically examined once in a year to ensure that they are free from any infectious, contagious and other communicable diseases. A record of these examinations signed by a registered medical practitioner shall be maintained for inspection purpose.
- The factory staff shall be compulsorily inoculated against the enteric group of diseases once a year and a record towards that shall be kept for inspection.

- In case of an epidemic, all workers to be vaccinated irrespective of the yearly vaccination.

Personal Cleanliness

- Food handlers shall maintain a high degree of personal cleanliness. The food business shall provide to all food handlers with adequate and suitable clean protective clothing, head covering, face mask, gloves and footwear and the food business shall ensure that the food handlers at work wear only clean protective clothes, head covering and footwear every day.
- Food handlers, with any cut or wounds in their person, shall not come in direct contact with food or food contact surfaces.
- Food handlers shall always wash their hands with soap and clean potable water, disinfect their hands and then dry with hand drier or clean cloth towel or disposable paper at the beginning of food handling activities; immediately after using the toilet; and after handling raw food or any contaminated material, tools, equipment or work surface, where this could result in contamination of other food items.

Personal Behaviour

- Food handlers engaged in food handling activities shall refrain themselves from smoking; spitting; chewing or eating; sneezing or coughing over any food whether protected or unprotected food and eating in food preparation and food service areas.
- The food handlers should trim their nails and hair periodically, do not encourage or practice unhygienic means while handling food.
- Persons working directly with and handling raw materials or food products shall maintain high standards of personal cleanliness at all times. In particular:
 - a They shall not smoke, spit, eat or drink in areas or rooms where raw materials and food products are handled or stored;
 - b Wash their hands at least each time work is resumed and whenever contamination of their hands has occurred; e.g. after coughing / sneezing, visiting toilet, using telephone, smoking etc.

Biological Inspection Of Establishments

While conducting inspection following parameters to be taken into consideration to address microbial contamination/ microbial hazards in the food establishments.

- 1 Raw Material Storage iV Refrigerated and Non-Refrigerated
 - a All raw materials should be
 - Free from insect and rodent infestation
 - Free of contamination from other sources, e.g. birds, moisture, mould etc.

- b If bulk floor handling and storage is in use then,
 - Hose couplings, inside and outside plant, should be adequately protected from rodents, clean and in good repair
 - Dust collectors or ventilation bags at top of the bulk tank should be clean and insect free
 - If system contains inspection ports, they should be free from contamination
 - c The microbial load of all the food items like raw fruits and vegetables, liquid milk, meat, eggs, flour, cereal grains etc. should be within the acceptable limits at receiving as well as during their storage in the raw material store.
 - d Depending on the nature of the food adequate facilities shall be available for storing refrigerated or frozen foods, monitoring food temperatures, and controlling ambient temperatures and humidity to ensure the microbiological safety and suitability of food.
 - e In case of grain storage, fumigation should be done at regular intervals to ensure the absence of any microbiological and pest activity.
 - f Swabs can be taken from crates, tanks in which the material is kept and stored, to check their microbiological suitability for the purpose.
- ## 2 Manufacturing Area
- a All pieces of food contact equipments viz. Dough mixers, conveyors, rounders, dough dividers, racks, proofing equipments, oven, rollers, slicers, sifters, pasteurizer, homogenizer, retort, bottling unit, pulper, filtering screens, mixing vats etc. should be clean and in good repair.
 - b All the equipments and their surroundings should be free from evidence of rodent or insect activity.
 - c Temperature of proofing equipment, ovens, retort, heat exchangers and cooling area should be maintained.
 - d Equipments should be cleaned (in place, wherever possible) before use.
 - e All vapor producing cooking equipment such as retort, ovens, grills, and fryers should be equipped with ventilation and an approved automatic extinguishing system to prevent unnecessary condensation in the working area which may harbor micro-organisms.
 - f Utensils like spoons, beaters, pans, bowls, trays, spatulas etc should be sanitized after every lot manufactured.
 - g Utensils and equipment washing facilities should be clean and adequate.
 - h Working area as well as the outside premises should be free from spilled powders or liquids, trash etc which may attract or harbor pests, rodents or micro-organisms.
 - i In slaughter house, diseased animal should be condemned and it should not be allowed to move further in the process.
 - j In meat processing units, carcass from diseased animal or with any internal bruise, boils etc should be removed from the process and be disposed off accordingly.
 - k Swabs of machine, working tables, utensils, food contact surfaces should be taken at regular intervals to ensure their microbial safety for food use.
 - l Air contamination should be adjudged by checking the microbial quality of air.
 - m Antiseptic/disinfectant foot bath should be provided at the entrance of plant.
- ## 3 Packaging and Storage of Finished Product
- a Packaging material (pouches, films, laminates, cans, glass/PET bottles, closures, jars, cardboard boxes) should be kept and stored under hygienic conditions in a room intended for that purpose.
 - b Packaging material/bottles/closures should be sanitized before use.
 - c All the products should be labeled according to the Food Labelling Act.
 - d Immediately after packaging and proper labelling, the products should be placed in the rooms provided for storage under required temperature and humidity conditions to prevent any spoilage.
 - e Temperature and relative humidity of the storage area should be maintained to optimum required level.
- ## 4 Personnel Hygiene
- ### a Health Status
- Personnel known, or suspected, to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through food, shall not be allowed to enter into any food handling area if there is a likelihood of their contaminating food. According to the type of disease, food handler work restrictions are given in Table 1.
 - The Food Business shall develop system, whereby any person so affected, shall immediately report illness or symptoms of illness to the management and medical examination of a food handler shall be carried out apart from the periodic checkups, if clinically or epidemiologically indicated.
 - Arrangements shall be made to get the food handlers / employees of the establishment medically examined once in a year to ensure that they are free from any infectious, contagious and other communicable diseases. A record of these examinations signed by a registered medical practitioner shall be maintained for inspection purpose.

- The factory staff shall be compulsorily inoculated against the enteric group of diseases once a year and a record towards that shall be kept for inspection.
- In case of an epidemic, all workers to be vaccinated irrespective of the yearly vaccination.

b Personal Cleanliness

- Food handlers shall maintain a high degree of personal cleanliness. The food business shall provide to all food handlers with adequate and suitable clean protective clothing, head covering, face mask, gloves and footwear and the food business shall ensure that the food handlers at work wear only clean protective clothes, head covering and footwear every day.
- Food handlers, with any cut or wounds in their person, shall not come in direct contact with food or food contact surfaces.
- Food handlers shall always wash their hands with soap and clean potable water, disinfect their hands and then dry with hand drier or clean cloth towel or disposable paper at the beginning of food handling activities; immediately after using the toilet; and after handling raw food or any contaminated material, tools, equipment or work surface, where this could result in contamination of other food items.
- Food handlers engaged in food handling activities shall refrain themselves from smoking; spitting; chewing or eating; sneezing or coughing over any food whether protected or unprotected food and eating in food preparation and food service areas.
- The food handlers should trim their nails periodically, do not encourage or practice unhygienic means while handling food.
- Persons working directly with and handling raw materials or food products shall maintain high standards of personal cleanliness at all times. In particular:
 - They shall not smoke, spit, eat or drink in areas or rooms where raw materials and food products are handled or stored;
 - wash their hands at least each time work is resumed and whenever contamination of their hands has occurred; e.g. after coughing / sneezing, visiting toilet, using telephone, smoking etc.
 - avoid certain hand habits - e.g. scratching nose, running finger through hair, rubbing eyes, ears and mouth, scratching beard, scratching parts of bodies etc.- that are potentially hazardous when associated with handling food products, and might lead to food contamination through the transfer of bacteria from the employee to product during its preparation. When unavoidable, hands should be effectively washed before resuming work after such actions.

Food Handler Work Restrictions

Disease	Work status	Duration of week Restriction / Comments
Abscess, boils, etc	Relieve from direct contact and food handling.	Until drainage stops and lesion has healed or employee has negative culture.
AIDS or ARC (AIDS related complex)	May work (per CDC guidelines). No open lesions, upper respiratory diseases, or communicable diseases.	Employee will be counseled and educated.
Diarrhea		
1 Acute stage (etiology known)	Relieve from direct food handling.	Until symptoms resolve and infection with Salmonella, Shigella or Campylobacter is ruled out.
2 Campylobacter	Relieve from direct food handling.	Until symptoms resolve or after appropriate antibiotic therapy for 48 hours.
3 Salmonella	Relieve from direct food handling.	Until stool is free of the infecting organism in two consecutive cultures, not less than 24 hours apart.

Diarrhea		
4 Shigella	Relieve from direct food handling.	Until stool is free of the infecting organism in two consecutive cultures, not less than 24 hours apart.
5 Hepatitis A disease.	Relieve from direct food handling.	Until seven days after onset of jaundice Must bring note from physician upon return.
6 Staphylococcus aureus	Relieve from direct food handling.	Until lesions have resolved and the employee has negative culture.

Fruit and vegetable processing unit.

Sanitary and hygienic Requirements of a F & VP Units to be verified by the Inspecting official:

- 1 The machinery installed in the processing hall should not occupy more than 50% of total space so as to permit hygienic production and easy movement of workers and materials. All machinery should be installed in such a manner which may allow continuous flow of production and the design which will permit easy cleaning
- 2 The tops of tables used for food preparation shall be made of impervious material, preferably SS top.
- 3 The equipment and the factory shall not be used for manufacture of repugnant products like fish, meat, eggs etc. However, permission may be granted as a special case if arrangements are made for disinfection of premises after changing from meat products to fruit products (one-month idle gap will be required for changeover.)
- 4 Adequate arrangements for cleaning equipments, machinery, containers tables and raw materials shall be provided.
- 5 Copper, brass or iron equipments, containers or vessels are not permitted, in the preparation, packing or storage of fruit products, only aluminum, stainless steel, glass or tin equipment are allowed.
- 6 The water used shall be potable and shall be got examined chemically and bacteriological by a Public Health Laboratory. The water sample should be drawn for such examination by the public Health Authority of the Area where the premises is located or should be drawn in the presence of the above authority. Free flowing tap water of 1 Kilo Liter per day shall be made available.
- 7 Wherever cooking is done on open fire, proper outlets for so smoke/steam etc. like chimney, exhaust fan etc. shall be provided. All extraction fans installed on the premises shall discharge into the open air at a height of at least 2.5m above ground in such a manner as not to be a nuisance.
- 8 The workers shall be provided with clean aprons; head- wears gloves etc. and shall be personally neat and tidy.

- 9 Medical examination of the workers, in respect to their fitness, and they are not suffering from contagious and loathsome diseases, and suitable to work in the food factory.

Special establishment inspection

Bakery products and consumer food products

1 Raw Material Storage iV Refrigerated and Non-Refrigerated

All raw materials should be iV

- stored off the floor and away from walls
- free from insect and rodent infestation or adulteration
- free of contamination from other sources, e.g. birds, moisture, mould etc.

Refrigerated items like chocolate, eggs should be stored at proper temperatures.

If bulk floor handling and storage is in use then,

- Hose couplings, inside and outside plant, should be adequately protected from rodents, clean and in good repair
- Dust collectors or ventilation bags at top of the bulk tank should be clean and insect free
- If system contains inspection ports, they should be free from contamination
- Tailings from sifting operations should be free from contamination.

FIFO (First In First Out) system should be applied to release the raw material from the store

Expired material should be discarded and not enter into the manufacturing process.

Food colours and additives should be used within the safe limits prescribed in FSS Act 2006.

2 Manufacturing Area

- All pieces of food contact equipments viz. Dough mixers, conveyors, rounders, dough dividers, racks, proofing equipments, oven, rollers, slicers, sifters etc. should be clean and in good repair.
- All the equipments and their surroundings should be free from dirt, dust and evidence of rodent or insect activity

- Inspection cleaning ports on flour conveyor systems should be accessible and easy to open.
- Conveyor systems should be free from evidence of insect activity
- Cloth connecting sleeves should be clean, tightly-fitted and insect free
- Tailing box on sifter should be free from evidence of insect activity
- Proofing equipment should be free from evidence of insects or rodents
- Temperature of proofing equipment, ovens and cooling area should be maintained
- Baking pans or storage bins should be clean equipments should be cleaned before use
- All grease vapour producing cooking equipment such as doughnut machines, grills, and fryers should be equipped with ventilation and an approved automatic extinguishing system.
- Utensils like spoons, beaters, pans, bowls, trays, spatulas etc should be clean and free from adulterants
- Utensils and equipment washing facilities should be clean and adequate
 - a Cleaning agents and compounds should be labelled properly and kept separate from food items
 - b Weighing practices should be adequate to ensure the declared quantity of contents would be achieved.
 - c All high temperature equipment should be equipped with high-temp cut-off devices which cut off the fuel or power source if the upper safe limit is exceeded.
 - d Working area as well as the outside premises should be free from spilled powders or liquids, trash etc which may attract or harbour pests, rodents or micro-organisms.

3 Packaging and Storage of Finished Product

- Only food grade packaging material (printed/unprinted) should be used for wrapping and packaging of food items.
- Packaging material should also be kept and stored under hygienic conditions in a room intended for that purpose.
- All the products should be labelled according to the Food Labelling Act.
- Immediately after packaging and proper labelling, the products should be placed in the rooms provided for storage under required temperature and humidity conditions.
- Temperature and relative humidity of the storage area should be maintained to optimum required level.
- FIFO system should be applied for dispatch of all products.

- Food colours and additives should be used within the safe limits prescribed in FSS Act 2006.

Personal Hygiene

- 1 High standards of personal hygiene should be maintained.
- 2 All employees handling food should wash their hands properly:
 - Before preparing food.
 - After touching raw food or materials, specially meat/poultry or eggs.
 - After breaks.
 - After using the toilet.
 - After cleaning the raw materials or utensils / equipments.
- 3 Staff working with food must wear suitable clean clothes and where necessary, shall wear head cover, apron, mask mouth and use gloves etc.
- 4 Street shoes inside the food preparation area should not be worn while handling & preparing food.
- 5 Food handlers should ensure careful food handling & protect food from environmental exposure.
- 6 Food handlers should avoid following practices while handling food:
 - Chewing or smoking tobacco
 - Chewing betel nut or gums
 - Touching mouth, tongue, nose, eyes or other body parts
 - Spitting, sneezing, coughing, etc.
 - Touching ready-to-eat food with bare hands
 - Handling food and money at same time
 - not to wear watches or jewellery while preparing food.
- 7 All food handlers should be medically fit and free from diseases.

Traceability

ISO 22005 has defined traceability as 'ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution.. Traceability systems should be able to document the history of the product and/or locate a product in the food chain. Traceability systems contribute to the search for the cause of nonconformity and the ability to withdraw and/or recall products if necessary. Traceability systems can improve appropriate use and reliability of information, effectiveness and productivity of the organization. Movement can relate to the origin of the materials, processing history or distribution of the food, and should address at least one step forward and one step backward for each organization in the chain.

Principles of traceability Traceability systems should be

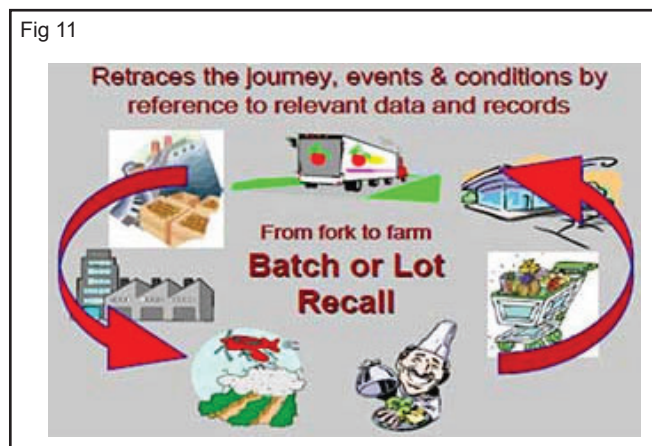
- Verifiable,
- Applied consistently and equitably,
- Results oriented,
- Cost effective,
- Practical to apply,
- Compliant with any applicable regulations or policy, and
- Compliant with defined accuracy requirements.

Objectives of traceability

In developing a food chain traceability system, it is necessary to identify the specific objectives to be achieved. These objectives should take into consideration the traceability principles. Ex. of objectives are the following:

- To support food safety and/or quality objectives;
- To meet customer specification(s);
- To determine the history or origin of the product;
- To facilitate the withdrawal and/or recall of products;
- To identify the responsible organizations in the feed and food chain;
- To facilitate the verification of specific information about the product;
- To communicate information to relevant stakeholders and consumers;
- To fulfil any local, regional, national or international regulations or policies;
- To improve the effectiveness, productivity and profitability of the organization.

Traceability system comprises two primary capabilities, the ability to track movements and to trace custody of a food product in the food chain. In defining traceability, it is important to distinguish between the terms “tracking” and “tracing”. The tracing is the ability to recreate the history of a product in the food chain and to identify the origin, movement and relevant associated information of a particular unit and/or batch of product located within the supply chain by reference to records held upstream. (See Fig 11)



Tracking is the ability to trace the destination of a product in a food chain and to follow a path of a specified unit and/or batch of product through the supply chain as it moves from organizations towards the final point-of-process, point-of-sale, point-of-service or point of consumption. In other words, it is the movement of the product forward through the food chain to understand where it has gone, what it has gone into and what it has come into contact with.

Four main factors to allow traceability:

- Identification of what has to be traced,
- Recording of the related data,
- The links between all data recorded, and
- The communication of data.

But to ensure traceability along the whole supply chain, there is inter-dependency of all stakeholders involved, so there is a need for a common language, hence, the role of standardisation. The issues which have a bearing on the subject of traceability are:

- a The place of traceability in risk management ;
- b The use of traceability for product integrity, authenticity and identification ;
- c The use of equivalent measures ;
- d The practicability of traceability, and the feasibility of its application in developing countries ;
- e Consumer confidence and information concerning the nature and origin of products ;
- f The possibility of using traceability for liability and redress.

Components of the Traceability/ Product Tracing Tool

- a The food supply chain is very complex and involves several companies, wherein various ingredients, components and packaging as well as the process of inspection play an important role. In selecting the items sought to be traced, there are a number of other factors that would also need to be ascertained, such as, the origin of food ingredients, processing history, definition of the batch, links between manufacturing batches, methods of production, methods of analysis, storage, personnel involved, the entire supply & distribution chain system, etc. It may also be necessary to establish product integrity, authenticity and identification at all the stages for consumer confidence in the context of food inspection and certification system. It might also need to address liability issues and redress mechanism.
- b The context of traceability incorporates different features of the process of implementation of HACCP/ ISO 22000 etc. in food businesses requiring record keeping at relevant stages of the value chain, where practicable. It also provides for preserving product identity. It is acknowledged that traceability/product tracing is not an end in itself but an instrument seeking to achieve the particular objective(s), such

as production of safe food and protection from unfair trade practices.

Importance

Traceability is a tool to control quality, to find the cause of a quality problem, help in logistics and in rationalizing the process linked to logistics flow. It plays an important role in consumer safety, in allowing speedy and targeted recalls and withdrawal. It answers the requirement of regulations, and is a part of marketing in contributing to the protection of brand image.

Limitations of Implementing the Traceability/ Product Tracing tool

- In countries where the product raw material, ingredients and components are produced by SMEs or in a co-operative structure or are procured through the market systems in smaller volumes, the backward identification of the product becomes quite difficult.
- Where the raw material, ingredients or components are of such nature (e.g. liquids or sometimes even solids) that these are inseparable, tracing to its source is impractical.
- In some developing countries, due to small farm holdings, farm production is in very small volumes. Marketable volumes are built up at the collection centers before being taken to a packing house or processing center. In such situations, traceability/ product tracing is possible only up to the stage of a packing house or processing center and not up to the primary level, unless an extra effort is put in place to bring in the small holdings into the fold through a grower group or through the system of recording data of the chain-of-custody.

Alternatives to Traceability/ Product Tracing Tool

- a At the primary level, group farming with an internal control system and record keeping can be a feasible alternative. In such alternative systems, random checks for food safety needs will work out be cost effective to the farmer or producer.
- b Food safety controls through HACCP/ISO 22000 applicable according to the size of the operation including checks of contaminants and appropriate labeling of batch/lot numbers with expiry dates, where applicable take into account the concerns of traceability needs.
- c Management of non-conformities pointed out by food safety experts from within or outside the production system with respect to the required rules and procedures as well as regular training of manpower involved in the production process.
- d Regular documentation of inputs and practices followed in the production system that facilitates identification of the possible reasons of contamination in food. Application of the alternatives would depend upon the nature and extent of risk involved that should be determined on the basis of necessary

risk management needs and the stage at which the alternative(s) should be applied should also be identified.

Recommended Steps for the Application of Traceability/ Product Tracing Tool

The following steps can be followed by countries for the application of traceability/product tracing tool in the context of food import and export inspection & certification system:

- a Identification and communication of the objectives and scope of traceability/product tracing by the importing country to the exporting country as required in respect of the specified product along with Performance Objectives.
- b Identification and communication of what is to be traced and, if appropriate, stage of the food chain as a risk management option. The recommendation may also state the suggested method of analysis, need for relevant data (e.g., origin, processing history, storage, and personnel), establishment of links between the recorded data, establishment of the integrity/authenticity of the links and liability/redress mechanism, if applicable.
- c Provide information to the exporting country about the possible causes of the risk, nature and extent of the risk and the assessment of risk by not applying the traceability/product tracing tool. This assessment would apply to concerns relating to food safety and deceptive marketing practices.
- d The importing country should suggest possible cost effective alternative yet equivalent measures (e.g., HACCP, internal control system, record keeping, random checks or other means to facilitate identification of the possible means of contamination, lot/batch numbers, labeling, management of non-compliances) to address the risk concerns without the use of traceability/product tracing tool to ensure protection from the assessed food safety risks and deceptive marketing practices on a case-by-case basis depending upon the nature of the product and production/marketing practices.
- e The importing country should also take into account that when and as appropriate a traceability/product tracing tool is to be implemented, it should be transparent, practical, technically feasible and economically viable and that it should not be more trade restrictive than necessary.
- f The extent of application of traceability in the food chain should also be established taking into account evaluation of the various alternatives referred to above to achieve the same objective.
- g Application of the traceability/product tracing tool should adequately address the needs of the developing countries and their traditional practices and may be applied as a food safety objective (SPS measure) and as a legitimate objective (TBT measure).

- h The exporting country should be able to establish that the alternative measures selected for application would appropriately address the risk concerns of the importing country without the need for application of a traceability/product tracing tool.

It must not be forgotten that traceability is only a tool for the establishment of product authenticity, reliability,

identification of the problem areas for the purposes of tracking and product recall. Food safety will come with the implementation of appropriate practices like Good Agricultural Practices, Good Manufacturing Practices, Good Handling Practices, HACCP, ISO-22000 coupled with Quality Management systems. ISO has brought out ISO 22005 which enunciates better approach to traceability of food products.

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