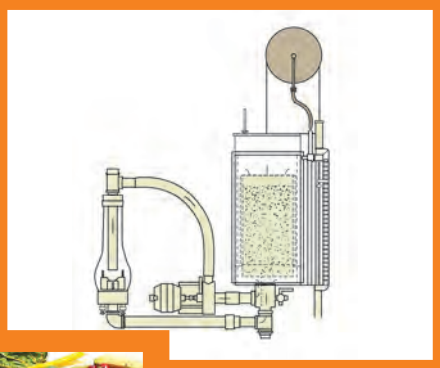
FOOD SCIENCE AND TECHNOLOGY

Standard XI






The Constitution of India

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties- It shall be the duty of every citizen of India–

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities, to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

(k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

The Coordination Committee formed by GR No. Abhyas - 2116/(Pra.Kra.43/16) SD - 4 Dated 25.4.2016 has given approval to prescribe this textbook in its meeting held on 20.6.2019 and it has been decided to implement it from academic year 2019-20.

Food Science and Technology

STANDARD ELEVEN

Y1V1C7

Download DIKSHA App on your smartphone. If you scan the Q.R. Code on this page of your textbook, you will be able to access full text. If you scan the Q.R. Code provided, you will be able to access audio-visual study material relevant to each lesson, provided as teaching and learning aids.

2019

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The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

Preface

Dear Students

It is a matter of pleasure and pride to place this exposition on food science and technology book in the hand of the young generation. This text book aims to create awareness about the food science and technology as food processing industry is highly significant for India's development because of vital linkages and synergies, it promotes between the two pillars of our economy, industry and agriculture. In India, the food sector has emerged as high growth and high profit sector due to its immense potential for value addition particularly within the food processing industry.

This book is designed for the Food Science and Technology students and offers the learner tremendous scope for life skill development. The National Curriculum Framework (NCF) was formulated in 2005, followed the state Curriculum Framework (SCF) in 2010. Based on the given these two frameworks, reconstruction of the curriculum and preparation of a revised syllabus has been undertaken which will be introduced from the academic year 2019-20. The text book incorporating the revised syllabus has been prepared and designed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, (Balbharati), Pune.

Food science can be expressed as the application of the basic science and engineering to study the fundamentals of physical, chemical, and biochemical nature of food and principles of food processing. Food technology is the use of the information generated by food science in the selection, preservation, processing, packaging and distribution as it affects the consumption of safe, nutritious and wholesome food by application of techniques.

The new syllabus focuses on the conceptual principles related to food and its various aspects, its understanding and application in day-to-day life and ability to solve different upcoming problem and issues like various deficiency disease, application of technology in food industry etc. For the first time in syllabus of food science and technology various independent activity have been introduced which not only help to comprehend the content but also understand its application.

The book is prepared by using 5 units with 16 chapters starting from Introduction to food science, scope and opportunities, food group in first unit, the second unit comprises of nutrients in food which contain macro, micro nutrients and food groups, the third unit cover methods of preservation with cooking methods, food spoilage and techniques in food preservation. Unit 4 explains different post harvest technology by covering fruits and vegetables, cereals, pulses and oilseeds, spices, tea, coffee and cocoa, sugar and their products. The last unit contains advances in food technology-1 with packaging technology, nanotechnology and functional foods.

The curriculum and syllabus confirm to the maxims of teaching such as moving from simple to complex, concrete to abstract, known to unknown and from part to whole.

Throughout the book, numerous tables, figures, photographs and illustrations are given, which will help in quick understanding and grasping the matter. QR codes have been introduced for gaining the additional information about abstract of chapters and practice question/activities.

The efforts taken to prepare the textbook will not only enrich the learning experiences of the students, but also benefit other stake holders such as teachers, parents, food entrepreneurs as well as candidates aspiring for the competitive examination.

We look forward to a positive response from the teachers and students.

Our best wishes to all!

(Dr. Sunil Magar)
Director
Maharashtra State Bureau of Textbook
Production and Curriculum Research, Pune

Pune
Date : 20 June 2019
Bharatiya Saur : 30 Jyeshtha 1941

- For Teachers -

Dear Teachers,

We are happy to introduce the revised textbook of Food Science and Technology for Std XI. This book is a sincere attempt to follow the maxims of teaching as well as develop a 'constructive' approach to enhance the quality of learning. The demand for more activity based, experiential and innovative learning opportunities is the need of the hour. The present curriculum has been restructured so as to bridge the credibility gap that exists between what is taught and what students learn from direct experience in the outside world. Guidelines provided below will help to enrich the teaching-learning process and achieve the desired learning outcomes.

- To begin with, get familiar with the textbook yourself.
- The present book has been prepared for constructive and activity-based teaching.
- Teachers must skillfully plan and organize the activities provided in each chapter to develop interest as well as to stimulate the thought process among the students.
- Always teach with proper planning.
- Use teaching aids as required for the proper understanding of the subject.
- Do not finish the chapter in short.
- Follow the order of the chapters strictly as listed in the contents because the units are introduced in a graded manner to facilitate knowledge building.
- Facilitate peer learning as much as possible by reorganizing the class structure frequently.
- Teaching-learning interactions, processes and participations of all students are very essential and so is your active guidance.
- Ask questions based on previous knowledge of different concepts of lesson.
- Do not use the boxes titled 'Do you know?' for evaluation. However, teachers must ensure that students read this extra information.
- Information provided in boxes with the title 'Can You Tell', 'Always Remember' should be considered for evaluation.
- Exercises provided after each unit are prepared using different parameters like observation, co-relation, critical thinking, analytical reasoning etc.
- Evaluation pattern should be based on the above mentioned parameters. Equal weight age should be assigned to all the topics. Use different combinations of questions. Stereotype questions should be avoided.
- Use demonstration, discussion method for teaching.
- 'Can You Recall' is the first main starting point of lesson which helps for the introduction of topic. This will also helpful for students regarding understanding the content of lesson.
- Use QR Code given in the textbook. Keep checking the QR Code for updated information.
- 'Activity' is used in lesson and exercise for better understanding and application of the content which studied.
- Exercise is given at the end of lesson. In exercise different type of questions/ activities are given.
- Teacher should use their freedom to acquaint the students with different food products and recipies of given region.
- Remember that mathematical and statistical tools are also important to understand Food Science and Technology.
- Glossary, brief definitions and abbreviations are provided towards the end of the textbook for further clarification.

Best wishes for a wonderful teaching experience and fruitful welcome!

Competency Statements

Standard XI

Unit	**Competency Statements** **After studying the content in Textbook students will …**
Food Science and Technology	• Explain the importance of food science and technology • Elaborate the scope and correlation of food science with other subjects • Select the opportunities regarding the occupations related to food science and technology • Compare food groups correlated with day-to-day food items • Define the terminologies in food science and technology • Explain and draw food pyramid and elaborate balance diet.
Nutrients in food	• Review the important constituents of food and their functions. • Understand relationship between deficiencies of nutrients. • Describe the energy value of food and various method to calculate it • Understand the Basal Metabolic Rate (BMR) and calculate the Body Mass Index (BMI)
Food Processing and Preservation	• Do the activities related to food cooking • Take precautions during food cooking • Explain food spoilage and its effects • Do the processes of food preservation and food processing • Explain the importance of food processing and food preservation • Draw the flow diagrams in food processing and food preservation
Post Harvest Technology	• Explain the term post-harvest technology • Elaborate different types in post-harvest technology • Explain the process of post-harvest technology with respect to » Fruits and vegetables » Cereals, pulses and oil seeds » Spices and condiments » Tea, coffee and cocoa processing » Sugar and its products
Advance in Food Technology	• Create awareness about advances in food technology • Explain the packaging technology and its importance • Explain the role of Nano technology in food science • Explain the concept of functional food

Contents

Unit - 1

Food Science and Technology

Objectives

- To understand meaning of the food
- To understand the different components of food science and technology
- To study the factors affecting the acceptability of food
- To study the functions of food
- To get acquinted with major food processing sectors in India
- To understand the scope and opportunities of food science and technology in different sectors
- To understand food groups and correlate with day to day food items
- To create awarenes about food pyramid and balance diet

"With every bite of food you eat, can get connected with science and technology applications."

Food is a basic requirement to satisfy hunger along with physical, physiological, intellectual and social life of human beings. Food has multidimensional aspects namely quantitative and qualitative. Quantitative dimension of food leads to progressively from mild discomfort to severe hunger and ultimately leads to the death, whereas qualitative dimension is also equally important because low quality or improper diet leads to development of malnutrition and diseases. Food becomes an integral part of human culture and emotions since it affects the health, physical fitness, body size and mental development. Hunger satisfaction gives body and mind peace with improvement in life span.

1 Introduction to Food Science and Technology

Contents at a glance

Man needs adequate food for growth, development and maintenance, which lead an active and healthy life. The quality of human life depends on the type of food that one eats, its quality and quantity. Man eats what his forefather ate, if possible, and what his environment offers. Primitive man lives as hunters and gatherers, they collected their foods from wild animals and plants in raw forms. Man's food pattern changed after the discovery of fire. Man eats most of his food in cooked form and this is one of the many characteristics, which separates him from other animals.

As food production expanded, food safety has become a critical role in preventing the hazards and illness among populations. We are lucky to have a relatively safe food supply today, but historically only royalty had access to high quality food.

Food science is crucial to the success of the food industry, helping to develop thousands of products that make life better for today's consumer. Many companies consider research in this field a profitable investment. Also, thanks to food science, consumers are capable of experiencing food products from all over the world.

Incredibly, the moon and space have already been conquered by food science several decades ago when scientists had to figure out how to keep astronaut food safe. Going forward, our aim should be to inform the consumer about the products and processes that we create, develop environment friendly processes, and continue to create functional products.

1.1 What is Food?

Food refers to anything, which nourishes the body. It includes solids, semisolids and liquids which can be consumed to sustain body and keep it healthy.

Foods are very important socially as well as scientifically. Socially foods are defined as "Foods are the materials, in raw, processed or formulated form, which are consumed orally by humans or animals for their growth, health, and satisfaction or pleasure.

Scientifically foods are defined as "Foods are mainly composed of nutrients such as carbohydrate, protein, fat, water with small amount of minerals and organic compounds. Minerals in the form of salts and organic substances are present in food as vitamins, emulsifiers, acids, antioxidants, pigments, polyphenols, or flavours.

1.2 Definition of food science and technology:

Food Sciences and Technology is an interdisciplinary subject which deals with different disciplines.

Food science can be defined as the application of the basic science and engineering to study the fundamental, physical, chemical, and biochemical nature of food and the principles of food processing.

Food technology is the use of the information generated by food science in the selection, preservation, processing, packaging and distribution as it affects the consumption of safe, nutritious and wholesome food by application of techniques.

With the right knowledge, understanding and application of the science, the food scientist can bring about desirable changes in food and control or eliminate the undesirable changes.

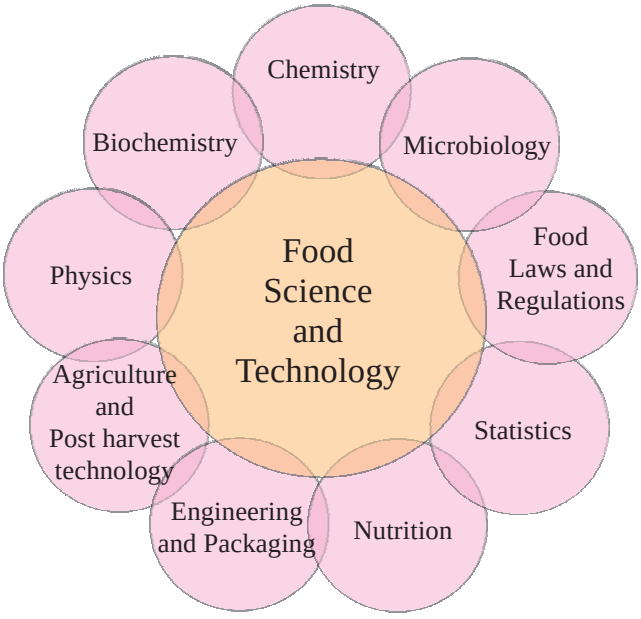


Fig. - 1.1 Components of food science and technology

1.3 Some terms used in food science and technology:

Some technical terms are very important to understand food science and technology such as food chemistry, food analysis, food microbiology, food processing, food engineering and packaging, food additives, food fortification, food fermentation, functional food, food safety and regulations, etc.

Food chemistry: Food chemistry covers the basic composition, structure, properties and changes occurring during processing and utilization of food.

Food analysis: Food analysis deals with the principles, methods and techniques necessary for qualitative and quantitative physical and chemical analysis of food products and ingredients. The analysis should be related to standards and regulations as per the Government regulatory agencies. (FSSAI)

Food microbiology: Food microbiology is the study of the microbial ecology related to foods, the effect of environment on food spoilage, the physical, chemical and biological destruction of microorganisms in food, the microbiological examination of food stuffs, public health safety and sanitation microbiology.

Food processing: Food processing covers general characteristics of raw food material, principles and methods of food preservation, factors which influence quality, packaging, waste management, good manufacturing practices, sanitation procedures, etc.

Food engineering and packaging: Food engineering involves study of engineering concepts and unit operations used in food processing such as thermodynamics, fluid flow, heat and mass transfer, food packaging aspects etc.

Food additives: Food additive is defined as a substance added intentionally to food, generally in small quantities to improve its functional, physical and sensory properties such as appearance, colour, flavour, texture, acceptability, taste and storage behaviour also.

Food fortification: Food fortification is defined as the process whereby nutrients are added to enrich foods in relatively small quantities to maintain or improve the nutritional quality of the diet.

Food fermentation: Fermentation is a biological process that breakdown organic materials, which is carried out by micro-organisms such as bacteria, yeast and mold to a desirable end products.

Functional food: Functional food provides health benefits beyond the nutrient contribution when they are eaten on a regular basis in adequate amounts. Functional food has positive effect on person's health, physical performance or state of mind, in addition they check number of health disorders.

Food safety and regulation: Food safety and regulation is related to food sanitation, safety and hygiene to food item, public health and regulations. The Food Safety and Standards Authority of India **(FSSAI)** has been established under the Food Safety and Standards Act, 2006.

Do You Know?

Mandate of FSSAI 2006 Act: Laying down science based standards for article of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.

1.4 Objectives of the study of food science and technology:

To understand the nature and composition of foods: The nature of the food like colour, texture, consistency and keeping quality depends on the constituents present in it. Hence, it is important to study the composition of different foods in order to understand the nature of these foods e.g. perishable food have a low keeping quality due to its high moisture content.

To study the changes that occurs in food during storage, preparation and processing: Food is exposed to different conditions during storage, preparation and processing which may bring about different changes in the nature and composition of food. These change may be desirable or undesirable e.g. preparation of curd is desirable change whereas curdling of milk is an undesirable change.

To learn ideal methods of food preparation, processing and storage, to conserve the nutritive value and increase sensory and aesthetic properties: Food gradually undergo deterioration of spoilage since the time they are harvested, slaughtered or manufactured. The knowledge of these changes will enable us to develop and use ideal method of food preparation, storage and processing which will retain the nutrients to its maximum along with increasing the acceptability e.g. addition of spinach or fenugreek in the dough of paratha that will make it more nutritious and will increase the acceptability and palatability of the product.

To improve the digestibility of food: Composition of food, processing and method of preparation affects the digestibility of food. Fermentation improves digestibility e.g. *dhokla* or *idli*, whereas fried foods or foods high in fats are more difficult to digest. Cooking increases the access of enzymes and improves digestibility.

To maintain the quality and safety of food: Food should be handled carefully while processing, storing and cooking. This will minimize food spoilage and maintain the quality of food to make it 'safe' for consumption. Government Certification like FSSAI/ISI/BIS, Agmark, FPO, etc. ensures the quality and safety of food.

To learn to avoid food wastage and minimize food cost: Generally optimum quantity of food should be bought and cooked according to the needs of the family. In each meal, quantity of food to be eaten should be according to the individual's need.

Even on special occasions like weddings, parties, festivals and meetings, quantity and variety of food should be prepared and served according to the requirement. Too much variety in preparation may lead to unnecessary expenditure and wastage of food.

To understand the meaning of food:

Study of the food science which enables us to understand the importance of food in life. Food performs different functions. It not only satisfies hunger and fulfill the physiological requirements of the body but also satisfies the sociological and psychological needs of the human beings.

1.5 Acceptability of food:

The acceptability of different food preparations varies from person to person. However, it depends on various factors that are depicted in figure 1.2.

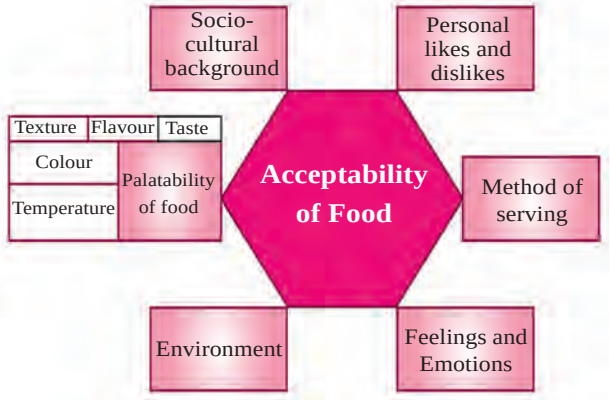


Fig. 1.2 Acceptability of Food

Factors affecting acceptability of food:

I. Palatability: The palatability of food is a composite of taste, flavour, texture, colour and temperature.

i) Taste: Sweet, sour, salty, and bitter are the basic tastes. When piece of food is placed in the mouth cavity specific stimuli is produced to the taste buds on the tongue. Higher the number of taste buds (Papillae) will give us more accurate taste response. The sense of taste is more highly developed in some individuals than in others. Foods may be too salty for one individual and just right for another. The four types of taste as sweet (tip of tongue), sour (just behind but both sides of tongues, salty (behind the sour taste buds) and bitter taste (near the esophagus).

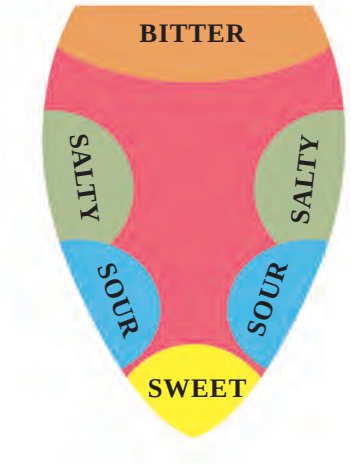


Fig. 1.3 Basic taste on the tongue

Improvement of taste in food products: Different types of tastes can be developed in food preparations by addition of ingredients like sugar (sweet), vinegar, tamarind, lemon juice (sour), common salt (salty), caramel, coffee (bitter). When necessary ingredients are added in correct proportion, food becomes tasty (combination of all tastes).

ii) Flavour: Food may be accepted because of their aromas, or rejected due to their repulsive odours. Flavour is a blend of taste and smell sensation evoked by a substance in the mouth cavity. Each food has a characteristic flavour due to the presence of varied constituents in different amounts. (aldehydes and ketone)

Improvement of flavour of food products:

- **Cooking:** Cooking enhances or brings out the natural flavour of food e.g. raw rice, *dal* or vegetable have a mild flavour which is improved appreciable due to cooking.

- **Addition of natural flavouring compounds:** Spices such as pepper, clove, cinnamon, cumin seed and mustard seed are added in whole form in food preparation like *pulav, masala* rice, *and* seasoning *for* vegetable *pachadi.* Spices can also be added in preparation in powderd form. Different spices are combined together to make *sambar masala, pav bhaji masala, garam masala* and others.
- **Addition of artificial flavouring agent:** Artificial essence such as cardamom, nutmeg, vanilla, rose etc. are used in preparations such as ice-creams, puddings, beverages, cakes and sweets.

iii) Texture: The texture of food is an important factor in its acceptance and chewability. Structural component of food confers on them a wide range of properties referred collectively as texture. Each food has a characteristics texture associated with it. Table 1.1 shows different texture with some food products associated with them.

The texture of food depends on the ingredients used, their proportion, method of preparation, time and temperature used during preparation, and storage.

Table 1. 1 Texture of Food Products

Sr. No.	Texture	Food Products
1.	Crunchy	Biscuits, *Shankarpale*, *Chiwada*
2.	Crispy	*Khakara*, Wafers
3.	Soft, Smooth, Velvety	Custard, *Shrikhand*, Ice Cream
4.	Spongy	Cake, *Dhokla*, *Idli* & Bread
5.	Brittle	*Chikki*

iv) Colour: Acceptability of food depends upon its colour. Natural and synthetic colour improves the colour of food products. Preserving the natural colour of food by optimum cooking of food is also essential to retain the natural colour of the food products.

Improvement of colour of food products: Colour of food preparation can be improved by :

- **Preserve the natural colour of foods:** This can be achieved by optimum cooking of food. Overcooking may result in a highly unpalatable, pale or dark coloured food.
- **Use of foods containing natural colour:** To make the preparation more attractive, natural, certain bright colours can be added to food preparation like green, yellow, red, white and other colours.

  [Natural colour of Saffron (orange), Turmeric (yellow) and Spinach (green etc.]
- **Use of spices:** Spices like turmeric, chilli powder and saffron are used in food preparations to improve the colour.
- **Use of synthetic colours:** Synthetic colour are added to beverage, ice-cream, sweets, cakes, *biryani*, etc. to improve the colour thereby increasing physical quality and the palatability of food preparations.

v) Temperature: Hot and cold sensations contribute to the composite flavor of a food like coffee, soup and ice-cream etc. Acceptability of food is highly influenced by temperature.

II. Socio-cultural background: Food is an integral part of the social cultural life of the people. The circumstances under which one eats food are largely determined by his culture e.g. use of mustard oil for cooking is common practice in North-India whereas

coconut oil is commonly used in Kerala. Hence socio-cultural background has to be kept in mind while serving food in order to see that it is acceptable and liked by everyone.

III. **Personal likes and dislikes:** People belonging to same geographical area or same socio-cultural background may have similar eating patterns, but acceptance for food may vary from person to person. Personal likes and dislikes are also noticed within the members of the same family. Hence, while preparing a meal, a judicious selection of foods and dishes is necessary, considering the likes and dislikes of all family members.

IV. **Method of serving**: The use of the right type of crockery, cutlery and other serving utensil in the dining area appreciably improves the acceptability of food. Each community has a particular traditional way of serving food e.g. Maharashtrian Thali.

Similarly, continental dishes should be served in proper crockery with appropriate cutlery like knives, forks, spoons and bowls.

Fig. 1.4 Traditional Maharashtrian style of service

Fig. 1.5 Continental style of serving

V. **Feeling and emotions:** Feeling and emotional state of an individual affects the acceptability of food. In a happy state of mind an individual consumes more food, whereas in stress a person may overeat or avoid food.

VI. **Environment:** Cleanliness of the area, serving utensils and person who is serving food affects the acceptability of food. Clean, hygienic and pleasant environment increases the acceptability of food. Well-ventilated and well-lit eating area is necessary. The food that is served with love and affection is more acceptable.

1.6 Functions of food:

Food nourishes our body and keeps it healthy. Food performs many different functions hence it is much more than a substance supplying nutrients for health. It is sum of man's culture and tradition, a means of communication, status, pleasure and relief from stress. Functions of food are classified as follows:

Physiological functions: Food is essential for maintaining specific body functions (Figure 1.6)

- **Energy:** We need energy for performing various voluntary activities such as walking, running, sitting, standing and involuntary activities like beating of heart, circulation of blood, digestion of food etc. Energy is provided by carbohydrates, proteins and fats.
- **Body building and growth:** Food rich in protein are called body building foods. Growth of the body right from birth to adulthood is due to consumption of protein rich foods along with other nutrients required for growth. During pregnancy and lactation, the food rich in proteins are required for proper growth of foetus and neonate.
- **Repair and maintenance:** Each cell in the body has a definite life span. During injury, infection, surgery or old age, cells are damaged which need to be rejuvenated for maintaining health. This function is carried out by proteins present in food.
- **Protection:** Food performs various important functions such as preventing infections. Person consuming a well balanced diet, hardly falls ill and has good resistance against infections.

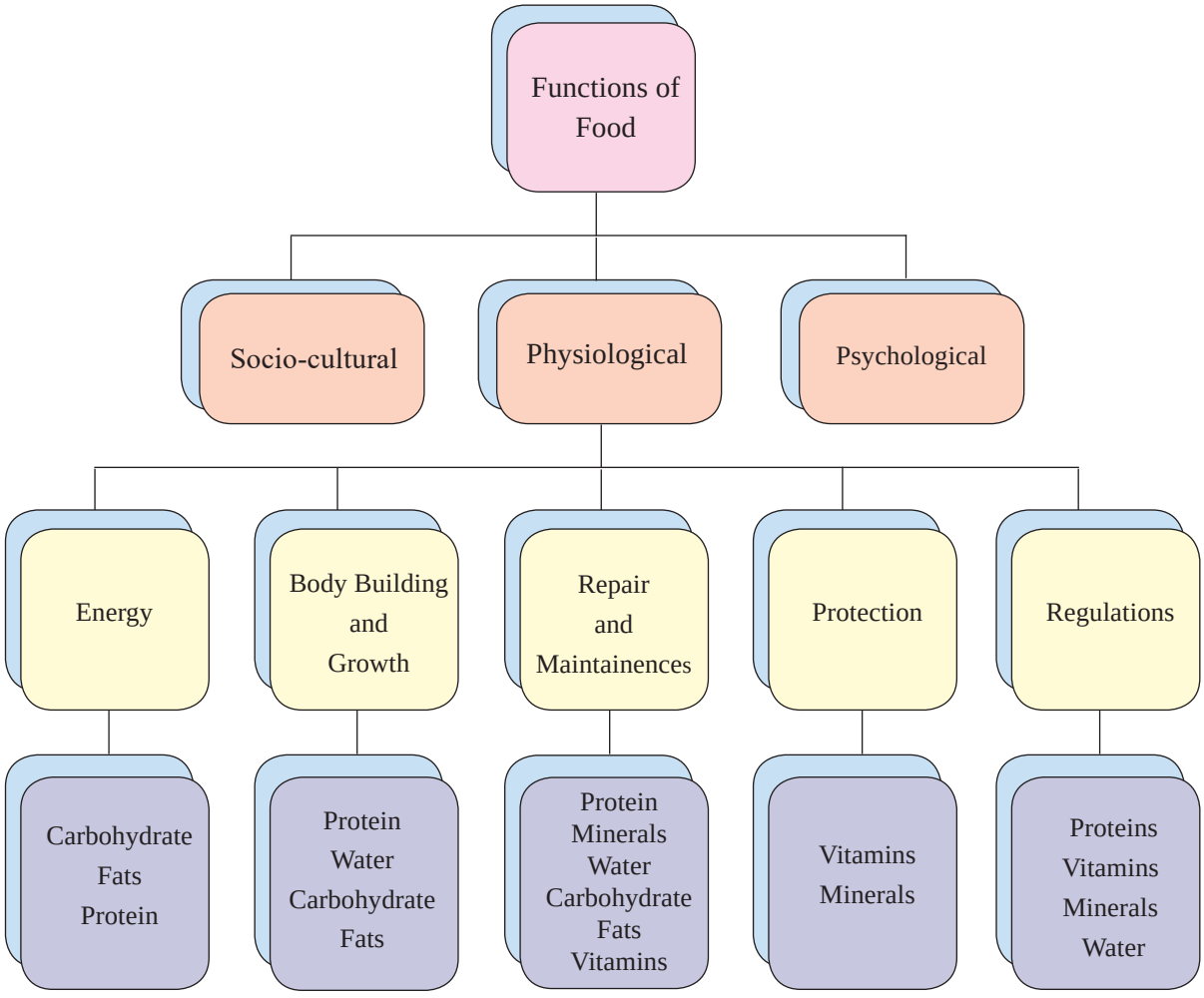


Fig. 1.6 Functions of food

- **Regulatory function:** Important functions like maintaining the heart beat, water balance, temperature are performed by foods rich in proteins, vitamins, minerals and water.

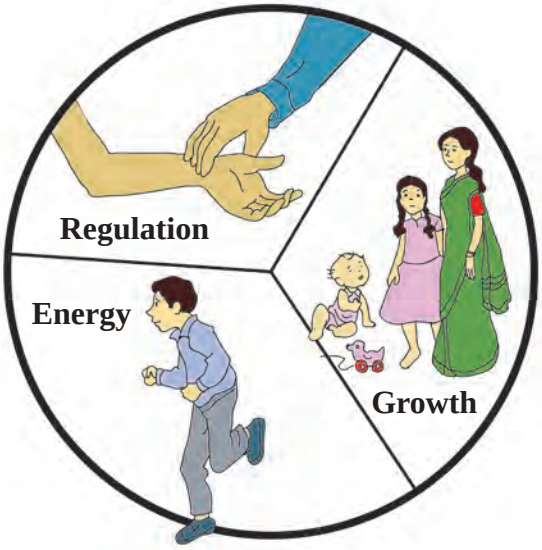


Fig. 1.7 Physiological functions of food

Socio-cultural functions: Food is a symbol of hospitability and friendship throughout the world. We express our hospitality to a guest through an offer of food or a drink. Offering a cup of coffee or tea is a symbol of friendship. In times of disaster or sorrow, food is offered to the affected persons. In schools, colleges or even in offices, people share their tiffins amongst groups as a token of friendship and affection. (Figure 1.8)

In a country like India many festivals are celebrated throughout the year. In celebration of festivals, food is a center of attraction. Not only in festivals, but also in joyous occasions like marriage, birthday, serving of food becomes an integral part of the celebrations. In professional meetings and business meetings, food is served to create a relaxed atmosphere.

Fig. 1.8 Socio-cultural functions of food

In religious rituals, food plays a significant role. In various *poojas,* we offer various seasonal fruits or coconut and *prasad* (*pedha* or *burfi*) to God. Specific sweets are prepared and distributed to devotees as *prasad* on various religious occasions e.g. *modak, sheera* and others. On specific festivals, specific dishes or food preparations have a very significant role e.g. on the occasion of *Diwali*, food preparations like *chiwada, chakli, ladu, karanji* and *anarsa* are prepared and on the occasion of *holi, puranpoli* is mandatory.

Psychological functions: Food is often used as a tool to express one's feeling. At home, mother shows her love and affection by preparing her child's or husbands's favourite dishes. It gives them a sense of security. A child readily accepts food eaten by his friends or by people whom he admires.

Food is also an outlet for emotion. For some people, loneliness and boredom are relieved by continuous nibbling on food. Anxiety of examination in some children leads to overeating or very less intake of food.

Points to remember

- Socially foods are defined as "foods are the materials, in raw, processed or formulated form, which are consumed orally by humans or animals for growth, health, and satisfaction or pleasure.
- Scientifically foods are defined as "Foods are mainly composed of nutrients such as carbohydrate, protein, fat and water with small amount of minerals and organic compounds. Minerals in the form of salts and organic substances are present in food as vitamins, emulsifiers, acids, antioxidants, pigments, polyphenols, or flavours.
- Food is also reffered to as anything solid or liquid which when consumed, digested and absorbed by the body, promotes growth, supply energy and regulates different body process.
- The study of food science deals with the composition of food and the changes that occur during its processing, cooking and storage.
- The sensations like taste, flavor, texture, colour and temperature of food decides its palatability
- Palatability, individuals socio-cultural background, personal likes and dislikes and method of serving, feelings and emotions and environment decide acceptability of food.
- Food serves physiological, sociological and psychological functions.

Exercise

Q.1 a) Select the most appropriate option:

i. Body building and growth is a …… function of food.

(Psychological, Physiological, Social)

ii. Method of serving is a cofactor affecting …… of food.

(Palatability, Acceptability, Nutrition)

iii. Sharing the food with others is ……..function of food.

(Socio-culture, Mental, Physical)

iv. …….. ensures the quality and safety of food.

(SBI, Agmark, Food Mark)

b) Match the following

A		B	
i.	Regulatory function	a.	*Prasad*
ii.	Protective function	b.	2006
iii.	Nutrient	c.	Favorite dish
iv.	Colour	d.	Palatability
v.	Psychological function	e.	Water balance
vi.	Religious occassion	f.	Fat
vii.	FSSAI	g.	Acceptability
		h.	Prevent infection

c) State whether the following statements are true or false:

i. To improve the digestibility of food is an objective of studying food science and technology.

ii. Bodybuilding is a Socio-culture function of food.

iii. *Chikki* has brittle texture.

iv. Functional food provides health benefits beyond the nutrient contribution.

v. Food additives is defined as a substance added intentionally to food.

Q.2 Answer the following

i. Name any three objectives of studying food science and technology.

ii. Name the physiological function of food.

iii. Define the social defination of food.

iv. Define the scientific defination of food.

Q.3 Write short notes on the following

i. Socio cultural functions of food

ii. Method of serving as a factor affecting acceptability of food

iii. Texture as a factor affecting palatability of food

iv Components of food science technology.

Q.4 Long Answer Questions

i. Discuss in details the factors affecting palatability of food

ii. Explain all the functions of food

❖ Project

Prepare charts on functions of food

2 Scope and Opportunities

Contents at a glance

Indeed, the essence of human life is to live in such a way to meet the basic demands of food, clothing and shelter. Individually food is very basic need for survival. The demand for processed, packed and convenient food with prolonged shelf life requires well-trained human resources in the food industry and allied sectors.

There is an encouraging, challenging and rewarding future for professions and careers in food science and technology. As, this field requires the application of science and technology to the processing, utilization, preservation, packaging and distribution of food and food products. It therefore encompasses a diverse range of specializations.

Food processing is the conversion of raw ingredients into the processed value added form (palatable, digestible, nutritious, stable and safe).

Typically the raw food ingredients like harvested crops or butchered animal products are converted to attractive, marketable and often long shelf-life food products.

The processed food industry may be divided into following broad segments:

1. Primary Processed foods
2. Secondary Processed foods
3. Tertiary Processed foods

Primary processed foods	• Raw materials are converted in to edible food commodities. • Traditional methods like drying, winnowing, milling of grains and butchering of animals for meat. • Examples: Drying of crops, processing of grains.
Secondary processed foods	• Fresh foods or the products of primary processed are converted into wide range of secondary processed foods. • Examples: Grinding of food grains, crushing of fruits into pastes or juices.
Tertiary processed foods	• Tertiary food processing is the commercial production of processed foods • Examples: Industrially manufactured products like biscuits, bread, jams, jellies, chocolates, etc.

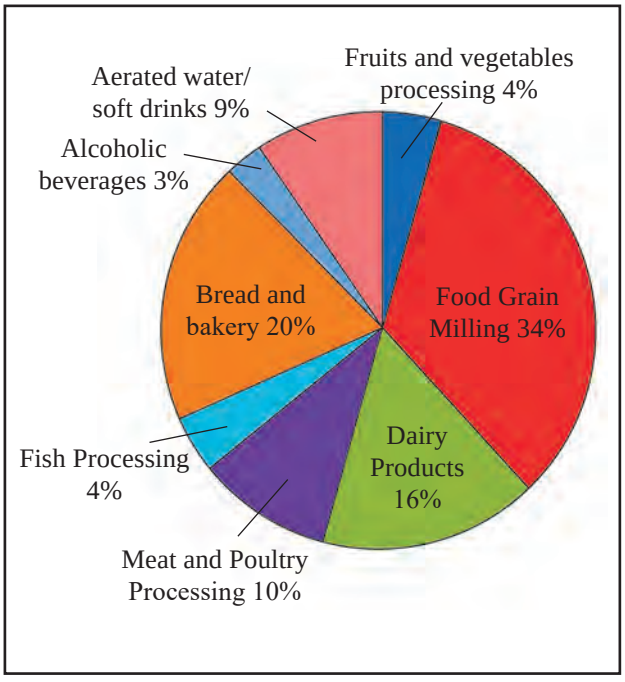
2.1 Major Food Processing Sectors in India:

Food processing is as large sector that covers agriculture, horticulture, plantation, animal husbandry and dairy, fisheries, meat, poultry, etc.

Food processing sectors may be broadly categorized in following segments

- Fruits and vegetables processing
- Dairy processing
- Grain processing
- Meat and poultry processing
- Fisheries
- Horticulture
- Consumer foods including packaged food, beverages and packaged drinking water.

The following diagram depicts the Status of food processing industries in India.



(Source: *Annual Survey of Industry (ASI), MOFPI and IMaCS analysis***)**

Fig. 2.1 : Status of food processing industries in India

2.2 Skill gap management in food industry:

The following table presents the functional distrubution of human resources across segment and distrubution of human resources by education level.

Table 2.1 : Functional distribution of human resources

Functions	% of employees
Procurement	10
Testing and quality	20
Production	55
R&D	1-2
Storage	2-3
Others (sales and others)	10

Source : Human resource and skill requirements in food processing sector. A report of NSDC (www.nsdcindia.org)

Table 2.2 : Distribution of human resources by education level.

Educational level	% of employees
Management education	1-2
Food technologists	20
Post graduates	0.5-1
Graduates	10
Diploma holders	2-5
Certificate holders	2-5
10^{th} standard or below	80

Source : Human resource and skill requirements in food processing sector. A report of NSDC (www.nsdcindia.org)

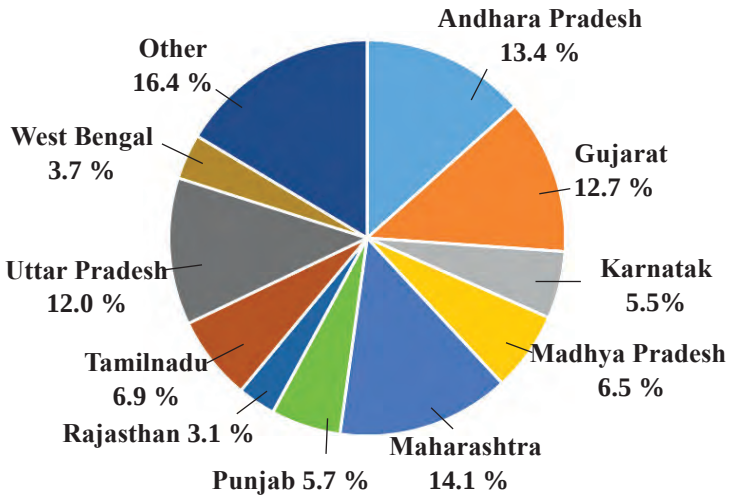
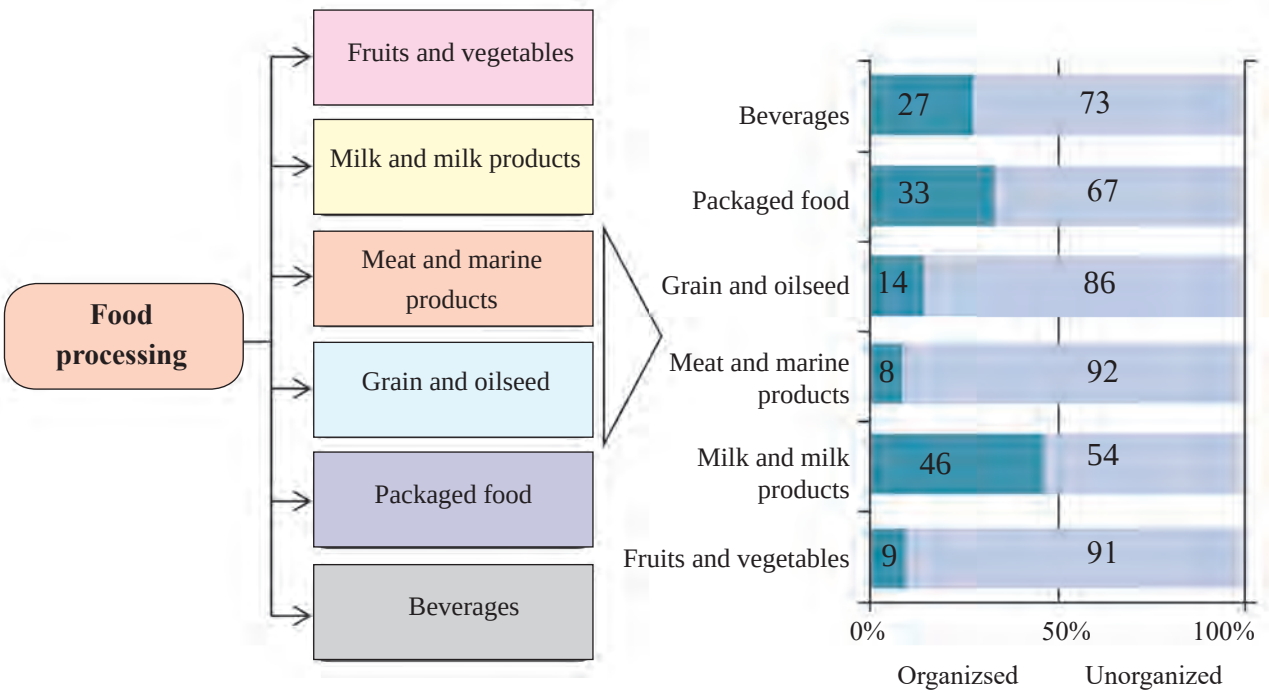


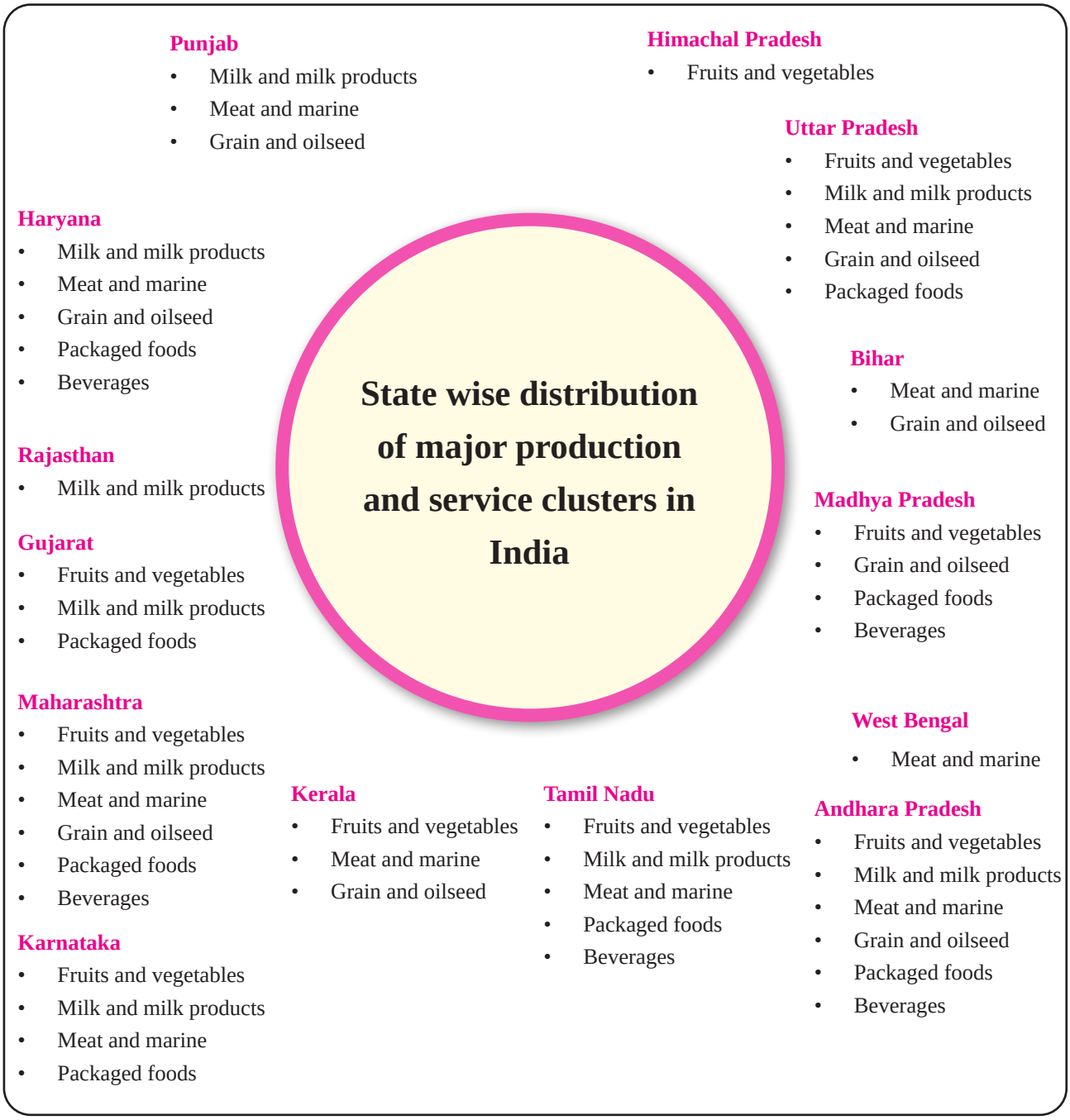
Fig. 2.2 : State wise distribution of food processing unit



Source : Human resource and skill requirements in food processing sector volume 10. A report of NSDC (www.nsdcindia.org)

Fig. 2.3 : Structure of the food processing sector: organised vs. unorganised (by employment)

Cluster : It is a group of food industries formulated by the government to achieve the specific objectives such as development of modern infrastructure to encourage entrepreneurs to set up food processing units based on group approach e.g. food park, special economic zone, etc.



Source : Human resource and skill requirements in food processing sector volume 10. A report of NSDC (www.nsdcindia.org)

Fig. 2.4: State wise major food production clusters in India.

2.3 Organisational structure, job roles and opportunities

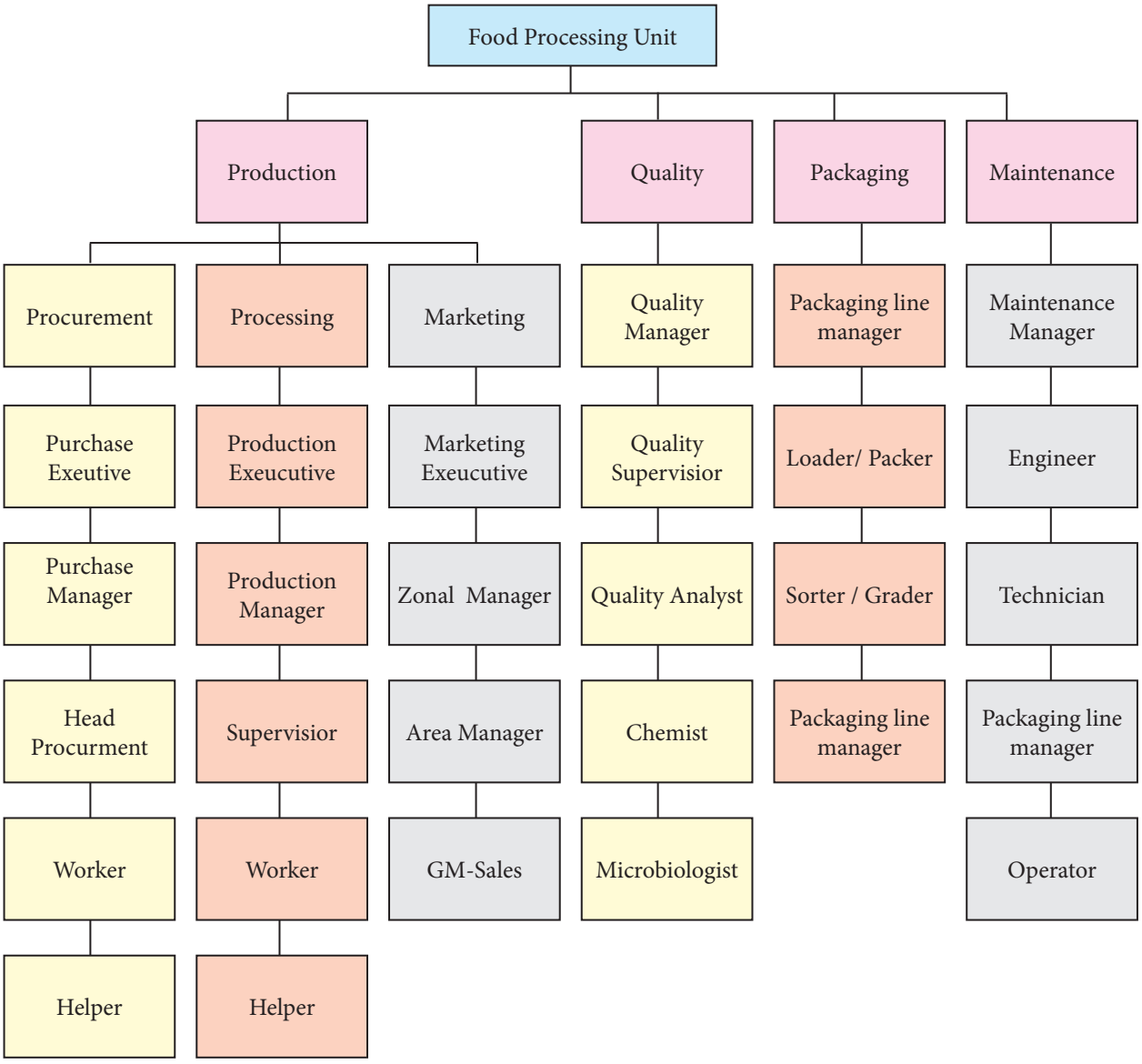


Fig. 2.5 : Flow chart of organizational structure of food processing unit

Table 2.3 :Various job roles in Food Processing Sector

	Process line	Non-Process line
Fruits and Vegetables	➢ Food technologist ➢ Production supervisor ➢ Machine operator ➢ Maintenance technician/Engg. ➢ Refrigeration technician ➢ Packers and loaders	➢ Procurement executive ➢ Quality head ➢ Shift head ➢ Marketing executive ➢ Research and Development head ➢ Research and Development Scientist

Milk and Milk Products	➢ Chemist/Dairy Technologist ➢ Supervisor ➢ Production manager ➢ Machine operator ➢ Maintenance technician/Engg. ➢ Refrigeration technician	➢ Procurement executive ➢ Quality head ➢ Shift head ➢ Marketing executive ➢ Research and Development head ➢ Research and Development scientist
Meat and Marine Products	➢ Deboners and butchers ➢ Feeders and hangars ➢ Maintenance technician ➢ Sanitation inspector / Shift supervisor	➢ Procurement executive ➢ Quality head ➢ Shift head ➢ Marketing executive ➢ Research and Development head ➢ Research and Development scientist
Grains and Oilseeds	➢ Milling operator/Sorter ➢ Shift Supervisor ➢ Production manager ➢ Machine operator ➢ Maintenance technician/Engg.	➢ Commodity buyer ➢ QC analyst/executive/ manager ➢ Warehouse executive ➢ Marketing executive ➢ Research and Development head ➢ Research and Development scientist
Packaged Food	➢ Packers and loaders ➢ Supervisor QA (Analyst/ checker) ➢ Technician	➢ Research and Development Scientist ➢ Marketing executive ➢ Quality head ➢ Shift head
Beverage	➢ Process line operator ➢ Filling line operator ➢ QA (analyst/chemist) ➢ Shift supervisor and maintenance technician ➢ Electrician and instrumentation engineer	➢ Procurement executive ➢ Quality head ➢ Shift head ➢ Marketing executive ➢ Research and Development head ➢ Research and Development scientist

Job opportunity: Several profiles and industries, where food technology professionals make a successful career are:

- Production manager, quality manager in food processing, packaging industries (Grains, Fruits, Vegetables, Fish, Meat, etc.)
- Research Scientists
- Academic opportunities
- Product/process development scientist
- Food Quality manager
- Food Safety Officer
- Nutritional therapist
- Regulatory affairs officer

- Scientific laboratories (Analytical) technician
- Technical brewer
- Production supervisor
- Sales, marketing and brand management
- Consultant
- Entrepreneur
- Others (Dietician, nutritionist, diet and fitness counselor)

Note :- FSSAI has made it compulsory to appoint food science graduates in each food industry to meet the health, hygiene, safety, GMP, etc. requirements.

2.4 Major universities and institutions

Major universities and colleges in India for studying food science and technology

- Central Food Technological Research Institute (CFTRI), Mysore
- Defence Food Research Laboratory (DFRL), Mysore
- National Institute of Food Technology Entrepreneurship and Management (NIFTEM) Sonipat, Haryana
- Indian Institute of Crop Processing Technology (IICPT), Thanjavur, Tamil Nadu
- National Dairy Research Institute, (Karnal), Haryana
- National Institute of Nutrition (NIN), Hyderabad
- Indian Agricultural Research Institute (IARI), New Delhi
- Central Agricultural University (CAU), Imphal, Manipur
- Indian Institute of Technology (IIT), Kharagpur.
- National Institute of Raurkela (NIT), Odisha
- Indian Council of Agriculture Research (ICAR), New Delhi.

Major universities and colleges in Maharashtra for studying food science and technology

- Vasantrao Naik Marathwada Agricultural University, Parbhani
- Dr. Panjabrao Deshmukh Agricultural University, Akola
- Dr. Balasaheb Sawant Konkan Agricultural University, Dapoli
- Mahatma Phule Agricultural University, Rahuri
- SNDT Women's University, Mumbai and its constituents campuses at Pune, Juhu etc.
- Institute of Chemical Techology Mumbai and two other campus at Jalna Bhubneshwar.
- Laxminarayan Institute of Technology, Nagpur
- Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
- Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
- North Maharshtra University, Jalgaon
- Shivaji University, Kolhapur
- Sant Gadge Baba Amravati University, Amravati
- Some other deemed, private university and colleges in Maharashtra state.
- Vocational education (B. Voc, Food Tech / Dairy Tech) have been started at different universities and colleges under NSQF, UGC, New Delhi.

  E.g. SPPU, Pune, Dr. BAMU, Aurangabad, Solapur University, Shivaji University Kolhapur, Mumbai University, etc.

Exercise

Q.1 a) Select the most appropriate option:

i. _____ is the conversion of raw ingredients into the processed food.
(Food processing, Crop science, Animal science).

ii. In the _____ food processing raw materials are converted to edible food commodities.
(Primary, Secondary, Tertiary)

iii. Grinding of food grains is a _____ processed food.
(Primary, Secondary, Tertiary)

iv. Maharashtra is a _____ producer of fruits and vegetables.
(Largest, Smallest, None)

b) Match the following:

A		B	
i.	Primary food processing	a.	20% employment
ii.	Secondary food processing	b.	Milk and milk products
iii.	Tertiary food processing	c.	Processing of grains
iv.	Food technology	d.	Jam, jelly
v.	Maharashtra	e.	Instant mixes
		f.	Crushing fruit into paste or juice

c) State whether the following statements are true or false:

i. FSSAI made it compulsory to appoint food science graduates in food industry.

ii. Bread and bakery industry comprises 20% of food processing industries in India.

Q.2 Answer in brief

i. Name the segments of Food Processing industry.

ii. Name the job opportunities in food technology.

Q.3 Short answer questions

i. Give in short about statewise production of different food commodities in India.

Q.4 Long answer question

i. Draw a table of all the job roles in a food processing sector.

ii. Draw a flowchart of a organization structure in a typical food processing unit.

❖ **Project :**

Visit to food technology colleges / universities / research organization / food industries etc. and prepare short project report on their functional activities.

3 Basic Food Groups

Contents at a glance

Food is an essential part of everyone's lives. It gives us energy and nutrients to grow, develop and maintain, be healthy and active, to move, work, play, think and learn. The body needs a variety of nutrients such as - carbohydrates, proteins, fat, vitamins and minerals from the food that we eat. Our body gets these nutrients through a variety of food available. Generally food supplies all the nutrients, however, no single food item can provide all the nutrients in adequate amount required by our body. Therefore, a wise selection of food, in order to plan a meal is very necessary so that these food provide all the nutrients required by an individual in an adequate amount to maintain good health.

Need of food grouping

1) Foods grouped together give an idea on accounts of the key nutrients of that food group. For example, milk, yogurt, cheese contain calcium and proteins, while the fruit group is a good source of fibre, vitamins and minerals.

2) It is also important to enjoy a variety of foods within each food groups because different foods vary in the amount of the key nutrients that they provide. For example, in the vegetable food group, carrots and pumpkin contain significantly more vitamin A than other vegetables such as potatoes.

3.1 Classification of food into four food groups

Foods are classified into four food groups according to the nutrients present in them. These food groups help in wise selection of foods to plan a balance diet.

The four basic food groups are as follows:

1) Cereals, Millets and Pulses

2) Vegetables and Fruits

3) Milk and Milk products, Egg, Meat, Fish, Poultry and their products

4) Fats and Oils, Nuts and Oilseeds, Sugar.

1) Cereals, Millets and Pulses Group:

This group includes

i) **Cereals:** Wheat, rice and their products like wheat flour (*atta*), semolina (*rawa*), refined wheat flour (*maida*), vermicelli (*sevai*), puffed rice (*churmura*), flaked rice (*poha*), rice flour, bread, noodles, and other such items.

ii) **Millets:** Sorghum (*jowar*), *bajra*, maize, ragi (*nachni*), corn flakes, puffed *jowar*, ragi malt and others. Cereals and millets are rich source of energy as they are rich in carbohydrates. Millets are considered

as coarse grains. Generally the size of one portion for Cereals and Millets is considered as 30g.

Number of portion per day for Cereals and Millets: 9 to 20

iii) **Pulses and Legumes:** Legumes such as bengal gram (*chana*/*harbara*), black gram (*urad*), green gram (*mung*), lentil (*masoor*) and their *dals* and red gram *dal* are included. Some other legumes like cowpea (*chawli*), moth beans (*matki*), dry peas (*watana*), soybean and field beans (*val*) are also included.

Pulses and legumes are rich source of proteins.

Size of one portion is considered as 30 g

No. of portion per day: 2 to 4

Cereals, millets, and pulses also provide B-Complex vitamin, minerals and fibre.

2) Vegetables and Fruits Group:

Vegetable: It includes leafy vegetables, roots and tubers and other vegetables.

i) **Green Leafy Vegetables:** (GLV) Spinach (*palak*), fenugreek (*methi*), coriander (*kothimbir*), onion leaves (*kanda pat*), amaranth (*math*), colocasia leaves (*aalu pane*), radish leaves, salad leaves, cabbage (*patta kobi*), dill leaves (*shephu*), drumsticks leaves (*shevga pala*) and others. These leafy vegetables are rich in vitamins like beta-carotene, vitamin C and minerals like calcium, iron and fibre.

Size of one portion is considered as: 100 g

Number of portion per day: 1

ii) **Roots and Tubers:** These include potatoes, sweet potatoes, colocasia, tapioca, beetroots, carrot and radish. Roots and tubers are rich sources of carbohydrates (mainly in the form of starch).

Size of one portion is considered as: 100 g

Number of portion per day: 2

iii) **Others vegetables:** These include all other parts of the plant like fruits, flowers, seeds, nuts, pods and others. Vegetables such as ladies finger, tomato, brinjal, peas, french beans, red pumpkin, all types of gourds and all other vegetables not included in subgroups i and ii are included in this group.

Size of one portion is considered as: 100 g

Number of portion per day: 2

iv) **Fruits:** It includes beta carotene rich fruits such as orange, fig, pomegranate, mango, papaya, etc., vitamin C rich fruits such as Indian gooseberry (*amla*), guava, orange, lemon, sweet lime, pine apple, straw berry, custard apple (*seetaphal*), cashew apple fruit and others are also included in this groups.

Other fruits such as apple, grapes, banana, water melon, cherry, peach, plums, pears, sapota (*chiku*), jamun, etc.

Do You Know?

All fruits provide carbohydrates (in the form of sugar, fibre) vitamins and minerals.

Size of one portion is considered as: 100 g

Number of portion per day: 1

3. **Milk and Milk Products, Eggs, Meat, Fish, Poultry and their products:**

   i) **Milk:** This includes whole milk, toned milk (low fat), double toned milk (very low fat), skim milk, condensed milk, powdered milk, etc.

   ii) **Milk products** include curd, khoa, cheese, paneer, yoghurt (except butter, pure ghee and cream), which are a good source of proteins, vitamins like B complex, vitamin A and minerals like calcium.

   Size of one portion of milk is considered as: 100 ml

   Milk products: 50 grams

   Number of portion per day: 3

   iii) **Eggs** - Chicken eggs, duck eggs

   iv) **Meat**: Red meat, lean meat, beef, lamb, veal, pork are good source of iron, zinc and B12 vitamin.

   v) **Fish and sea-foods** - Fish, prawns, crab, lobster, mussels, oysters, scallops, clams are good source of vitamins, minerals, porteins and omega 3 fatty acids.

   vi) **Poultry**: Chicken, turkey, duck, goose

   Size of one portion is considered as: 50 grams
   Number of portion per day: 1

Do You Know?

1 medium size egg weight is approximately 50 grams.

4) **Oils and Fats, Nuts and Oilseeds, Sugar:**

   i) **Oils and Fats:** This group includes oils and fats like butter, pure ghee, cream, vanaspati ghee and vegetable oils which are a concentrated source of energy.

   Size of one portion is considered as: 5 grams / 5 ml

   Number of portions per day: 4 to 8

   ii) **Nuts and Oilseeds:** These includes groundnuts, gingelly seeds (*til*), cashew nuts, almonds, dry coconut, fresh coconut, walnut, etc. These are rich source of energy, proteins and minerals.

   iii) **Sugar:** This group includes cane sugar, jaggery, honey, etc. Sugar is a good source of energy

   Size of one portion is considered as: 5 grams

   Number of portions per day: 4 to 11

Do You Know?

Milk and Milk Products provide good quality nutrients

3.2 Contribution of food groups to the diet:

Selection of different foods from the four food groups will avoid monotony and bring variety in the diet. If these foods are consumed in appropriate amounts, it will lead to good health. Table 3.1 shows the use of food groups and their contribution to the diet.

Table 3.1: Four food Groups

Food Groups	Foods	Size of Portion (g)	Number of Portions /day for adults	Nutrients Present
1. Cereals, Millets and Pulses	Cereals and its products	30	9 to 20	Carbohydrates, B Complex, Vitamin A and minerals
	Millets and Its Products	30		
	Pulses and legumes	30	2 to 4	Proteins, B-Complex Vitamins, Minerals
2. Fruits and Vegetables	i. Fruits	100	1	Carbohydrate, Vitamins and Minerals
	ii. Vegetables			
	a) Green Leafy	100	1	Beta-Carotene, Calcium, Iron and Fiber
	b) Roots/Tubers	100	2	Carbohydrate
	c) Other Vegetables	100	2	Minerals, Fiber
3. Milk and Milk Products	i. Milk and Milk Products	100 ml 50 grams	3	Protein, Vitamins and Minerals
	ii. Meat, Poultry Fish and Egg	50grams	1	Protein, Vitamins and Minerals
4. Oils and Fats, Nuts and Oilseeds, Sugar	i. Oils and Fats	5 grams	4 to 8	Energy
	ii. Nuts and Oilseeds	5 grams	4 to 8	Energy, Proteins and Minerals
	iii. Sugar	5 grams	4 to 11	Energy

Reference: Dietary Guidelines for Indians, A Manual, National Institute of Nutrition, 2nd Edition 2011.

3.3 Concept of Balanced diet:

All individual should get all the nutrients in adequate proportions from the diet to maintain good health. The food groups serve as a guide to plan this type of diet which is called as balanced diet.

Balanced diet is a diet, which supplies all the essential nutrients in adequate amounts according to an individual's age, sex, physiological status and physical activity, it also provides amounts of nutrients for growth, development, wear and tear of the body and a small reserve for emergency.

The nutritional requirement of an individual varies according to a perosn's age, sex, physical activity and physiological condition. Daily requirement of some nutrients for the individuals is given in Table 3.2

Table 3.2: Recommended Dietary Allowance for Indians (Macronutrients and minerals)

Group	Particulars	Body wt. kg	Net Energy Kcal/d	Protein g/d	Fat g/ day	Calcium mg/d	Iron mg/d
Man	Sedentary Work	60	2320	60	25	600	17
	Moderate Work		2730		30		
	Heavy Work		3490		40		
Woman	Sedentary work	55	1900	55	20	600	21
	Moderate work		2230		25		
	Heavy work		2850		30		
	Pregnant Woman		+350	82.2	30	1200	35
	Lactation 0-6 months		+600	77.9	30	1200	25
	6-12 Months		+520	70.2	30		
Infants	0-6 Months	5.4	92Kcal/ kg/d	1.16g/ kg/d	--	500	--
	6-12 Months	8.4	80Kcal/ kg/d	1.69g/ kg/d	19		46µg/kg/d
Children	1-3 Years	12.9	1060	16.7	27	600	09
	4-6 Years	18	1350	20.1	25		13
	7-9 Years	25.1	1690	29.5	30		16
Boys	10-12 Years	34.3	2190	39.9	35	800	21
Girls	10–12 Years	35.0	2010	40.4	35	800	27
Boys	13- 15 years	47.6	2750	54.3	45	800	32
Girls	13-15 Years	46.6	2330	51.9	40	800	27
Boys	16-17 Years	55.4	3020	61.5	50	800	28
Girls	16-17 Years	52.1	2440	55.5	35	800	26

Reference: Dietary Guidelines for Indians, A Manual, National Institute of Nutrition, 2nd edition, 2011

Planning of balance diet using food group:

The following points should be considered while planning a balance diet for an individual

- Include foods from all food groups in the daily diet.
- According to requirements of the individual, correct number of portions from each food groups should be included in the diet.
- Variety of foods should be selected from within each sub group because food within the sub group have a similar but not identical nutritive value.
- Variety in selection will also bring variety to the meals.
- In a vegetarian diet, to improve the quality of proteins, either use a cereal/pulses combination or incorporate small quantity of milk or milk products in the meal.
- Include uncooked vegetables and fruits in the meals.
- Use seasonal fruits and vegetable which are delicious, cheap and nutritious.
- Use green leafy vegetables (GLV) in every day diet.

While planning a balanced diet, in addition to the above factors, food pyramid should be considered (Fig. 3.1)

The food pyramid offers a pattern for daily food choices based on the serving from the four basic food groups.

- ➔ The first food group consisting of cereals, millets, pulses and their products is the broad base of the pyramid as it is the base of good diet.
- ➔ Second group is vegetables and fruits which is in the next layer (rich in minerals, vitamin and fibres).
- ➔ The third group is rich in protein which forms the next layer.
- ➔ At the tip of the pyramid, the fats, sugars and their products are included. These foods are assigned the smallest area in the pyramid indicating that these foods should be a very small part of our diet.

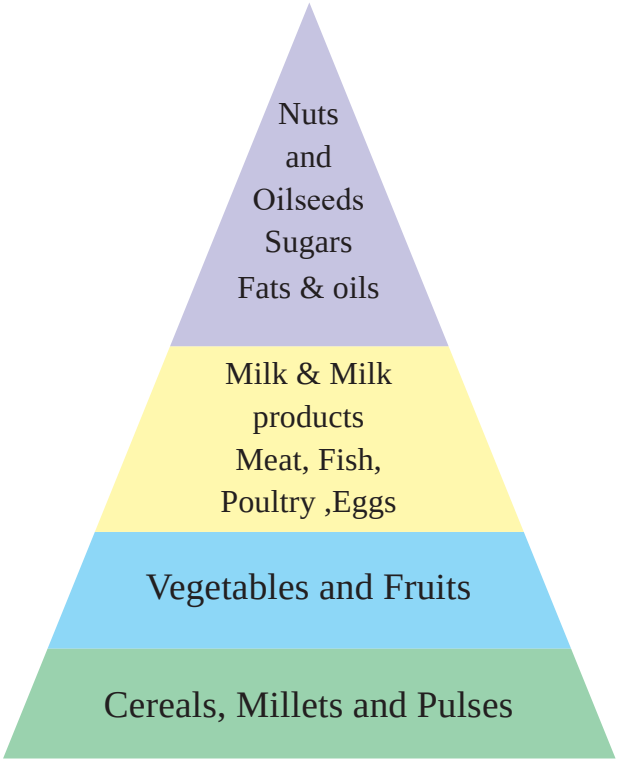


Fig. 3.1 : Food pyramid

Points to remember

- Different types of foods are classified into four food groups on the basis of the nutrients present in them.
- The food groups serve as a tool to plan a balanced diet.
- Variety of foods should be selected from within each sub group because their nutritive value is similar but not identical.
- The factors to be considered while planning a balanced diet are sex, age, type of work, financial status, physical state of a person, availability of food, likes and dislikes, climate and variety, etc.
- Food pyramid offers a pattern for daily food choices based on the serving from the food groups.

Exercise

Q.1 (a) Select the most appropriate option:

i. The major nutrients provided by pulses and legumes group are ……
(protein, vitamin, fat)

ii. Fats and sugars group mainly provide……..to the body
(energy, strength, satiety)

iii. Different types of foods are grouped into four basic food groups on the basis of the ……present in them.
(protein, nutrient, carbohydrates)

iv. Green leafy vegetables are good source of ..... nutrients.
(protein, fat, vitamin)

v. Top group of pyramid provide .....
(fruits, oilseeds, millets)

(b) State whether the following statements are true or false:

i. Cereals and whole grains are rich source of protein.

ii. Carbohydrates are the major nutrient and energy source present in vegetables

iii. 1 g of carbohydrates gives 4 kcal energy value.

iv. Legumes and pulses are rich source of proteins.

v. Milk and milk products are rich in fiber.

(c) Match the followings:

A		B	
i.	Toned milk	a.	Rice
ii.	Millets	b.	Rich in fiber
iii.	Cereals	c.	Lentil
iv.	Pulses	d.	Sorghum
v.	Vegetables	e.	Rich in beta carotene
vi.	Carrot	f.	Soyabean
vii.	Oilseeds	g.	Low fat Milk product
		h.	Meat and Fish

Q.2 Answer in brief (Give two examples of the followings)

i. Milk products
ii. Cereal products
iii. Fruit products
iv. Green leafy vegetables
v. Orange coloured beta carotene rich vegetables
vi. Vitamin A rich fruits
vii. Vitamin C rich fruits
viii. Pulses/*dals*
ix. Millets
x. Sugar products
xi. Iron rich food

Q.3 Short answer question

i. Explain food pyramid with the help of diagram.

ii. Explain fruits and vegetables groups.

Q.4 Long answer questions

i. Define balanced diet. Write in detail the way to plan a balanced diet.

ii. Discuss in detail the protein rich food group.

❖ **Project :**

i. List the food items used to prepare the following recipes and classify the items of each recipe into four basic food groups

a) *Potato paratha*

b) *Palak poori*

c) *Sabudana khichadi*

d) *Gulab jamun*

e) *Dal khichadi*

ii. Prepare variety of visual aids on four food groups and arrange an exhibition.

Unit - 2

Nutrients in Food

Objectives :

- To study the important constituents of food and their functions
- To gain the knowledge about the diseases occurred due to the deficiency of nutrients
- To know the different sources of the nutrients
- To understand the energy value of food and various methods to calculate it
- To understand the terms BMI and BMR

"Good nutrition is a fundamental requirement for positive strong health, functional efficiency and productivity."

Living systems are made up of various complex bio - molecules like carbohydrates, proteins, fats, vitamins and minerals, etc. Good nutrition involves an accounting of calories and other essential nutrients. These are required for human body and can be supplied in many ways. It is known that no universal food will satisfy all nutrient requirements. Humans consume a variety of foods such as cereals, pulses and legumes, nuts and oilseeds, fruits and vegetables, milk and milk products, meat and meat products, eggs and poultry, spices and herbs, etc. Upon consumption they undergo physio-chemical changes during digestion and absorption to supply energy and various other nutrients required by the body.

4 Macro and Micro Nutrients

Contents at a glance

A-Z of Nutrients

Can you recall?

1) How are foodstuffs and nutrient useful for body?
2) What happens when people consume too little food?
3) How can people get vitamin from sunlight?

Food is any substance consumed to provide nutritional support for human being. It includes food intake, absorption, assimilation, biosynthesis, catabolism, and excretion.

Food is composed of Nutrients

❖ Nutrients are chemical components present in food that supply nourishment to the body. A nutrient must accomplish at least one of the following three functions:

- Supply energy to the body.
- Build, repair and maintain body tissues
- Regulate body processes.

There are six main nutrients, which perform specific function in our body- Carbohydrates, Proteins, Fats, Vitamins, Minerals and Water.

4.1 Classification of Nutrients:

Nutrients are classified into two main groups according to the amount required.

- Macronutrients are required in relatively large amounts. These include carbohydrate, protein and fat.
- Micronutrients are required in smaller amount by the body. These include vitamins and minerals etc.

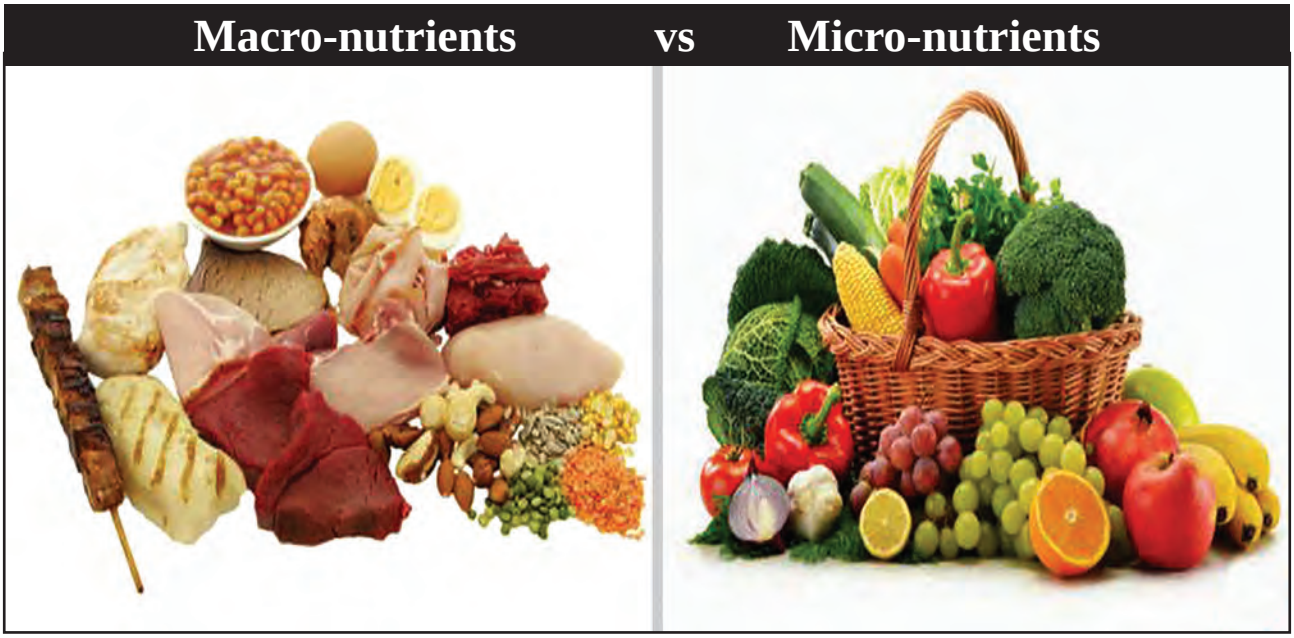


Fig. 4.1 : Sources of macro-nutrients and micro-nutrients

Table 4.1 Difference between Macro - nutrients and Micro - nutrients

Macro-nutrients	Micro-nutrients
1. Macronutrients are required in large amounts.	1. Micronutrients are required in small amounts.
2. Carbohydrates, proteins, fat, and water are examples of macronutrients.	2. Vitamins and minerals are examples of micronutrients.
3. Macronutrients contribute to the bulk energy needed for the metabolic system	3. Micronutrients assist in various functions of metabolic activities of body, growth and disease prevention.
4. Cereals, legumes, meat, fish, roots and tubers, nuts, oilseeds are rich in macronutrients.	4. Mainly, fruits, vegetables (green leafy vegetables) germinated food, fermented foods, etc are rich in micronutrients.

4.2 Carbohydrates:

Carbohydrates are main source of energy and present in major quantity in our foods. Carbohydrate is a chemical compound made up of elements-carbon, hydrogen and oxygen. The chemical building blocks (units) of carbohydrates are given below.

Classification of Carbohydrates

- **Monosaccharides** (2-6 Carbon units)
  - Glucose
  - Fructose
  - Galactose
- **Disaccharides** (Made up of 2 Monosaccharides)
  - Sucrose
  - Maltose
  - Lactose
- **Oligosaccharides** (3-9 Monosaccharides)
  - Raffinose
  - Stachyose
- **Polysaccharides** (10 or More Monosaccharide)
  - Dextrin
  - Starch
  - Cellulose
  - Hemi Cellulose
  - Pectin
  - Gums

Table 4.2 Sources, functions, deficiency of carbohydrates

Sources		Functions	Deficiency disease
Plant	**Animal**		**Marasmus**
1. Cereals and Millets 2. Pulses and Legumes 3. Vegetables 4. Fruits and dry fruits 5. Sugar	1. Milk (Lactose) 2. Muscles and Liver (Glycogen)	1. To provide energy 2. Protein sparing action 3. Utilization of fat 4. Role in gastrointestinal function 5. Energy for brain	**Symptoms:** 1. Insufficient energy 2. Loss of weight in adults.

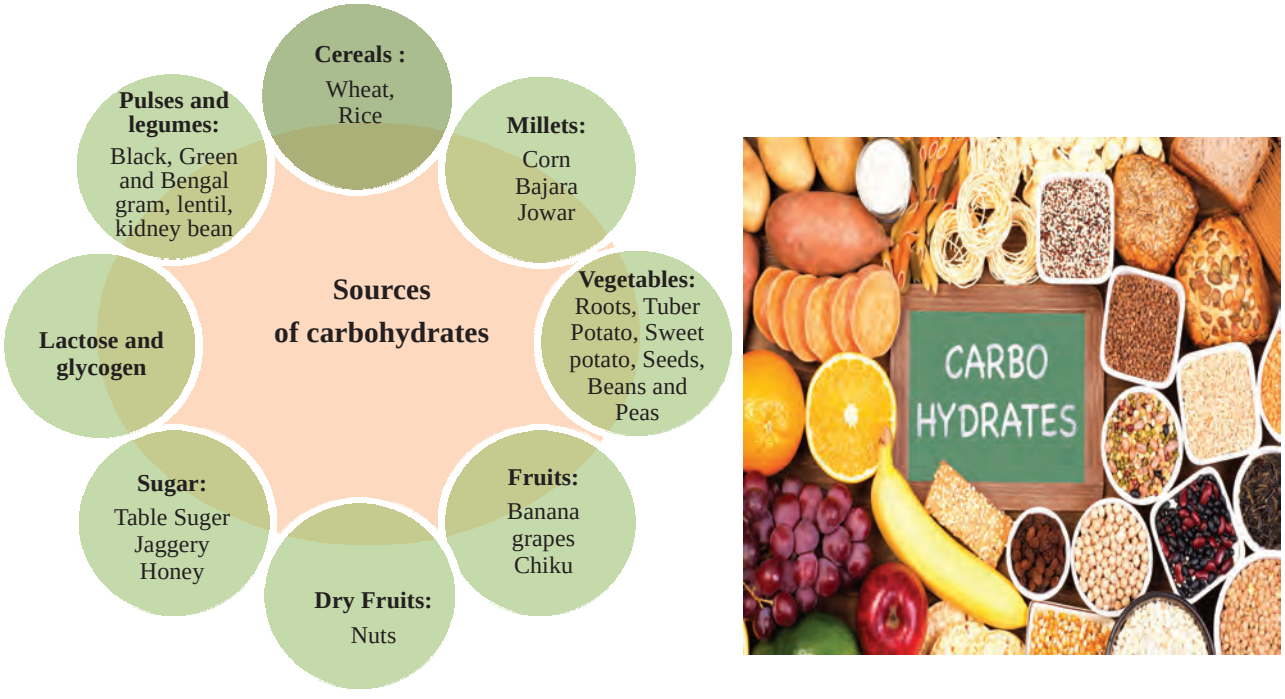


Fig. 4.2 : Sources of carbohydrate

Functions in detail:

1. **To provide energy**-The main function of carbohydrate is to provide energy. 1gram carbohydrate gives 4 kilocalories
2. **Protein sparing action**- Insufficient amount of carbohydrate will force the body to breakdown proteins for releasing energy instead of using them for their major functions i.e. body's growth and maintenance.
3. **Utilization of fat**-Carbohydrate is essential for proper utilization of fat from the diet.
4. **Role in gastro-intestinal function-** Carbohydrate encourages the growth of desirable intestinal bacteria and provides faecal bulk, which facilitates elimination.
5. **Energy for brain-** Carbohydrates supplies glucose to central nervous system to perform the body function.

Do You Know ?

The **Glycemic Index (GI)** is a relative ranking of carbohydrate in foods according to how they affect blood glucose levels. Carbohydrates with a low **GI** value (55 or less) are more slowly digested, absorbed, metabolised and cause a lower, slower rise in blood glucose e.g. oat products.

4.3 Proteins :

The word protein is derived from Greek word "Proteios", which means prime or principal. Protein is the main component of all living cells. Protein is a complex organic compound. It contains the elements, carbon, hydrogen, oxygen and nitrogen. Some proteins contain sulphur, iron, phosphorus, iodine and copper.

Amino Acids: Proteins are made up of small units or building blocks known as amino acids. Protein consumed in food is broken down and absorbed in blood stream as amino acids. Amino acids are joined together by peptide link to form peptide chain.

Types of Amino Acids: There are 20 common amino acids that occur frequently in food proteins, of these nine are considered essential. Essential amino acids are those which are necessary for growth and health of an individual but they are not synthesized in adequate amount in the body. Non essential amino acids are those that are equally important but can be synthesized in body.

Table 4.3 : Essential and Non Essential Amino acids

Essential Amino Acids	Non Essential Amino Acids
Methionine	Alanine
Isoleucine	Asparagine
Threonine	Aspartic acid
Phenylalanine	Glutamic acid
Valine	Glutamine
Tryptophan	Serine
Histidine	Arginine
Leucine	Cysteine
Lysine	Glycine
	Proline
	Tyrosine

Do You Know ?

Complete and incomplete protein

Complete protein or whole protein is a food source of protein that contains an adequate proportion of each of the nine essential amino acids necessary in the human diet. Examples of single-source complete proteins are eggs, red meat, poultry, fish, milk, cheese, yogurt.

Complete protein	Incomplete protein
Milk	Vegetables
Eggs	Fruits
Beef	Oats
Cheese	Bread
Yogurt	Rice

Incomplete Proteins: Plant foods are considered incomplete proteins because they are low or lacking in one or more of the essential amino acids necessary in the human diet. Incomplete proteins found in plant foods can be mixed together to make a complete protein e.g. rice and pulses.

Do You Know ?

Calculate your daily protein need

Protein requirement / day is same as your body weight.

Table 4.4 : Sources, functions and deficiency of proteins

Sources		Functions	Deficiency disease
Plant	**Animal**		**Kwashiorkor**
1. Pulses 2. Legumes 3. Nuts and Oilseeds 4. Vegetables: Peas	1. Milk and Milk products like Paneer, Cheese, *Khoa* 2. Meat 3. Egg 4. Fish	1. Body building, growth and maintenance 2. Regulation of body processes 3. Supply of energy 4. Transport nutrients	**Symptoms:** 1. Weight loss 2. Nutritional oedema 3. Muscular wastage 4. Growth retardation 5. Weakness 6. Anaemia 7. Drying of skin 8. Sparse dry, brittle and discoloured hair

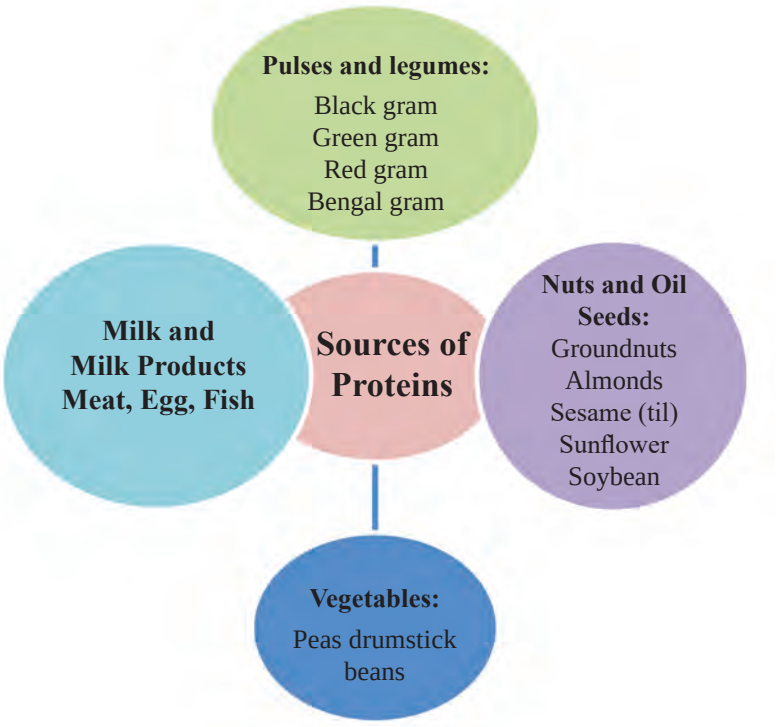


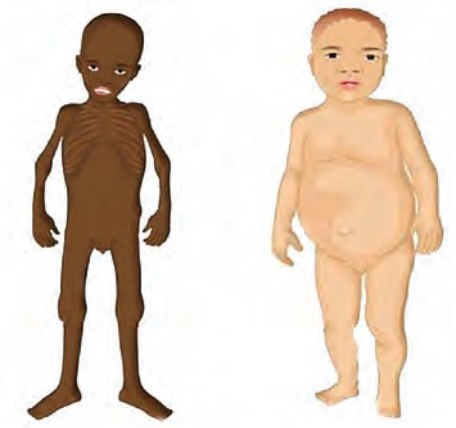
Fig. 4.3 : Sources of proteins

Functions in detail:

- Protein is the main structural component of cells.
- It supplies building blocks (amino acids) to the body.
- Proteins are required for highly specialized metabolic functions as follows:
  a) Hormones and enzymes (proteins) are essential for digestion and metabolic activities in the body.
  b) Protein helps in making antibodies, which are natural, defence against infection.
  c) Haemoglobin (found in blood) is a protein which carries oxygen.
- Proteins provide energy to body if carbohydrates are less. Each gram of protein gives 4 kilocalories.

Do You Know ?

Biological value : It is the percentage of absorbed protein which is converted into body protein e.g. The score of egg is 100 which means that it is absorbed 100% in body.



Marasmus **Kwashiorkor**

Fig. 4.4 : Deficiency of carbohydrate and protein

4.4 Fats

Fats or lipids are largest group of organic compounds, which are important for body. Fat is a more concentrated form of energy. It contains carbon, hydrogen and oxygen. The simplest form of fat is fatty acids.

Fat is a complex molecule consisting a mixture of three fatty acids and an alcohol generally glycerol.

Fatty acid	+	Glycerol	→	Triglycerides
(3 Molecule of fatty acid)		(Alcohol)		(Simple Fat)

Do You Know ?

Oils are liquid at room temperature while fats are solid at room temperature (20^0 C)

Table 4.5 : Sources, functions and deficiency of fat

Sources		Functions	Deficiency
Plant	**Animal**		**Permanent learning defects**
1. Edible nuts and oil seeds. 2. *Vanaspati ghee* and margarine	1. Whole milk and milk products. 2. Pork 3. Egg yolk 4. Poultry	1. Concentrated source of energy 2. Carrier of fat soluble vitamins (A, D, E, K) 3. Insulation and padding 4. Palatability and satiety value	Deficiency of fat may lead to deficiency of fat soluble vitamins. Fats provide essential fatty acid (EFA) which may lead to permanent learning defects.

- Oil obtained from edible nuts and oilseeds- groundnut, sesame (til), coconut, soybean, sunflower, mustard, etc
- Vanaspati ghee and margarine

Plant source

- Whole Milk and Milk products like cream, butter, ghee, cheese, khoa.
- Pork / beef fat
- Egg yolk
- Poultry

Animal source

Fig. 4.5 : Sources of fat

Functions in detail:

- Fats are richest source of energy and 1gm of fats provide 9 Kilocalories.
- Fat is a carrier of fat-soluble Vitamin A, D, E, K in the body and helps in their absorption.
- Fat provides padding around the vital organ such as kidney, heart which serves to hold them in position and protect them from physical shock.
- Fats serve as insulating barrier against cold and thus helps to conserve body heat and regulate body temperature.
- Fat increases the taste of food. Fat tends to leave the stomach relatively slowly that helps to delay the onset of hunger and gives a feeling of satiety.
- Fat / oil also supply omega fatty acids.

Micro-nutrients

4.5 Vitamins

Vitamins are the vital organic dietary substances. Vitamins are defined as organic compounds occurring in small quantities, but necessary for growth, reproduction and maintenance of good health in human beings. Vitamins may occur in its active form in the food or as a precursor compound which can be changed into its active form in body.

Do You Know?

Most of the vitamins are not synthesized in body and must be supplied through diet.

Classification of Vitamins: Vitamins are classified into two groups on the basis of their solubility into fat and water i.e. fat soluble and water soluble vitamins.

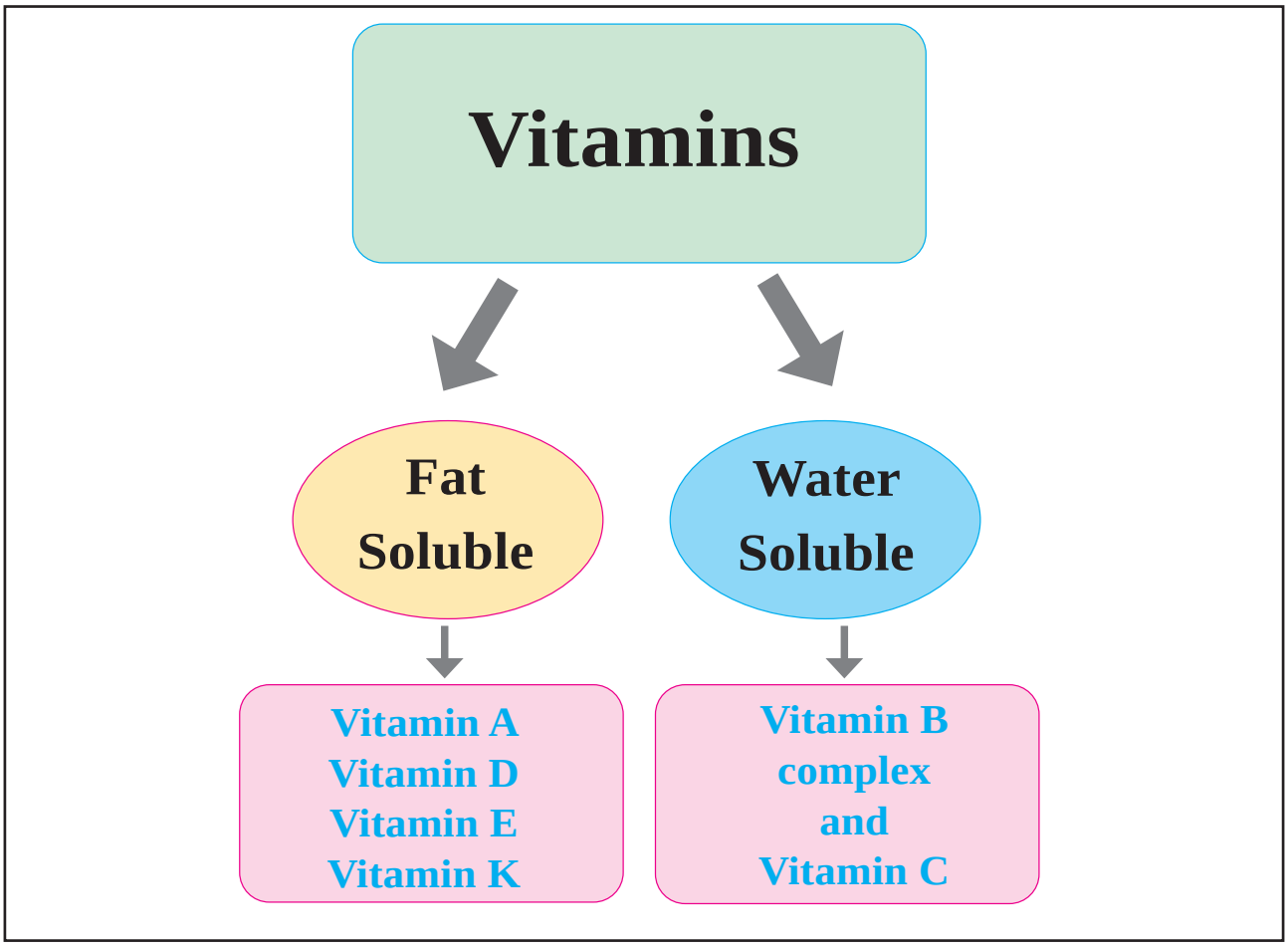


Fig. 4.6 : Classification of Vitamins

Table 4.6 : Difference between fat soluble and water soluble vitamin

Fat soluble vitamin	Water soluble vitamin
1. These vitamins are soluble in fat	1. These vitamins are soluble in water
2. These include vitamin A, D, E, K	2. These include vitamin B complex and C
3. They can be absorbed in presence of fat	3. They can be absorbed in the presence of water
4. The amount of fat soluble vitamin, not utilized, can be stored in body.	4. The amount of water soluble vitamin, not utilized, are excreted in the urine.
5. Not much of fat soluble vitamins are lost in cooking procedures.	5. Some of the water soluble vitamins are lost in normal cooking procedures.

A) Fat Soluble Vitamins : A, D, E and K are the fat soluble vitamins.

1. Vitamin A: Vitamin A is found in plants in the form of **Beta-carotene** and in animals in the form of **Retinol**. It is found in all yellow and orange fruits and vegetables. Beta-carotene is called as precusor of vitamin A

Table 4.7 : Sources, functions and deficiency of vitamin A

Sources		Functions	Deficiency
Plant	**Animal**		**Night Blindness**
1. It is found in Yellow and orange fruits and vegetables like mango, papaya, carrots and pumpkin 2. Green Leafy Vegetables: Fenugreek, spinach, coriander and drumsticks	1. Milk and Milk products. 2. Fortified vanaspati ghee 3. Liver meat 4. Egg yolk 5. Fish 6. Fish liver oil (cod liver oil)	1. Vision process: It is necessary in maintenance of good vision 2. It is essential for growth of skeletal and soft tissues 3. Protects body from infection 4. Support normal functioning of reproductive system in both females and males	1. Xeropthalmia 2. Conjunctival xerosis 3. Bitot's spot 4. Corneal xerosis 5. Keratomalacia 6. Reduced resistance to infection. 7 Severe deficiency causes blindness. 8. Skin becomes rough

2. **Vitamin D:** It is formed in skin by the action of ultraviolet rays from the sun. Our skin consists of a substance called '7 Dehydrocholesterol' which gets converted into vitamin D in our body in the presence of sunlight.

Table 4.8 : Sources, functions and deficiency of vitamin D

Sources		Functions	Deficiency
Plant	**Animal**		**Rickets (children), Osteomalacia (adults)**
Vitamin D is not found in plant foods. Natural Source- Sunlight	1. Fortified vanaspati ghee 2. Egg yolk 3. Fish 4. Fish liver oil	1. Plays important role in absorption of calcium from digested food. 2. Plays important role in mineralization and calcification of bone.	**A) Rickets (children)** • Impairment of calcification function • Bones and skull become soft and fragile • Bowing of legs • Swelling of wrist, knees and ankle joints • Restlessness • Nervous irritability **B) Osteomalacia (adults)** • Bone malformation

A D

E K

Fig. 4.7 : Sources of fat soluble vitamin A, D, E and K

3. Vitamin E: Vitamin E designates a group of compounds called Tocopherols, which act as antioxidants.

Table 4.9 : Sources, functions and deficiency of vitamin E

Sources		Functions	Deficiency
Plant	**Animal**		**Reduces fertility**
1. Cereals: Wheat and rice 2. Pulses: black gram, green gram, bengal gram 3. Green leafy vegetables 4. Nuts 5. Vegetable oils	1. Meat 2. Eggs 3. Dairy products.	1. Required for normal reproduction to maintain fertility and potency 2. Vitamin E acts as an antioxidant 3. Maintain stability and integrity of cell membrane	**Symptoms**: 1. It reduces fertility 2. Causes impotency 3. Premature aging 4. Muscular dysfunction 5. Liver damage 6. Weakness in heart muscles

4. **Vitamin K:** Vitamin K is often called as coagulation vitamin. Vitamin K is available in plants as well as animal food having similar biological activity. It is widespread and also synthesized by some usefull bacteria.

Table 4.10 : Sources, functions and deficiency of vitamin K

Sources			Functions	Deficiency
Plant	**Animal**	**Physiological:**		**Haemorrhage**
1. Green Leafy Vegetables : fenugreek, colocasia, cabbage, spinach 2. Vegetables: tomatoes, cauliflower 3. Soyabean oil	1. Egg yolk 2. Milk 3. Organ meat like liver	Synthesized by a bacteria in intestinal tract	Helps in blood clotting	**Symptoms:** It reduces the clotting tendency of blood. Continuous bleeding from wounds and cuts may occur.

Fig. 4.8 : Deficiency of fat soluble vitamins A, D, E and K

B) Water soluble vitamins: Water soluble vitamins consists of a large number of substances. These include B - complex vitamins like thiamine, riboflavin, niacin, etc. and vitamin C. Some of the water soluble vitamins are partly lost during cooking. Being water soluble, these cannot be stored in the body for a long time.

1. **Thiamine**: It is also known as vitamin B_1 and rapidly destroyed by heat.

Table 4.11 : Sources, function and deficiency of vitamin B_1

Sources		Functions	Deficiency
Plant	**Animal**		**Beriberi**
1. Whole cereals 2. Legumes 3. Wheat germ 4. Nuts 5. Vegetables 6. Fruits	1. Meat 2. Fish 3. Milk	1. Controlling agent in energy metabolism 2. Involved in proper functioning of nerves and muscles	**Symptoms:** 1. Affects digestive and nervous system 2. Loss of appetite, Impaired digestion 3. Weakness and numbness 5. Pain in the legs 6. Irritability 7. Mental depression 8. Confusion and fear

2. **Riboflavin**: It is also known as Vitamin B_2.This vitamin is slightly soluble in water and stable to heat in neutral or acidic solution but destroyed rapidly in alkaline media.

Table 4.12 : Sources, function and deficiency of vitamin B_2

Sources		Functions	Deficiency
Plant	**Animal**		**Ariboflavinosis**
1. Whole cereals 2. Legumes 3. Millets 4. Green leafy vegetables	1. Milk and milk products 2. Eggs 3. Organ meat like liver and heart 4. Yeast extract	1. Controlling agent in energy production and tissue building 2. It is a vital factor in protein and carbohydrate metabolism	**Symptoms:** 1. Affects oral and facial skin and eyes 2. Angular stomatitis 3. Cheilosis which includes inflammation of lips and tongue 4. Cracks at corner of the lips 5. Eyes become sensitive to light with itching and burning

3. **Niacin**: It is also known as Vitamin B_3.The precursor of niacin is tryptophan, which gets converted into niacin in body. Niacin is also water soluble, fairly stable to acid, heat, alkali, light and oxidation.

Table 4.13 : Sources, functions and deficiency of vitamin B_3

Sources		Functions	Deficiency
Plant	**Animal**		**Pellagra**
1. Whole cereals 2. Beans and peas 3. Nuts 4. Oilseeds	1. Meat 2. Fish 3. Poultry 4. Milk 5. Egg	1. It is essential for normal function of skin, intestinal tract and nervous system. 2. Niacin is a part of coenzyme which helps in carbohydrate, protein and fat metabolism. (Coenzyme is a compound that is necessary for the functioning of an enzyme.)	**Symptoms:** 1. This condition involves gastrointestinal tract, skin and nervous system 2. It is also known as disease of 4D's because it causes- a) Dermatitis b) Diarrhoea c) Dementia d) Death

Fig. 4.9 : Sources of water soluble vitamin B_1, B_2, B_3 and C

4. **Vitamin C**: It is also known as ascorbic acid. It is the most unstable vitamin as it is easily destroyed by heat, oxygen, alkalies and high temperature.

Table 4.14 : Sources, functions and deficiency of vitamin C

Sources		Functions	Deficiency
Plant	**Animal**		**Scurvy**
1. Citrus Fruits are the richest sources of vitamin C 2. Best source of vitamin C is amla 3. Other sources- guava, ber, orange 4. Green leafy vegetables 5. Sprouted pulses and others	Not present in animal sources	1. It is a powerful reducing agent 2. Helps in formation of haemoglobin 3. Formation of structural protein collagen that helps in bone, teeth formation and healing of wounds 4. Activation of many enzymes. 5. Increases resistance to disease 6. For better absorption of iron	**Symptoms :** 1. General weakness 2. Fatigue 3. Shooting joint pains 4. Anaemia 5. Infections 6. Poor wound healing 7. Spongy bleeding gums 8. Rough and dry skin.

Fig. 4.10 : Deficiency of water soluble vitamin B_1, B_2, B_3 and C.

4.6 Minerals

Minerals are an inorganic element occurring in the form of their salt e.g. calcium, phosphorus, sodium, iron etc. They are also required in small amounts and are vital to body. Minerals are present in all body fluids and tissues. Minerals have two distinct characteristics:

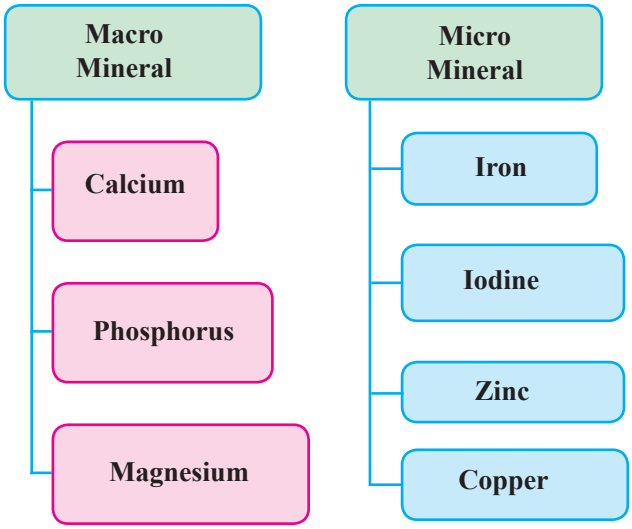
a) Minerals do not provide energy, but are highly essential for metabolic and physiological activities.

b) Minerals are not destroyed during food preparation.

Do You Know ?

Minerals do not act singly in their function and regulation of body process, but work with the help of other minerals and organic compounds.

Classification of Minerals:



A) Calcium: The name calcium is derived from Latin word 'calx'which means chalk. Calcium is inorganic mineral element. It is a white substance which is stable to heat and light and dissolves in an acid medium.

Table 4.15 : Sources, functions and deficiency of calcium

Sources		Functions	Deficiency
Plant	**Animal**		**Rickets (children) Osteomalacia (adults)**
1. Green leafy vegetables: Fenugreek, colocasia, cabbage, spinach, drumstick, mustard 2. Nuts and oilseeds 3. Ragi 4. Dry Fruits 5. Paan (eaten after Indian meal)	1. Milk and milk products like cheese 2. Small fish	1. Important for formation and maintenance of bones and teeth 2. Necessary for normal growth 3. It plays a vital role in mechanism of blood clotting 4. Needed for activation of many enzymes and secretion of hormones 5. Important role in regulation of cell permeability, thus control the uptake of nutrients by the cell	**A) Rickets (children)** 1. Bones become soft and fragile 2. Bowing of legs 3. Knock knees 4. Enlargement of wrist, knees and ankle joints **B) Osteomalacia (adults)** **1.** Softening of bones of leg, spine, thorax and pelvis which may bend and show deformities 2. General weakness

B) Phosphorus: It is an important constituent in every body tissue.

Table 4.16 : Sources, functions and deficiency of phosphorus

Sources		Functions	Deficiency
Plant	**Animal**		
1. Whole grain cereals and flour 2. Legumes and pulses 3. Vegetables 4. Nuts	1. Milk and milk products 2. Eggs 3. Fish 4. Liver	1. Plays a vital role in 'Calcification' of bone and teeth 2. Regulates energy released and acid base balance of body 3. Facilitates absorption and transportation of nutrients 4. Constituent of essential compounds like DNA and RNA	This deficiency is rare, but if it occurs, the symptoms are: 1. Retarded growth 2. Poor teeth and bone formation 3. Weakness 4. Anorexia 5. Pain in bones

C) Iron: Iron is a very important nutrient. In the body most of the iron is found in blood and rest of it is stored in organs like liver, spleen and kidney.

Table 4.17 : Sources, functions and deficiency of iron

Sources		Functions	Deficiency
Plant	**Animal**		**Anaemia**
1. Whole grain cereals 2. Legumes 3. Dark leafy vegetables 4. Dry fruits	1. Meat 2. Fish 3. Poultry	1. Component of haemoglobin is necessary for carrying oxygen 2. Myoglobin is an iron containing protein required for muscle contraction 3. Iron is an integral part of many enzymes which are required for metabolism	**Symptoms:** This is more common in women 1. Paleness of skin, tongue, lip and conjunctiva 2. General fatigue 3. Breathlessness 4. Anorexia 5. Headache 6. Spoon shaped nails 7. Poor attentiveness and memory 8. Lower physical work capacity 9. Adverse effect on immune system

Do You Know ?

Iron is a carrier of oxygen :- Haemoglobin which is a red coloured compounds present in red blood cells contains iron in the 'haem' part. Haemoglobin carries oxygen to various parts of the body and bring back carbondioxide to the lungs.

D) Iodine: Iodine is an essential element for normal growth and development of human body. It occurs widely in nature.

Table 4.18 : Sources, functions and deficiency of iodine

Sources		Functions	Deficiency
Plant	**Animal**		**Goiter (adults)**
1. Vegetables 2. Fruits 3. Iodised salt	1. Salt water fish 2. Shell fish 3. Eggs 4. Dairy products 5. Meat 6. Poultry	1. Component of thyroxine hormone secreted by thyroid gland 2. Regulates the rate of oxidation and metabolism within the cells 3. Influences physical and mental growth	**Symptoms :** 1. Enlargement of thyroid gland 2. Reduced mental function
The iodine content of food obtained from animals and plants depend upon the iodine in the animal's diet or the soil in which the plants are grown.			

Fig. 4.11 : Sources of calcium, phosphorus, iron and iodine

4.7 Water :

Water is the largest constituent of the body. About 70% of body weight is water. Body water is distributed as follows:

a) Intracellular water-Inside the cells of tissues

b) Extracellular water- Outside the cells of tissues.

Table 4.19 : Sources, functions and deficiency of water

Source	Functions	Deficiency
1. Drinking water: We should consume at least 6-8 glasses of water every day 2. Water contributed by food: All foods contain water in varying amount eg. Cereals -12-15% Fruits -70-90% 3. Water contributed by beverages. 4. Water used in food preparation. 5. Water formed in body due to nutrient metabolism: Chemical reactions involved in nutrient metabolism produce water in the body	1. Major constituent of our body: All body fluids like blood, saliva, sweat, digestive juices, and urine have water as an important constituent 2. Universal solvent: Water dissolves a variety of substances including all the products of digestion. 3. Regulation of body temperature: Water regulates body temperature through evaporation of water from lungs and skin 5. Acts as lubricant and prevents friction	**Dehydration** 1. Fatigue 2. Headache 3. The person may even collapse

Know About Facts :

The Mid-day meal scheme has been launched by the Government of India. Under this scheme school going children are provided free nutritious food in their schools .It has two main motives- to promote education in rural India, especially among poor children, and to prevent malnutrition in children.

Mid Day Meal Scheme

Fig. 4.12 Mid day meal in School

Points to remember

- Food is made up of nutrients which are carbohydrates, proteins, fats, minerals, vitamins and water.
- Carbohydrates make up the bulk of our diet. They are primary source of energy. They are mainly present in plants in the form of sugar, starch and fibre.
- Proteins are mainly responsible for tissue building and cell repair, regulation of various body processes and provide energy when needed.
- Fats are most concentrated form of energy in the food.
- Minerals are required to build body tissues, activate, regulate and control metabolic processes.
- Vitamins play a very vital role for maintaining and protecting good health as they regulate various body processes.
- Water is an essential solvent and performs many functions.
- A diet lacking in specific nutrients leads to specific deficiency disorders.

Exercise

Q.1 (a) Select the most appropriate option:

i. Deficiency of carbohydrates leads to a disease called_____.
(Kwashiorkor, Obesity, Marasmus)

ii. Proteins are made up of _____.
(Glucose, Amino acid, Fatty acid)

iii. Vitamin A is found in animals in the form of _____.
(Beta carotene, Retinol, Tryptophan)

iv. Goiter is caused by deficiency of _____.
(Fats, Calcium, Iodine)

v. Citrus fruits are rich source of _____.
(Vitamin A, Vitamin C, Iron)

vi. _____ is a precursor of vitamin A.
(Beta carotene, Tryptophan, Ascorbic acid)

(b) Match the following:

A		B	
i.	Thiamine deficiency	a.	Amino acids
ii.	Iron deficiency	b.	Green and yellow fruits
iii.	Protein	c.	Blood clotting
iv.	Vitamin K	d.	Anaemia
v.	Vitamin A	e.	Beriberi
		f.	Scurvy

(c) State whether the following statements are true or false:

i. Carbohydrates are good sources of energy.

ii. Proteins are made up of amino acids.

iii. Monosaccharides mean 10 or more polysaccharides.

iv Deficiency disease of iron is Beri-Beri.

Q.2 Answer in one word

i. I give 4 Kcal and help to spare the protein.

ii. I give 4 Kcal but my main function is body building.

iii. I am the richest source of Vitamin C.

iv. I am found in both green and yellow fruits and vegetables.

Q. 3 Short answer questions

(a) Enlist three important dietary sources of the following nutrients:

i. Fats ii. Carbohydrates

iii. Iodine iv. Vitamin A

v. Vitamin D

(b) Explain the Deficiency disorders of following:

i. Vitamin D ii. Vitamin A

iii. Thiamine iv. Iron

v. Protein

(c) Write in short

i) Give difference between fat and water soluble vitamin.

ii) Give classification of carbohydrates.

iii) Give classification of minerals.

Q.4 Long answer questions

- **Explain the functions of following:**

i. Carbohydrate ii. Vitamin C

iii. Riboflavin iv. Iron

v. Vitamin K

❖ Project

i. Prepare a scrap book on different sources, functions and deficiency diseases of any five nutrients.

ii. Prepare a chart on fat and water soluble vitamins.

5 Food Values

Contents at a glance

Can you recall?

1) What is the difference between Calorie and Kilocalorie?
2) Can we measure the energy released from food?
3) Which nutrients in food give energy?
4) Can energy be stored in body?

Energy is the ability to do work. The energy contained in food can either be trapped within the chemical constituents of the body or used to produce heat and body movement.

Energy is a precisely defined property of chemical compounds and other physical systems. The major sources to provide energy are carbohydrate, lipid and protein in the diet. Water, vitamin and minerals do not provide energy but they are important for other body activities. The energy of carbohydrate, lipid and protein is made available to the body, when these compounds are oxidised and release the energy during respiration / metabolism.

5.1 Definition of Kilocalorie

All forms of energy are interconvertible. The energy value of food is expressed in Kilocalories and determined by complete combustion of food in container surrounded by specific amount of water.

Definition : One Kilocalorie is defined as the amount of heat energy required to raise the temperature of 1Kg of water by 1^0C from 15^0C to 16^0C at normal atmospheric pressure.

The unit of energy which has been used in nutrition for a long time is the Kilocalorie (Kcal). However, the International Union of Nutritional Science (IUNS) have adapted "Joule" as the unit of energy in place of Kcal.

Definition: A joule is defined as the energy required to move 1kg mass by 1 metre by force of 1 newton. One newton is the force needed to accelerate 1kg mass by 1 m/scc.

The international conversion factor is 1 Kcal = 4.184 Kilojoules (KJ)

Physiological fuel value:

The amount of energy actually available to the body from a given amount of nutrients is called physiological fuel value. Difference between the physiological fuel values and gross fuel values is as follows

Table 5.1 : Difference between physiological fuel values and gross fuel values

Physiological fuel values	Gross fuel values
The amount of energy actually available in the body from a given amount of nutrient	Amount of energy released from the nutrient after complete combustion (in bomb calorimeter or oxy calorimeter).
In the human body the processes of digestion does not proceed with 100% efficiency.	All the nutrient are completely oxidised
In human body fibres are not digested and hence energy is not utilized.	In calorimeters the fibre present in the food is burnt and its energy is calculated.
During the protein digestion energy is lost as urea due to incomplete oxidation.	Protein is also completely oxidised.
The physiological fuel values Carbohydrate-4Kcal Protein-4 Kcal Fat-9 Kcal	The gross fuel values Carbohydrate-4.10 Kcal Protein-5.65 Kcal Fat-9.45 Kcal

5.2 Methods to determine the calorific values:

The amount of energy released from foods and the amount of energy expended by an individual can be obtained by Direct and Indirect calorimetry.

Table 5.2 Calorimetry equipment with their purpose

Direct Calorimetry	Indirect Calorimetry
Equipment and purpose a) Bomb Calorimeter – Energy value of food b) Atwater and Rosa respiration calorimeter- Energy expenditure during BMR/REE or at light activity	Equipment and purpose a) Benedict's oxy calorimeter- Energy Value of food b) Benedict-Roth respiration apparatus- BMR determination c) Douglas bag- Energy expenditure during work

Direct Calorimetry

a) Bomb Calorimeter:

Principle : Direct Calorimetry

Purpose : Determination of energy value of food

Method : It consists of a heavy steel bomb with tight cover, which is placed inside a vessel of containing water. The foodstuff is placed in a small crucible inside the bomb is filled with oxygen at high pressure and the food stuff ignited by means of electric leads. The material in bomb burns and produces heat which is absorbed by water and results in rise in temperature which can be measured by following equation.

$q = mc\Delta T$

where q = the energy evolved (J)

m = mass of the water (g)

c = the specific heat capacity of the water = 4.18J/Kg

ΔT = the temperature change in the water

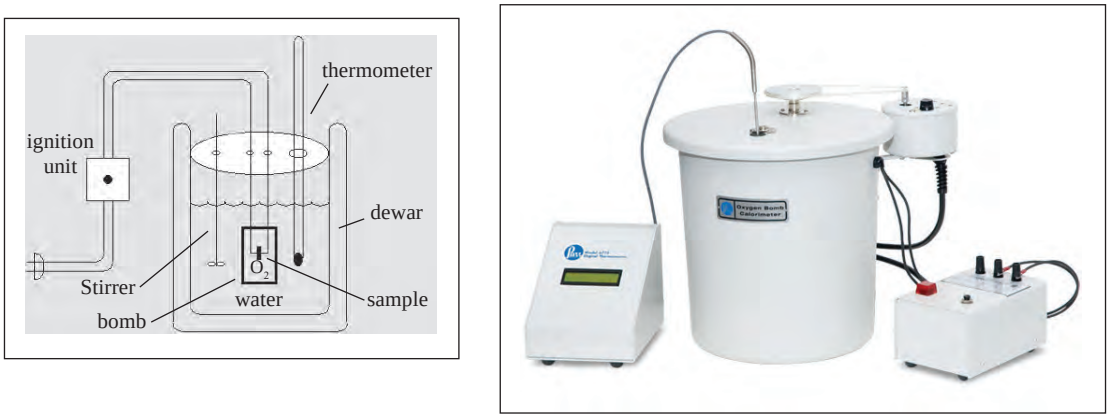


Figure 5.1 : Diagram of bomb calorimeter

b) Atwater and Rosa respiration calorimeter:

Principle : Direct calorimetry

Purpose : Determinaton of Energy expenditure during BMR/ REE or a light activity.

Method :

In this method the subject is placed in calorimeter, a small room with heavely insulated walls. The heat generated by the subject is taken up by water, pumped through the series of finned pipes which pass through the calorimeter.

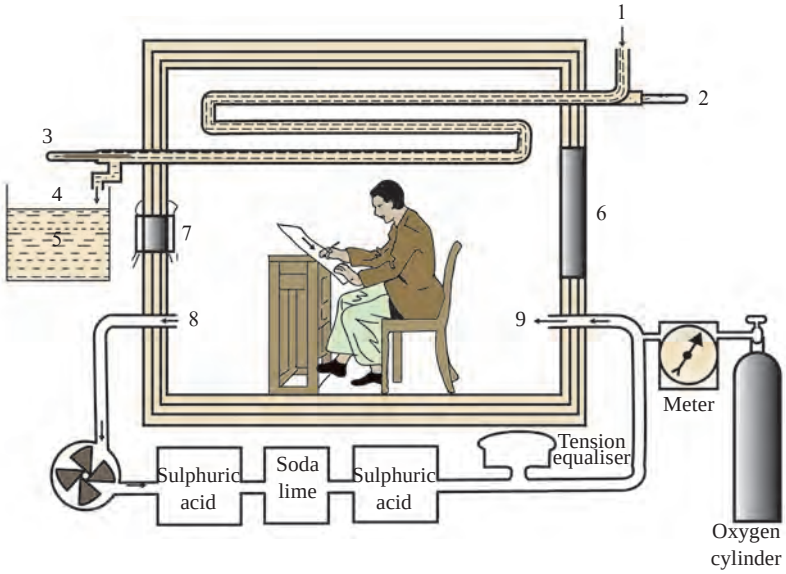


Figure 5.2 : Atwater and rosa respiration calorimeter

Multiplying the difference in temperature between the incoming and outgoing water, by volume of water flowing, heat output can be obtained.

BMR	-	Basal Metabolic Rate
REE	-	Resting Energy Expenditure

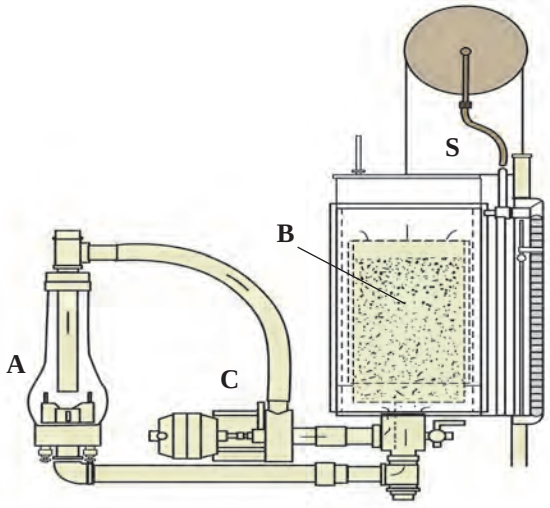
Indirect calorimetry :

a) Benedict's oxy calorimeter

Principle : Indirect calorimetry

Purpose : Determination of energy value of food

Method : In this method an organic substance is completely combusted in calorimeter or in the human body, oxygen is consumed in amounts directly related to the energy liberated as heat.



A : Combustion chamber
B : Lime soda container
C : Motor blower unit
S : Spirometer for measuring the oxygen

Fig. 5.3 : Benedict's oxy Calorimeter

b) Benedict - Roth respiration apparatus

Principle : Indirect calorimetry

Purpose : Determination of BMR

Method : In this method subject wears a nose-clip and breathe through a mouthpiece, which is connected to the apparatus by two tubes. The subject breathe-in the oxygen through respiratory valve and breath-out the carbon dioxide into spirometer bell. The amount of oxygen used recorded on the revolving drum by the pen attached. Using the Kymograph basal metabolism is calculated.

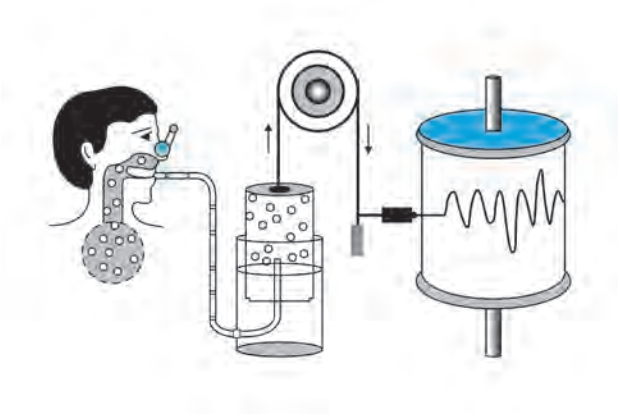


Fig. 5.4 : Benedict - Roth respiration apparatus

c) Douglas bag

Principle : Indirect Calorimetry

Purpose : Determination of energy expenditure during work

Method : The Douglas bag is used for determining energy expenditure during work. The subject wear the Douglas bag of 100 liters capacity, which is partially filled with expired air. The subject breath-in the atmospheric oxygen through nose and breath-out the carbon dioxide through mouth. This carbon dioxide is passed though corrugated pipes in Douglas Bag. The gas collected in Douglas bag is then analyzed for volume and compositing.

Fig. 5.5 : Douglas bag

5.3 Basal metabolic rate (BMR) :

Metabolism comprises everything that goes on inside the body to maintain and build tissues, produce energy and ensure good health.

Metabolism: The whole range of biochemical processes that occur within a living organism. Metabolism consists of anabolism (the buildup of substances) and catabolism (the breakdown of substances). The term metabolism is commonly used to refer specifically to the breakdown of food and its transformation into energy.

Basal metabolism refers to the basic or least amount of energy the body needs to survive when at rest. It is number of calories required to keep your body functioning at rest.

Basal Metabolic Rate is defined as the amount of energy required to carry on the involuntary functions of the body. It includes functional activities of various organs such as brain, heart, liver, kidney and lungs, etc.

The BMR of an average Indian man is 1750-1900 Kcal/day.

Factors influencing basal metabolic rate: There are many factors that affect BMR. These include:-

1. **Body size and surface area:** Both are major factors influencing BMR. On the basis of height and weight of the individual, surface area can be calculated. More the surface area, higher the BMR.
2. **Body composition:** Adipose or fatty tissue has an influence on BMR. Lower the body fat percentage, higher the BMR.

Do You Know ?

The lower body fat percentage in the male body is one reason why men generally have a 10-15% higher BMR than women.

3. **Age:** BMR reduces with age i.e. it is inversely propotional to age. Children have higher BMR than adults.
4. **Gender:** Men generally have a faster metabolism than women.
5. **Diet:** It affects the BMR both immediately as well as over a long period. BMR of strict vegetarians is 11% lower than meat eaters.
6. **Climate:** Exposure to cold temperature causes an increase in the BMR, so as to create the extra heat needed to maintain the body's internal temperature.
7. **Genetics** (Race): Some people are born with faster metabolism and some with slower metabolism. This may be due to dietary differences between the races.
8. **Hormonal state:** Thyroxine is the key regulator which speeds up the metabolic activity of the body. If thyroxine is more BMR will be increased whereas too little thyroxine reduces the BMR.
9. **Psychological state:** Anxiety and tension tend to increase the metabolic rate.
10. **Pregnancy:** The BMR is increased during pregnancy and lactation. This increase can be due to increase in women's weight.
11. **Exercise:** Exercise increases the BMR by building the extra lean tissues. Lean tissues is more metabolically required than fat tissues which causes more calories to burn during sleeping also.
12. **Active substances:** Caffeine and nicotine can increase the BMR.
13. **Body temperature / health :** For every increase of 0.5^0 C in internal temperature of the body, the BMR increases by about 7% e. g. fever also increases BMR.

Do You Know ?

The determination of BMR is the principal guide for diagnosis and treatment of thyroid disorders.

Activity-1

Calculating your energy needs:

Determine your BMR. It is generally held to be equal to about 1 calorie per kilogram per hour. This method is applicable to people who lead a moderately active life. (Does not apply it to heavy workers or athletes).

Step 1- Find your weight in kilograms (kg)

Step 2- Multiply the number of kilograms of body weight by 24 (hours per day).

Step 3- Multiply the answer in step 2 by 0.5% (50%).

Step 4- Add answers in step 2 and 3.

The total sum is your minimum daily calorie requirement.

Example:

Step 1- A person weights 50 kgs.

Step 2- 50 × 24 = 1200

Step 3- 50% of 1200 = 600

Step 4- 1200 + 600 = 1800 Kcal is total minimum requirement.

5.4 Body mass index (BMI)

- Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight and obesity in adults. BMI is an estimate of body fat.
- Body mass index (BMI) is defined as the weight in Kilograms divided by the square of the height in meters (Kg/m^2).
- **Formula to calculate Body Mass Index (BMI):**

$$BMI = \frac{Weight\ (kg)}{Height\ (m)^2}$$

- The International classification of adult underweight, overweight and obesity according to BMI is indicated in Table 5.3.

Table 5.3 : Body mass index (BMI)

Classification	BMI score (kg/m^2)
Underweight	<18.5
Normal	18.5 - 24.9
Overweight	25.0 - 29.0
Obese	30.0 - 40.0
Extreme Obese	>40.0

Points to remember

- Humans need energy for all activities.
- We get energy from carbohydrate, protein and fat.
- Energy value is expressed in Kilocalories.
- Bomb calorimeter is an equipment used for direct calorimetry.
- Basal metabolic rate is the amount of energy required to carry on the involuntary work of the body. BMR or basal metabolic rate is defined as the rate at which the body uses energy, when it is in resting stage, in order to keep the vital functions going on such as breathing, pumping blood to maintain body temperature, etc.
- BMI or basal metabolic index is the estimation of fat by which we can catagorise individuals into underweight, normal weight, overweight and obese.

Exercise

Q. 1 (a) Select the most appropriate option:

i. _____ does not provide energy.
(Protein, vitamins, fats)

ii. The energy value of food is expressed in _____.
(Kilocalories, kilograms, grams)

iii. _____ is an equipment used in direct calorimetry.

(Benedict's oxy calorimeter, Benedict's – Roth respiration calorimeter, Bomb calorimeter)

iv. An adult having BMI of 32 will come under_____.

(underweight, normal weight, obsese)

(b) Match the following:

A		B	
i.	Carbohydrate	a.	Benedict's oxy Calorimeter
ii.	Fat	b.	17 BMI
iii.	Indirect calorimetry.	c.	Bomb Calorimeter
iv.	Direct Calorimetry	d.	9 Kcal
v.	Underweight	e.	4 Kcal
		f.	32 BMI

(c) State whether the following sentences are true or false:

a. The amount of energy actually available to the body from a given amount of nutrients is called Physiological fuel value.

b. The gross fuel value of carbohydrate is 4 Kcalorie.

c. Bomb calorimeter is based on indirect calorimetry.

d. A person having 20 BMI will come under obese category.

Q. 2 Answer in brief

i. 1 Kilocalorie is equal to how many joules.

ii. Douglas bag is based on which calorimetry.

iii. Give examples of direct colorimetry.

iv. Give examples of Indirect calorimetry.

Q. 3 Short answer question

a. Define Kilocalorie.

b. Define joule.

c. Give the table of Calorimetry equipment with their purpose.

d. Explain Benedict's oxy-calorimeter.

e. Give difference between physiological fuel value and gross fuel value.

Q. 4 Long answer question

a. Explain the structure of bomb calorimeter with the help of diagram.

b. Define BMR. Explain the factors affecting it.

c. Define BMI. Explain how will you calculate BMI?

❖ Project.

i. Give the ingredients and their Physiological fuel value of any 5 recipes.

e.g. Aloo Paratha (100 gms) having composition of 60% carbohydrate, fat 20% and protein 12%. Calculate the energy values.

• **Energy value of Aloo Paratha:**

Carbohydrate: 60%

Energy value of carbohydrate 1gm = 4kcal.

So 60 × 4 = 240 kcal

Fat: 20%

Energy value of fat 1gm = 9 kcal.

So 20 × 9 = 180 kcal.

Proteins: 12%

Energy value of Protein 1gm = 4 kcal.

So 12 × 4 = 48 kcal.

Total calories = 240 + 180 + 48

= 468 kilocalories.

ii. Calculate BMI of 5 Adults and categorise them into underweights, normal, overweight and obese.

Unit - 3

Food Processing and Preservation

Objectives

- To get acquainted with different methods of food preparation for creating various delicacies.
- To understand heat transfer methods involved in food processing.
- To provide an understanding of the causes of food spoilage and principles involved in its preservation.
- To know the methods and techniques of food preservation for different food products.

"Process of transforming raw food into value added and nutritious finished food product is an art perfected by science."

Food preparation is the process of producing safe and edible food. Various ingredients used in food preparation are derived from living organisms. Vegetables, fruits, grains, nuts, herbs and spices come from plants, while meat, eggs and dairy products come from animals. There are different methods of food preparation, most of which have been known since antiquity. These include baking, roasting, frying, grilling, boiling, steaming, etc. A recent innovation is the use of microwave and retorting in food industries.

Food spoilage is the deleterious process leading to a product undesirable or unacceptable for consumption. It is caused due to variety of factors and mechanisms, including microbial, chemical, enzymatic, physical reactions and insects. A number of methods of preservation can be used that can totally prevent, delay or otherwise reduce the food spoilage.

Food preservation is one of the oldest technologies used by the mankind. The highly perishable foods like fruits, vegetables, milk, meat, fish, etc. deteriorate or decay quickly, leading to considerable loss of such commodities in various stages of food supply chain unless special methods are applied for their preservation. Preservation of food involves the processes (techniques) in which, the perishable food commodities are given a suitable physical or chemical treatment to prevent their spoilage and to retain their nutritive value and wholesomeness for longer periods.

6 Methods of Food Cooking

Contents

In pre-historic times, man used to eat raw food. After discovery of fire, he realized the importance to make the food more palatable and acceptable. Gradually he learnt the art of cooking with heat or fire which was a unique activity to humans. These days with the advancement of technology and new equipment, various ways of cooking are available.

Definition :

"Cooking is the application of heat to food for the purpose of making it more digestible, safer to eat, more palatable and to change its appearance".

Cooking or cookery is the art, technology, science and craft of preparing food for consumption and preservation. Cooking techniques and ingredients vary widely across the world, from grilling food over an open fire to using electric stoves, to baking in various types of ovens, reflecting unique environmental, economic and cultural traditions and trends. Cooking is done both by people in their own dwellings, by professional cooks (chefs) in restaurants and other food establishments.

WHY DO WE COOK FOOD?

6.1 Objectives of cooking food:

a) Improve taste and food quality

b) Destruction of micro-organisms

c) Improve digestibility of food

d) Increase variety in diet

e) Eliminate antinutrient (toxicants) in food

a) Improve taste and food quality

Cooking helps to improves the overall sensory properties like natural flavour, taste, colour, texture, appearance and overall acceptability of the food. For example, roasting groundnuts, frying onions and papads, cooking rice, roasting coffee seeds improve the flavour, colour and taste. Cooking meat with spices, rice with spices in making *pulao*, frying cashew nuts in ghee, addition of turmeric, curry leaves, pepper in *pongal* blend flavour with one another during cooking. Prolonged cooking may lower the flavour as flavouring compounds are volatile in nature.

b) Destruction of micro-organisms and extension of shelf life

Microorganisms are present everywhere and some are useful (friends) in making curd, cheese and bread. Some microorganisms are harmful (foes) as they produce toxins like *Clostridium botulinum* and *Salmonella*. Application of heat during cooking is one of the most effective methods for protecting the food against microorganisms. Cooking food for specific time at specific temperature may destroy harmful micro-organisms in food, reduce naturally occuring antinutritional factors, thus making it safe, palatable and digestible for consumption and increasing the keeping quality e.g. pasteurization of milk or juice.

c) Improve the digestibility of food

Cooking softens the connective tissues of meat and the coarse fibres of cereals, pulses and vegetables. Cooking improves the texture, hence it becomes more chewable and soft. When dry heat is applied to starches in food they get converted to easily digestible dextrins i.e. during cooking complex substances are broken down into simpler one. The human body can absorb and utilize these simpler substances more readily.

d) Increase variety in diet

Variety can be brought about in meals easily by using different methods of cooking *e.g.* *rice* can be made into, *jeera* rice, *biryani*, *pulao*, lemon rice, *khichdi*, etc. Wheat can be converted into *phulka*, *chapatti*, *paratha*, *puri*, *halwa*, etc. simply by changing the methods of cooking. The variety preparation decreases monotony and makes eating a pleasure.

e) Eliminate anti-nutritional factors

Some food grain, fruits and vegetables contain a number of naturally occuring antinutritional factors. During cooking, the antinutritional factors can be destroyed from food, thus increasing the availability of nutrients and making it more safe e.g. raw egg contains avidin which binds biotin making it unavailable to body. Cooking destroys this property of avidin and hence increasing availability of biotin. Other toxic substances like trypsin inhibitor, haemagglutinins, saponin, tanins, etc. occuring in pulses are also destroyed during cooking, thereby incresing the availability and absorption of nutrients.

6.2 Preliminary treatments of cooking food:

The different preliminary treatments used for various food preparations and the changes brought are listed in table, 6.1.

Table 6.1 : Preliminary Treatments and its effects on foods

Food product	Ingredients	Preliminary treatments	Effect on food
1. *Chapati/ Roti*	Wheat flour	Addition of water and kneading	- Easy for rolling to give desired specific shape
2. *Pulao*	Rice Vegetables	Washing Washing, peeling, cutting, slicing	- Clean and safe - Attractive
3. Sprout salad	Moth beans Carrot Onion, tomato	Soaking, germination Peeling, grating Cubing, chopping	- Reduces cooking time - Easy to digest - Reduces antinutritional factors - Increases nutritive value

4. *Idli*	Rice and black gram	Cleaning, soaking, grinding, fermentation	- Spongy texture - Increase in nutritive value - Reduces antinutritional factors - Easy to digest
5. Sago Khichadi	Sago Groundnuts	Cleaning, soaking Roasting, grinding or pounding	- Easy to cook - Improves flavour - Avoids sticky and lumpy texture

The quality of final product is partially affected by the preliminary treatment given to foods. Incorrect preliminary treatment will result in unacceptable final product. Hence appropriate preliminary treatment should be carefully used so that the colour, flavour, texture, taste and nutritive values are preserved to its maximum, e.g. *Idli* prepared from over fermented batter, may give an off flavour to the product which is not acceptable.

6.3 Modes of heat transfer:

Do You Know ?

How food is cooked? How heat is transferred during cooking?

Heat naturally moves from hot surfaces to cooler surfaces. The movement of heat is commonly referred to as heat transfer. There are three methods of heat transfer: conduction, convection and radiation. Cooking of food usually takes place by a combination of these methods.

1. Conduction :

Conduction is the transfer of heat between substances that are in direct contact with each other. Here, heat flows from the source to the utensil and the utensil gets heated. The efficiency of the heat transfer depends on the conductivity of materials in contact with the food. Copper is one of the best conductors of heat. Heat transfers quickly from the heat source into the food through the copper cookware (container).

2. Convection :

Convection heat transfer is faster than conduction. Convection occurs by the movement of air, liquid or steam around the food. It uses the motion of fluids to transfer heat. When liquid or air is heated, the particles nearest to the source of heat become warm and rise upward. These are replaced by the cold particles which are away from the source of heat. The movement of particles results in formation of convection currents which ultimately heats all the liquid or air present.

3. Radiation :

Heat can be transferred in the form of electromagnetic waves emitted from one body and absorbed by another body. It is rapidly transmitted to the surface of material so used primarily for surface heating. Examples of use include: a) Dehydration of fruits and vegetables

b) Roasting of cocoa beans

c) Dehydration of grains, tea, etc.

d) Baking

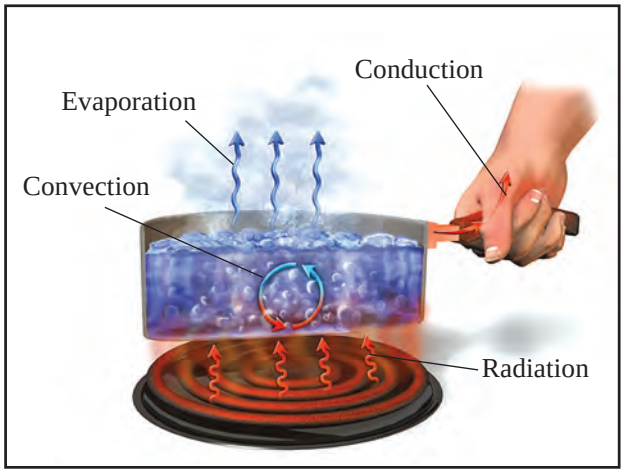


Fig. 6.1 : Modes of heat transfer

6.4 Methods of cooking :

The methods of cooking are classified into different groups mainly according to the medium of heat transfer.

A) Moist heat methods: Direct and Indirect Methods

B) Dry heat methods

C) Use of fat

D) Microwave cooking

E) Solar cooking

F) Combination cooking or Braising

A. Moist heat method

Water is the medium of heat transfer. The food may come in direct contact with water or indirect contact with water (steam).

(a) Direct methods: In this method food comes directly in contact with water. These methods are boiling, simmering and stewing.

(i) Boiling : In this method the foodstuffs are cooked in boiling water (at about 100^0 C). The water is enough to completely immerse the food in it. Once a vigorous boiling starts, the heat can be reduced and cooking continued till the food is tender. Food may be boiled in any liquid, which is bubbling at the surface such as water, milk, juices or syrups. Foods that are cooked by boiling are rice, eggs, *dals*, potatoes, meat, etc.

Advantages

- It is simplest method of cooking.
- It does not require any special skill and equipment.
- Uniform cooking can be done.
- The food cooked is light and easily digestible.

Disadvantages

- It is time consuming.
- Loss of water soluble nutrients, color and flavour may take place if water is discarded.

Fig. 6.2 : Boiling

(ii) Simmering

Simmering is a food preparation method in which foods are cooked in hot liquid kept just below the boiling point of water at 85-90^0 C. It is a useful method when foods have to be cooked for a long time to make it tender as in the case of cheaper cuts of meat, fish cooking, custards, *kheer*, *dal*, curries, soups etc. This method is also employed in making soups.

Advantages

- Uniform cooking takes place
- Due to low temperature loss of

nutrients are less as compared to boiling.

- Useful for foods which curdles by boiling temperatures, e.g. *kadhi*, *kheer* etc.

Disadvantages

- Loss of water soluble nutrients, colour and flavour.
- Requires more time to cook.

Do You Know ?

Poaching is the cooking of food in water at just below the temperature used for simmering. It is therefore a very gentle method of cooking. Foods containing protein which would become tough or curdled at higher temperature like eggs and fish are suitable for poaching.

(iii) Stewing

This is slow method of cooking, in which the food is cooked in a closed pan using only a small quantity of liquid. Temperature is similar to simmering temperature (85^0C to 90^0C). The water should be enough and tempearture should be low, otherwise the food may burn due to quick evaporation of water. The amount of water left after cooking is only marginal which is served along with the food. The foods which are generally stewed are fruits, vegetables, meat etc.

Advantages

- A minimum nutrient loss is observed as the temperature is low and food is served with left over gravy.
- The flavour is retained.

Disadvantages

- It is a very slow method of cooking and requires constant attention.
- A significant amount of vitamin C is destroyed because of the slow process of cooking.

(b) Indirect methods: In this method, food does not come in direct contact with water. Here two methods are commonly used.

(i) Steaming

Food is cooked with the heat generated by steam and therefore it requires slightly longer time as compared to boiling. Steaming is carried out in two ways i.e. direct steaming and indirect steaming.

Fig. 6.3 : Direct steaming

Fig. 6.4 : Indirect steaming

- **Direct steaming**:

Food comes in direct contact with the steam. e.g. steaming of cut vegetables or sprouted pulses, fish, *idli*, *dhokla* etc.

- **Indirect steaming**:

Food does not come in direct contact with the steam. The process takes a slightly longer

time than direct steaming method. e.g. melting of chocolates in double boiler.

Advantages

- The food cannot be easily over-heated.
- It does not require constant attention.
- The food cooked by this method is easy to digest.
- It requires less time, thus it saves fuel and money.

Disadvantages

- This method cannot be used for all foodstuffs.
- Special equipment is required for this method.

(ii) Pressure cooking

In this method, food is cooked using water or other cooking liquid, in a sealed vessel. The equipment used for this purpose is a pressure cooker. The cooker works by trapping the steam produced from boiling the cooking liquid inside the vessel. This leads to increase in internal pressure and temperature quickly. After use, the steam is slowly released so that the vessel can be opened safely. All types of cereals, pulses, vegetables and meat can be cooked in a pressure cooker.

Fig. 6.5 : Pressure cooker

Advantages

- Time required for cooking is less than steaming.
- Retention of nutrients is maximum.
- This is economical method of cooking because it saves fuel.
- By using the separate containers, more than one type of food can be cooked at one time in one vessel.

Disadvantages

- Special equipment is required for this method.
- Food can be mushy if cooked for longer time period.

B. Dry heat method

In dry-heat method of cooking, air is the medium of heat transfer. Foods cooked using these methods have a rich flavour due to caramelization and browning. There are different dry methods of cooking which are as follows;

(a) Roasting

This method involves cooking of food in open fire i.e. dry heat. This can be done in a tandoor, in an oven or in a thick heavy pan. Sometimes chicken is roasted with occasional addition of a little fat, so as to prevent the surface from drying that helps to add the flavour whereas vegetables likes potatoes, sweet potatoes and brinjals (egg plant) are roasted on a direct flame or in an oven without addition of any fat.

Fig. 6.6 : Roasting

Some foodstuffs can also be roasted in a suitable medium like sand or salt which gets heated faster and can retain the heat. They immediately puff up and are ready to eat e.g. popcorn.

Advantages

- The food develops good colour and flavour.
- It becomes easy to digest.
- Nutrient losses are less.
- It reduces the moisture content of food and thus improves keeping quality and flavour e.g. *rawa*, groundnuts, etc.

Disadvantages

- The foodstuff being roasted requires constant attention otherwise food may get burned.

(b) Baking

Baking is the cooking of food with hot air in a closed compartment known as oven. A uniform temperature of 160^{0}C to 220^{0}C is maintained. Usually the oven is heated to a particular temperature according to the type of food which is to be baked and this temperature is maintained throughout the cooking time. Food cooked by baking includes cakes, biscuits, pies, pastries, pudding, breads, etc.

Advantages

- Food develops a good colour, flavour and texture.
- Uniform bulk cooking can be done.
- Less loss of nutrients as compared to the moist heat method.

Fig. 6.7 : Baked food products

Disadvantages

- Specific equipments i.e. an oven is required.
- It is a slow method of cooking and takes a longer time.

Fig. 6.8 : Electric baking oven

(c) Grilling

This method involves application of dry heat to the surface of food, on grilled bars, commonly from above or below so that it gets cooked by radiant heat like in grilled sandwich or grilled chicken. Grilling usually involves a significant amount of direct radiant heat and tends to be used for cooking meat and vegetables quickly. This method is generally used for surface browning. Temperature range is 163^{0}C to 177^{0}C.

Advantages

- Grilling is quick method of cooking and therefore suitable for snacks and time saving meals.
- Food is crispy, brown, tasty and more attractive.
- Less loss of nutrients.
- Healthy method of cooking as it requires less or no fat.

Fig. 6.9 : Grilling

Disadvantages`

- Special grilling equipment is required.
- Grilling requires careful attention to prevent overcooking.

C. Use of Fat

In this method fat or oil is the medium of heat transfer. Fat or oil can be heated to a much higher temperature as compared to water. Frying is a quick, convenient and traditional method of cooking. Fried foods are very tasty, crispy, crunchy and popular in our meals. Different methods of frying used are as follows:

(i) Sauteing

(ii) Shallow fat frying

(iii) Deep fat frying

(i) Sauteing

In this method a small quantity of fat is used which is just enough to be absorbed by the food. The food is stirred frequently for uniform cooking. It is usually done as a pre-preparation step in many dishes. e.g. sauteing of vegetables for preparations of *pulao*, noodles, fried rice, etc.

(ii) Shallow fat frying

In this method sufficient amount of fat is used in pan or *tawa*, but not enough to cover (dip) the food completely. Usually thin foods like *dosa, paratha*, pancake, omlet etc. are cooked by this method where food is turned on both the sides equally for uniform cooking. Excess fat, if any should be drained on paper.

(iii) Deep fat frying

Enough oil or ghee is used to completely cover the food, then it is cooked uniformly on all the sides. This is faster method as compared to boiling because fat can attain a much higher temperature of 180^0C to 220^0C. This high temperature results in immediate removal of moisture and hardening of the outer surface, preventing any loss of flavour and juices. Foods like *batata wada, samosa, gulabjamun*, etc. are cooked by this method.

During frying the moisture in the raw food is transformed into vapour at - high temperature, and more oil gets absorbed in the food. Thus the food becomes more spongy and crispy. It attains golden brown attractive crust colour and pleasant flavour.

Advantages

- It is quick method of cooking.
- Fried foods are very appetizing and tasty.
- Fried foods have better keeping quality e.g. *puries* can be kept for a longer time as compared to *chapatis*.
- Frying introduces variety in the meals, as fried foods are crispy in texture.

Disadvantages

- Fried foods are difficult to digest due to high fat or oil content.
- Frying increases the calorific value of food products.
- Due to high temperature the nutrient losses are higher particularly of fat-soluble nutrients.
- As fats and oils are expensive, it is not an economical method of cooking.
- More attention and care should be taken during frying. Otherwise there would be excessive browning and caramelization.

- Repeated use of heated oils may produce harmful substances (Poly acril amide) and reduce the smoking points.

Sauteing **Shallow frying** **Deep fat frying**

Fig. 6.10 : Methods of frying

4. Microwave cooking

With changing food patterns, the popularity of microwave oven is increasing because it is convenient and fast method of cooking. Microwave oven is an electronic oven containing an instrument called the magnetron tube. This tube converts electric current into high frequency microwaves (electromagnetic energy radiations). These are absorbed and penetrated in the food. These waves cause vibration of food molecules resulting in friction. Due to friction, heat is generated within the food and it results in cooking of food. The water molecules in the centre of food first get heated then that heat diffuse out towards surface thus heating takes place of the whole commodity.

Since heat is generated in the food, there is no medium of heat transfer. Microwave heating of food require to use paper, bone china, glass, some plastics and special microwabe containers.

Figure 6.11 : Microwave oven

Advantages

- It is time saving and convenient method to use.
- There is less loss of nutrients.
- The food gets cooked uniformly as the microwaves directly enter the food.
- The oven or containers do not become hot.
- It is useful for defrosting frozen foods or heating cold foods.
- Oil consumption is less in microwave cooking, thus helps to prepare low-fat diet, food.
- It is an economical method because electricity consumption is lesser than traditional method.

Disadvantages

- This method is not suitable for bulk cooking as the time taken for cooking is directly proportional to the amount of food.
- Special containers made of paper, glass, plastic, etc. have to be used in microwave oven.
- Metal containers are not suitable for microwave cooking.

5. Solar cooking

For solar cooking, an appliance called solar cooker is required. A solar cooker is a device which uses the energy of direct sunlight to heat, cook or pasteurize food materials. Solar cooker is a box like structure, the lid of which holds mirror. The containers in which food is kept are placed in the chamber of box, which is covered by glass. When solar cooker is placed in the sunlight, solar energy from the sun heats it, by radiation.

The sun rays containing solar energy fall on the mirror, get reflected by it to the glass cover and pass through the glass to the inner chamber where food is kept. The principle involved in this method is that solar energy is converted to heat energy. The inner walls of chamber and food container are coated with black colour, so that the heat is absorbed and retained to the maximum.

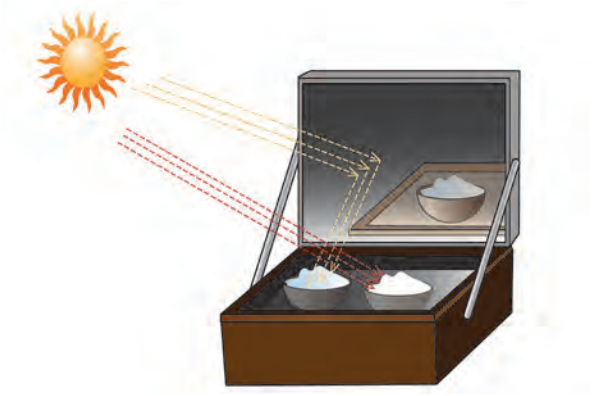


Figure 6.12 : Solar cooker

Advantages

- It is economical method as conventional fuels like gas, kerosene, coal, etc. are not required.
- Constant attention is not required.
- Food remains hot for longer period when kept in this cooker.
- This is eco-friendly method as it does not cause any pollution.

Disadvantages

- The process is slow at low temperature and takes 2-4 hours depending on the intensity of sunlight available.
- The method is weather dependant and cannot be used in rainy and cloudy season.
- The solar cookers position has to be changed with changing position of the sunlight.
- Frying is not possible in solar cooker.
- It cannot be used at night.
- Frequent cleaning of cooker is required.

6. Combination cooking or Braising

Many food preparations are made not by single method but by a combination of different cooking methods. Two mediums of heat transfer such as fat and water or air and water are used very commonly in many food preparations. This is usually referred as Braising. e.g. vegetable curry (sauteing and simmering), *upma* (roasting and boiling), meat cutlet (boiling and deep fat frying), *matar paneer* (frying and stewing), etc.

Advantages

- The food is very tasty and full of flavour. Even most of the nutrients are retained.
- Excellent sensory quality properties (colour, flavour, taste, texture and appearance)

Disadvantages

- It is a time consuming method and requires constant attention.

Activity-1

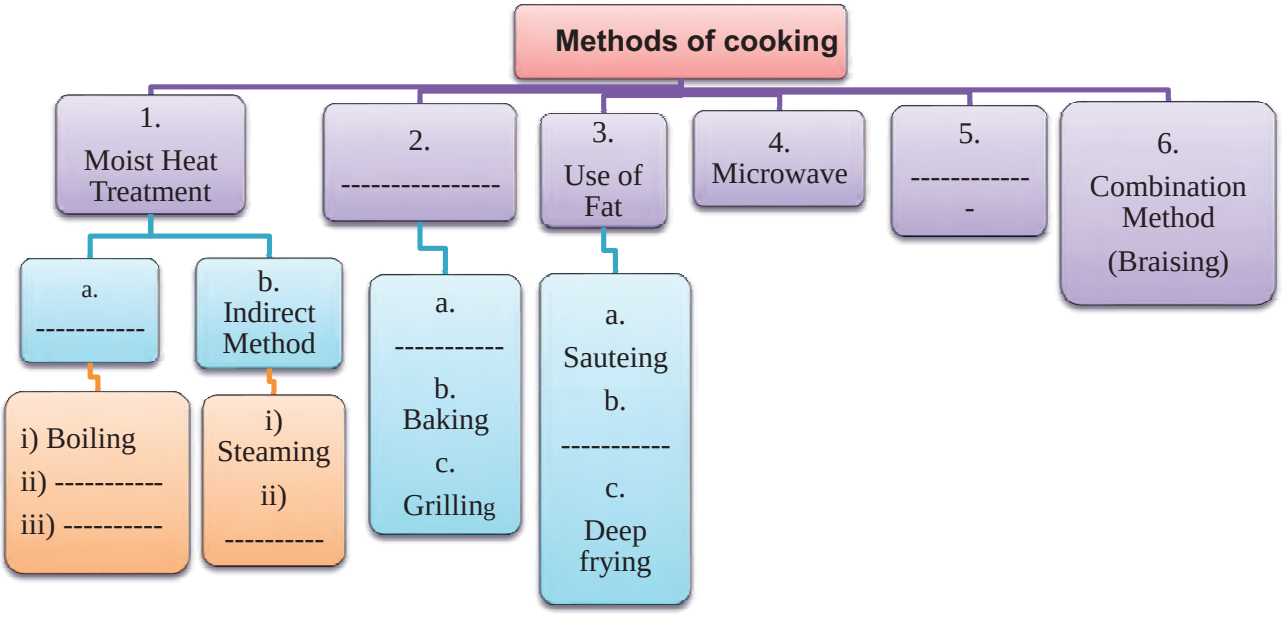


Table 6.2 : Methods of cooking food

Sr. No.	Medium of heat transfer	Method of cooking	Temperature	Examples
1.	**Water**	**A. Direct method**		
		1. Boiling	100^0C	*Dal*, rice
		2. Simmering	85^0C to 90^0C	*Kadhi*, *kheer*, egg, soup
		3. Stewing	85^0C to 90^0C	Meat stew, vegetable stew, vegetables with little gravy, stewed fruits
		B. Indirect method		
		1. Steaming	100^0C	*Idli, Dhokla, Aluwadi*
		2. Steaming under pressure	110^0C to 120^0C	Rice, *dal*, vegetables
2.	**Hot Air**	1. Roasting	160^0C to 175^0C	*Phulka*, *papad*, *rawa*, groundnuts, corn on cob
		2. Baking	160^0C to 220^0C	Cake, cookies, biscuits
		3. Grilling	163^0C to 177^0C	Grilled sandwich, grilled fish, grilled paneer
3.	**Fat**	1. Sauteing	-------	Sliced vegetables for noodles, fried rice
		2. Shallow frying	-------	*Dosa, paratha, thalipeeth*
		3. Deep frying	180^0C to 220^0C	*Jalebi, samosa, puri*
4.	**Combination of two mediums** **A. Fat and water** **or** **B. Air and Water**	Braising	-------	Meat cutlet, vegetable noodles, potato *wada* *upma, sheera*

Activity-2

Enlist the products which can be prepared using different cooking methods from following food.

1. Potato 2. Rice

Activity-3

Write down an explanation of the following methods and give at least 5 examples of food cooked in this way. One example is shown in table.

1) Moist Heat Cooking Methods	***2) Dry Heat Cooking Methods***	***3) Fry Cooking methods***
a) Boiling	**a) Roasting**	**a) Saueting**
Cooking foods in a liquid at temperature of about 100°C. e.g. eggs, potato, rice, *dal*, meat		
b) Simmering	**b) Grilling**	**b) Shallow frying**
c) Steaming	**c) Microwave heating**	**c) Deep fat frying**

Points to remember

- Cooking is important food processing method to prepare variety of food products from single ingredient by applying different cooking methods.
- Cooking improves palatability and digestibility of food. Adds variety to diet and also make it safe for consumption.
- Heat can be transferred to food during cooking with modes like conduction, convection and radiation.
- The cooking methods are mainly classified according to the medium of heat transfer such as air, water and fat.

Exercise

Q.1 (a) Select the most appropriate option:

i. In _____ heat transfer occurs when microwave or infrared energy are spread into the food.
(Convection, Radiation, Conduction)

ii. In _____ method food is cooked with water in a sealed vessel.
(Pressure cooking, Grilling, Roasting)

iii. _____ foods are difficult to digest due to high fat content.
(Roasting, Fried, Boiled)

iv. Combination of different cooking methods is known as _____
(Braising, Boiling, Steaming)

(b) Match the following:

A	B
i. Roasting	a. Cookies
ii. Simmering	b. Dhokla
iii. Steaming	c. Kheer
iv. Baking	d. Papad
	e. Cutlet

(c) State whether the following statements are true or false:

i. In conduction method, heat transfer is faster than convection.

ii. Roasting is dry heat treatment method of food processing.

iii. The principle effect of heat on fats is denaturation.

Q.2 Answer in brief

i. Give two examples of food prepared by steaming.

ii. Give two examples of food prepared by shallow frying.

iii. Enlist objectives of food cooking method.

Q.3 Short answer questions

i. Define conduction/ convection/ radiation.

ii. Give advantages and disadvantages of microwave food cooking.

Q.4 Long answer questions

i. Discuss modes of heat transfer to food during cooking.

ii. Describe solar cooking with diagram

❖ Project :

Select any 10 recipes prepared with braising and prepare an attractive booklet.

7 Food Spoilage

Contents

Most of the natural foods have a limited shelf life. Some foods such as fish, meat, milk, bread, tomatoes, etc have a short life span as they contain high amount of moisture. Other foods are kept for a considerably longer time (low moisture food) but may get decomposed eventually. Once food has been harvested, gathered or slaughtered, it starts to deteriorate until it becomes unfit for consumption. This deterioration is known as decay and leads to food spoilage.

Spoilage is the process in which original nutritional value, texture, flavour, etc. of food are damaged, such food ultimately becomes unacceptable for consumption. Hence, it is essential to process or preserve foods after harvesting or slaughtering to combat the problem of food spoilage.

Definition :

"Food spoilage is the process of change in physical, chemical, microbial and sensory properties of the food so that it becomes unfit for human consumption. Food spoilage is any undesirable change in food and such changes can be detected by smell, taste, touch or sight".

7.1 Classification of food on the basis of spoilage:

Food commodities can be classified into three groups on the basis of moisture content as perishable foods (high level of moisture), semi-perishable foods (medium level of moisture) and non-perishable foods (low moisture).

1. Perishable foods

Perishable foods are those likely to spoil, decay or rot quickly so that they become unsafe for consumption unless special preservation methods are used. Perishable commodities usually require some sort of refrigerated storage. Perishable foods include dairy products, eggs, meat, fish, poultry, fruits and vegetables, cooked foods and leftovers.

2. Semi-perishable foods

Semi-perishable foods are those that do not require refrigeration, having medium level of moisture but still have a limited shelf life. They include foods like potatoes, apples, onions, etc.

3. Non-perishable foods

Foods that do not spoil under normal storage conditions for a reasonably long time (contain low moisture) are known as non-perishable foods. These foods have long shelf life and don't require refrigeration. These items are usually kept under dry and cool storage conditions and are protected from moisture e.g. grains, flour, sugar, pulses, toast, biscuits, etc.

7.2 Signs of food spoilage:

Food deterioration is manifested by the reduction in aroma, flavour, texture and nutritional values of foods. Different types of undesirable changes may occur due to spoilage in food are listed as follows:

- **Change in colour:** The fruits like banana turn black after storing for a long period of time and reduce the acceptability of food. (black, soft and fermented)
- **Change in smell:** Rancid smell of spoiled oils, fatty food, bitter smell of curd or sour smell of starchy food. (rancid *samosa, potato wada, chakali, etc.)*
- **Change in consistency:** Curdling of milk, stickiness and undesirable viscosity in spoiled cooked *dal, curries* and vegetables (thread, foam, bubbles).
- **Change in texture:** Some vegetables like potato, brinjal, carrot, etc. undergo too much softening leading to rotting, changes in firmness. Lump formation take place in powdered materials (milk powder, wheat flour).
- **Change due to mechanical damage:** Mechanical damages such as eggs with broken shells, bruising of fruits and vegetables during harvesting, packaging transportation and handling, causes damage.

These gradual changes that cause deterioration and decay (rotting) in foods may occur due to certain organisms and chemicals present in the food and outside the food.

7.3 Factors affecting food spoilage:

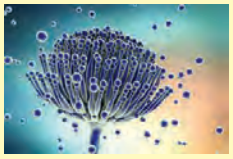
Food spoilage may occures mainly due to one or more of the following factors;

a. Microorganisms

The microorganisms that can cause food-borne illness are called pathogenic microorganisms. These microorganisms grow best at room temperatures, but most do not grow at refrigerator temperatures. Pathogenic microorganisms may grow in foods without any noticeable change in odour, appearance or taste. When food spoilage microorganisms are present, the food usually looks and/or smells

Table 7.1 : Different microorganism, their characteristics and food susceptible to it.

Micro-organism	Characteristics	Examples of Organisms	Commodities Susceptible to Spoilage
Bacteria  *(Pseudomonas)*	- Round, rod or spiral shaped - Grow under wide variety of conditions - Spore or Non-spore forming	*Staphylococcus aureus,* *Escherichia coli, Clostridium Botulinum* *Pseudomonas, Salmonella*	Meats, Milk, Eggs
Yeasts  *(Saccharomyces)*	- Uni-cellular fungi produced by budding - Produces bubbles on food surface	Zygosaccharomyces, *Saccharomyces, Candida*	Fresh and processed fruits, Vegetables, Dairy products, Fermented alcoholic beverages

Moulds  (*Aspergillus*)	- Multi-cellular, filamentous fungi - White cottony appearance - Some moulds produces mycotoxins - Spoilage occurs in field or storage	*Penicillium* *Alterneria species* *Aspergillus niger* *Aspergillus flavus*	Animal products (Meat, egg, fish) Fruits and Vegetables Cereals, nuts and their products

unpleasant. These microorganisms include bacteria, yeasts and moulds.

b. Enzymes

Enzymes are proteins in nature and they acts as biocatalyst in chemical reactions. They are responsible for spoilage in fruits and vegetables that causes changes in texture, color and flavour e.g., softening of banana tissues, browning of cut apple.

c. Air

Oxidation is a chemical process that produces undesirable changes in colour, flavour, texture and nutritional content of food. e.g. rancidity, discoloration of light-colored fruits and loss of vitamin C.

d. Light

Light exposure could result in loss of colour and vitamin. Light also may be responsible for the oxidation of fats.

e. Insects and rodents

These creatures require food to survive, therefore they damage packed and stored food making it more vulnerable to further deterioration.

f. Physical damage

Bruises, cuts and cracks on raw produce (fruits and vegetables) cause due to mishandling where microorganisms can grow easily and leads to spoilage. Dented cans, improper and broken packages provide places for microorganisms, air, light and creatures to enter into it easily.

g. Temperature

At higher temperatures food will get deteriorated at faster rate. Microorganisms, will grow rapidly at room temperature. At this temperature the growth of microorganisms, chemical reactions, biochemical reactions, metabolic reactions (ripening, respiration and transpiration) increases the rate of spoilage.

Do You Know?

Water is an essential component of all foods, even dry foods items like flour also contains water. Water or moisture greatly affects the keeping qualities of food. Moisture can absorb on the surface of a product and can cause many food defects like moulding, sogginess, caking and lumping of dry products. Water in foods can be controlled by drying, freezing, concentration, packaging, etc.

h. Time

Microorganisms require optimum time and favourable atmosphere to grow and multiply. Under favourable conditions such as temperature, moisture, pH, gas, concentration, microorganisms grow rapidly and thereby cause food spoilage and illness.

7.4 Prevention of food spoilage:

Various methods can be used to prevent, delay or otherwise reduce food spoilage.

- A food rotation system uses the first in first out method (FIFO), which ensures that the first item purchased is the first item consumed.
- Manipulation of factors controlling the conditions required for microbial growth and enzyme action viz. temperature,

moisture, air and pH other than the food itself can help to prevent food spoilage.

- The key for preventing food spoilage is to store food at proper conditions.
- Enzymes and microorganisms get inactivated by heat and chemical treatment.
- Using modern techniques of preventing food spoilage such as canning, pasteurization, irradiation, aseptic packaging, modified atmospheric packaging, vacuum packaging, nitrogen flushing, high pressure processing etc.

Activity

Keep some fresh food items such as tomatoes, mangoes, oranges, banana, etc. on the kitchen shelf for about three to five days and then observe what happens to them. List and describe the signs of deterioration on each food item.

Discussion: You will realize that their appearance, smell, texture and taste might have changed. Some of them will be covered with a whitish and blackish substance. All these signs will indicate that these foods are not wholesome since they are contaminated.

Points to remember

- Food spoilage is a naturally occurring process in which food deteriorates to the point at which the food becomes unfit for consumption.
- Food gets spoiled due to physical, chemical and microbial degradation resulting in development of off-flavours or the textural changes leading to rejection of food.
- Food spoilage can be prevented by using various food preservation techniques.

Exercise

Q.1 (a) Select the most appropriate option:

i. The microorganisms that can cause food-borne illness are known as _____ microorganisms.
(Pathogenic, Non-pathogenic, Aerobic)

ii. _____ is the process of change in the physical and chemical properties of the food so that it becomes unfit for consumption.
(Food spoilage, Food processing, Food preservation)

iii. A food rotation system _____ ensures that the first item purchased is the first item consumed.
(FIFA, FIFB, FIFO)

iv. Food spoilage related to white cottony appearance on food products is due to _____.
(Bacteria, Mould, Yeast)

(b) Match the following:

A	B
i. Perishable	a. Round, rod and spiral shape
ii. Semi-perishable	b. Unicellular fungi
iii. Non-perishable	c. Multicellular
iv. Bacteria	d. Meat and Fish
v. Yeast	e. Apple
vi. Moulds	f. Grains
	g. Oxidation

(c) State whether the following statements are true or false:

i. Most of the natural food have a limited shelflife.

ii. The microorganism that can cause food born illness are called non-pathogenic microorganisms.

iii. Enzymes are not bio-calalyst.

iv. Meat is a non-perishable product.

Q.2 Answer in brief

i. Give examples of Perishable foods.

ii. Give examples of Non-perishable foods.

Q.3 Short answer questions

(a) Define the term

i. Food spoilage

ii. Perishable foods

iii. Semi-perishable foods

iv. Rancidity

(b) Enlist factors affecting food spoilage.

Q.4 Long answer questions

i. Describe food spoilage and explain the causes of food spoilage.

ii. How can we prevent food spoilage?

iii. Discuss the signs of food spoilage.

❖ Project :

Identify reasons and characteristics of food spoilage in five food commodities.

8 Techniques in Food Processing and Preservation

Contents

Food preservation is a group of methods that helps to preserve food. For thousands of years, humans have used methods of preserving food, so that they can store their food to eat it later. Food preservation helps to reduce the quantitative loss to maintain nutritional quality and to increase the availability of food.

What is Food Preservation?

"Food preservation can be defined as the science which deals with the methods of prevention of decay or spoilage of food, thus allowing it to be stored in a fit condition for future use".

8.1 Need of food preservation:

When food is available abundantly than our consumption, it should be preserved for future utilization. Thus, preservation activities ensure proper utilization of food. In the past, food was preserved to provide a store of food during winter, when there was no other source of food. Today, preservation of fresh produce is required for following reasons:

- To increase availability of certain foods which have a short and specific growing season such as fruits and vegetables, for availing its use throughout the year.
- To utilize surplus crops into value added products and prevent wastage.
- To save money by preserving foods when they are most abundant, cheaper and are of good quality.
- To produce such food items which are easy to store, distribute, transport and that can be made available at all places at all time.
- To meet the needs of people for food in secluded and difficult areas.
- To ensure constant supply of preserved food at homes, hotels and other such places.
- It helps in reducing the national food loss by saving the food and improving food availability significantly.

8.2 Principles of food preservation:

All food preservation methods are based upon three general principles of preventing or retarding the causes of spoilage. Those are as follows :

A. Prevention or delay of microbial decomposition

- By keeping out microorganisms (asepsis) e.g. fruit pulps in multilayer pack.
- By removal of microorganisms e.g. washing or filtration etc.
- By destruction of microorganisms e.g. by heat or radiation.

- By slow down the growth and activity of microorganisms e.g. by using low temperature, drying, anaerobic conditions, chemicals, etc.

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

- By destruction or inactivation of food enzymes e.g. by blanching
- By preventing or delay of chemical reactions e.g. prevention of oxidative rancidity with the use of antioxidant.

C. Prevention of damage due to insects, animals, mechanical causes, etc.

8.3 Methods of food preservation and processing:

To retain the nutritional profile alongwith natural taste and aroma of a product, it is necessary to preserve it soon after preparation. Various methods of food preservation are employed and each has its own merits and demerits. The methods generally used are as under:

1. Asepsis (Keeping out micro-organisms)

Asepsis means preventing the entry of microorganisms during processing, packaging and storage. The aseptic environment can be created by -

- Proper packaging of the product, which protects the internal product from the surroundings.
- Maintenance of general cleanliness, hygiene and sanitary conditions during processing and handling of product from raw material to finished stage.

2. Removal of micro-organisms

The dust and dirt adhering to the raw material contain microorganisms and by applying various pre-treatments such as cleaning, washing, blanching, etc. help to reduce them considerably. Filteration of water, juices etc. can remove microorganisms, thereby preserve it from microbial spoilage.

3. Preservation by high temperature

Application of heat to foods leads to the destruction of microorganisms. High temperatures used for preservation are usually:

(a) Pasteurization- temperature below 100^0C (Except UHT pasteurization)

(b) Boiling - at about 100^0C and

(c) Sterilization- temperature above 100^0C.

One of the most important modern applications of the heat preservation is the pasteurization of milk.

(a) Pasteurization

The process of pasteurization was first discovered by the French microbiologist Louis Pasteur in 1862. The process uses temperature less than 100^0C to eliminate pathogenic

Louis Pasteur

bacteria and extend shelf life of the food products. The heating may be achieved by means of steam, hot water, dry heat or electric currents and the products are cooled promptly after the heat treatments e.g. milk, wine, beer, fruit juices and aerated waters.

Table 8.1 : Methods of pasteurization

Sr. No.	Method of Pasteurization (for milk)	Tempera-ture	Time
1	Low Temperature Long Time (LTLT) or Batch type	62.8^{0}C	30 min
2	High Temperature Short Time (HTST)	71.7^{0}C	15 sec
3	Ultra High Temperature (UHT)	137.8^{0}C	2 sec

Do You Know ?

Ultra-high temperature processing (UHT), is a food processing technology that sterilizes liquid food, mainly milk, by heating it above 137.8 °C temperature required to kill microbial spores in milk for 2 seconds

Blanching

Blanching is a heat treatment at about 100^{0}C. The term is usually used in conjunction with vegetable processing, where the goals are inactivation of enzymes, reduce microflora and improve the colour. Blanching is usually performed by dipping the products in boiling water or steaming for 2-3 minutes.

(b) Boiling

Cooking of rice, vegetables, meat, fish, etc. at home is usually done by boiling the food with water and involves a temperature around 100^0 C.

(c) Sterilization

Sterilization is a heating process (above 121^{0}C for 15 min) used to completely destroy all living micro-organisms in food. It can be achieved by moist heat, dry heat and irradiation heat source. Vegetables like green peas, okra, beans, etc. being non acidic and containing more starch than sugar, require higher temperature to kill the spore forming organisms.

(d) Canning is the method of preserving food from spoilage in which the foods are filled in cans heated to 115-125^{o}C tempreature and then sealed hermetically. Finally these cans are processed in boiling water for about 30 minutes and then cooled, removed and stored. They remain stable for about a year. It helps to destroy microorganisms and inactivates enzymes e.g. all kinds of canned foods such as soup, meat, beans, pulp, slices, legumes, nuts, etc.

Nicolas Appert
Father of Canning

In 1809, Nicolas Appert, a French confectioner and brewer, observed that food cooked inside a closed jar did not spoil unless the seals leaked, and developed a method of sealing food in glass jars or cans (Thermal method of canning). This method of canning is known as Appertization.

Fig. 8.1 : Canned Mango Pulp

Do You Know ?

In canning of food items, more than 88°C temperature kills most of the pathogenic organisms and retains most nutrients with other quality attributes.

Table 8.2 Difference between pasteurization and sterilization

Pasteurization	Sterilization
1. Partial destruction of microorganism	Complete destruction of microorganism
2. Temperature below 100^0C (generally except UHT).	Temperature above 100^0C
3. Require definite time	Require more time
4. Maximum nutrients are preserved	Heavy loss of nutrients

4. Preservation by irradiation

Foods are exposed to high-energy rays called gamma rays or by fast-moving electrons, which kill bacteria, fungi and insect by protecting the major nutrients. A major advantage of irradiation is that it can be done after the food is packaged and sealed. It has been used in pasteurizing or sterilizing perishable foods such as meat, fish, fruits, spices, ghee, etc. and extending their storage lives for long periods. It is also used for sprouting inhibition in onions, potatoes, garlic etc.

5. Preservation by low temperature

Low temperature preservation include following methods :

(i) Cellar storage (about 15^0C): It is used for the storage of surplus foods like root crops, potatoes, onions, apples, fresh fruits and vegetables, etc. for limited periods.

(ii) Refrigeration or chilling (0 to 5^0C): It is used for fruits, vegetables, meats, poultry, eggs, fish, fresh milk and milk products, etc. that can be preserved for 2-7 days by refrigeration.

(iii) Freezing (-18^0C to -40^0C): Mostly processed foods like fruit and vegetable products, peas, juice concentrates, ice-creams, meats, poultry, fish, etc. can be preserved for several months at this temperature range.

6. Preservation by Drying

Drying is one of the oldest and simplest methods of food preservation which removes water from the food. The reduced moisture content does not allow microorganisms to grow and also controls the enzymatic activity. Drying can be accomplished by sun-drying, mechanical drying (dehydration unit) and freeze drying.

- **Sun dried products:** Raisin, figs, apricots, etc.
- **Mechanical dried products:** Potato chips, milk powder, etc.
- **Freeze dried products:** Fruits, vegetables, sea foods, enzyme, bacteria, etc.

Dried foods are compact and lightweight; (low moisture content), do not require refrigeration and kept for longer time than the fresh foods. Dried foods should be stored in airtight containers to prevent re-absorption of moisture and allowing microbial growth, there by maintaining the crispiness and quality attribute.

Figure 8.2 : Preservation by drying

7. Use of high sugar or salt content

Sugaring: A strong sugar (more than 68.5^0 brix) concentration prevents mould, yeast and bacterial growth e.g. fruits in heavy sugar syrup (preserve or *murraba*), jams, jellies, marmalades, candies and sweetened condensed milk, etc.

Salting: Salting is one of the oldest natural method of food preservation. Dry salting is used in India for the preparation of tamarind preserve, raw mango, Indian gooseberry (*amla*), fish, meat, etc. Salting preserves the food by removing moisture from food through osmosis and makes it unavailable for microbial growth and enzyme action. The chloride in salt has direct effect on the growth of microorganisms.

Fig. 8.3 : Preservation by Sugar

Fig. 8.4 : Preservation by Salt

8. Use of organic acids

Organic acids are used to inhibit growth of many spoilage microorganisms that helps in food preservation e.g. acetic acid, lactic acid, citric acid, malic acid are widely used for preservation in food products. Vinegar contains 4 % acetic acid which is used for pickling of vegetables like onion, red cabbage, garlic, chillies, etc.

9. Fermentation

The term fermentation is defined as breakdown of carbohydrates by micro-organisms under anaerobic conditions. This is one of the oldest methods of food preservation. The chemicals produced by the microorganisms such as alcohol, or acetic and lactic acids cause the preservative effect of fermentation by slowing down spoilage factors (checking the growth of microorganisms and thereby the spoilage of food). Some food preserved by fermentation are alcoholic products (fruit wine) and acid products (vinegar, pickled vegetables), yogurt, cheese, etc.

Fig. 8.5 : Preservation by Fermentation

10. Preservation by oil and spices

A layer of oil on the surface of any food creates anaerobic conditions which further prevent the growth of bacteria, moulds and yeasts. Thus pickles in which enough oil is added to form thick layer at the top of bottle can be preserved for long periods.

Spices like turmeric, chilli, clove, ginger pepper, and asafoetida have bacteriostatic effect and thus helps in preservation of the food. Their primary function is to impart their characteristic spicy flavour and taste to the food e.g. Oil in mango pickle, lime and chilli pickles.

Fig. 8.6 : Preservation by oils and spices (Pickles)

11. Use of chemical preservatives

Preservatives are classified into two groups like class I and class II preservatives. The class I preservatives are called as natural preservative whereas class II preservative are known as chemical preservative.

Class I Preservatives

The class I preservatives are generally preservatives that are found in common kitchen occuring naturally. It includes sugar, salt, spices, vinegar, honey, vegetable oil, smoke and gases. As class I preservatives are natural, there is no need to be cautious while using it.

Class II Preservatives

Class II preservative includes benzoic acid, sulphurous acid, propionic acid, sorbic acid and their salt, nitrates and nitrites of potassium and sodium. Class II preservatives are chemical preservatives therefore used within the permissible limits prescribed by the regulatory bodies of the country. (In India, FSSAI-2006)

Table 8.3 Class II preservatives

Name of chemical	Salt	Products
Benzoic acid	Sodium benzoate	Tomato sauce, fruit squash, syrup and jam, jelly, etc.
Sulphurous acid	Potassium / Sodium meta-bisulphite (KMS) / (NaMS)	Lime cordial, fruit pulp, fruit products like juice, syrups, squash, candies etc.
Propionic acid	Sodium and Calcium propionate	Bread, juices, dried fruits
Sorbic acid	Potassium / Calcium sorbate	Meat, sea food, confectionery, cheese, cereal products
Nitrates and nitrites	Sodium nitrate, potassium nitrate	Meat and meat products

12. Carbonation

Carbonation is the process of preservation of fruit juices in which carbon dioxide gas is dissolved under pressure. The principle behind this is that by eliminating oxygen and forming carbonic acid from carbon dioxide gas, inhibits bacterial growth e.g. carbonated beverages (soft drinks).

Fig. 8.7 : Preservation by carbonation

13. Preservation by antibiotics

Certain metabolic products of microorganisms have been found to have germicidal effect and are termed as antibiotics. Some antibiotics are used to preserve fruits, vegetables and their products.

Nisin is an antibiotic produced by *Streptococcus lactis*, an organism commonly found in milk, curd, cheese and other fermented milk products. It is non- toxic and has no

adverse effect on the sensory qualities of food. It is widely used in the food industry especially for preservation of acid foods in which it is more stable.

14. Hurdle technology

Combination of two or more of the above methods are called as Hurdle Technology.

15. Advanced methods of food preservation or non-thermal processing techniques

1. High Pressure Processing (HPP)

High pressure processing (HPP) is a way to modify and preserve food without using heat.

2. Pulsed Electric Field (PEF) Processing

Pulsed electric field (PEF) is a non thermal food preservation technology suitable for preserving liquid and semi-liquid food products. It involves application of short, high voltage pulses of electricity to food for microbial inactivation.

Some other methods of non-thermal food processing

- Ultrasound Processing
- Ultra-violet (UV) light
- Electron Beam (E-beam) irradiation
- Gamma irradiation
- Cold Plasma

Points to remember

- Food preservation is process of slowing down the food deterioration activities.
- Thermal food processing involves heating food in an effective way to preserve the food.
- Food additives, preservatives also play important role in food preservation by checking the food spoilage at critical level.
- Non-thermal food processing and preservation method exert minimal impact on nutritional and sensory properties of foods and extend shelf life by killing microorganisms.

Activity

Look at the table. It shows a variety of foods with their water content. Lower the water content in food product better shelflife.

Draw a bar chart to show the water content of each food product in the table.

Using the information from your bar graph answer the following questions.

1. Which two foods are the most difficult for microbes to grow in?
2. Which two foods are the easiest for microbes to grow in?

Food Products in packed form	Water Content (%)	Shelf-life at ambient temp (Approx)
Macaroni	10	2 Months
Fresh meat	70	1 day
Bread	40	4 days
Biscuits	5	>4 Months
Boiled sweets	3	>4 Months
Dried vegetable	5	>4 Months
Rice	16	> one year

Exercise

Q.1 (a) Select the most appropriate option:

i. Keeping micro-organisms out from entering into the food is termed as _____.
(Spoilage, Asepsis, Canning)

ii. Nicholas Appert is the father of _____.
(Boiling, Fermentation, Canning)

iii. _____ is the non thermal method of food preservation.
(HPP, Drying, Pasteurization)

(b) Match the following:

A	B
i. Pasteurization	a. Keeping out microorganisms
ii. Asepsis	b. Father of canning
iii. Nicholas Appert	c. Oldest method of preservation
iv. Salting	d. Louis Pasture
v. Benzoic Acid	e. Use of chemical preservatives
	f. Sterlization

(c) State whether the following statements are true or false:

i. Combination of two or more preservation method is known as hurdle technology.

ii. Salt and sugar are class II preservatives.

iii. Pasteurization leads to the complete destruction of micro-organisms.

iv. HPP processing is a non-thermal method of preservation.

Q.2 Answer in brief

i. Asepsis

ii. Food preservation

iii. High pressure processing

iv. Pulsed electric field processing

v. Canning

Q.3 Short answer questions

(a) Write in short

i. What is the need for food preservation?

ii. Discuss the principles involved in food preservation.

(b) Give the full form of following:

i. HTST

ii. UHT

iii. PEF

iv. HPP

v. LTLT

Q.4 Long answer questions

i. Describe the method of high temperature preservation.

ii. Explain in detail the method of low temperature preservation.

iii. Discuss non-thermal method of preservation

❖ **Project :**

Identify the method of preservation done for value added products. (sauce, pickle, jam, jelly, etc.)

Unit - 4

Post harvest technology

Objectives :

- To learn the importance of fruits, vegetables, cereals, pulses and other food commodities.
- To understand classification, types and perishability of the agriculture commodities.
- To know the composition and nutritional value of fruits and vegetables.
- To study the procedures while cooking and processing of fruits and vegetables.
- To learn the various methods used for extending post harvest shelf life of the agriculture commodities.
- To learn the importance and used of spices and their products in our diet.
- To gain knowledge about sugar processing and its products.

"Post harvest technology can minimize the losses of fresh food commodities and increases the value addition (products) to crops, horticulture, livestock and fisheries sectors etc."

Post harvest technology plays a vital role in reduction the wastage of perishable agricultural produce, enhancing shelf life of food products, ensuring value addition to agricultural produce, diversification and commercialization of agriculture, generation of employment, enhancing income of farmers and creating surplus for the export of agro and processed foods.

Farmers produce grains, fruits, vegetables and livestock's whereas farm produces are consumed after post harvest treatment. Therefore, post harvest technology is an important intervention in the agriculture value chain. It is very critical intervention as it reduces post - harvest losses at farmer's level and links the agriculture farm to consumer plate. Post harvest techonology add significantly to income of the farmers.

9 Fruits and Vegetables

Contents at a glance

Fruits

Fruits and vegetables are living entity containing more amount of water, having perishable nature. Fruits are the ripened ovary or ovaries of a plant, together with adjacent tissues. Fruits are important for their attractive colour, pleasing aroma, sweet taste, crispy and crunchy texture and the nutrients that they contribute to the diet.

9.1 A Classifications and composition:

Classification of fruits: Fruits can be clasified on the basis of shape, cell structure, type of seed, or natural habitat etc. They may be grouped into soft fruits, segmented fruits, stone fruits, hard fruits, tropical, subtropical, temperate fruits, etc.

Table 9.1 Classification of fruits

Sr. No.	Groups	Examples
1.	Berries and soft fruits	Strawberries, grapes and all berries
2.	Citrus fruits or segmented fruits	Orange, sweet lime, pomelos, grapefruits, mandarins and tangerines
3.	Drupes or stone fruits	Peaches, plums, apricots and cherries
4.	Melons	Watermelon and muskmelon
5.	Pomes and hard fruits	Apple and pears
6.	Tropical and subtropical fruits	Banana, guava, papaya, jackfruits, dragon fruits, custard apple, kiwi fruits.

Fig. 9.1 Fruits

Composition of fruits: Fruits are a complex food commodity, composed of number of nutrients such as water, carbohydrates, fibre, vitamins, minerals and pigments, etc. Nutritive value of some fruits is given in table- 9.2

Water: Fruits tend to be juicy because of their high water content which varies from 75 to 90 percent.

Carbohydrate: Fruits contain good amount of carbohydrates including sugar, starch, cellulose, hemicellulose and pectic substances. Sugar namely fructose, glucose and sucrose give sweetness to the fruit. Cellulose contributes to the textural qualities of the fruits. The sugar and starch content of fruits differ with the type of fruit.

Protein and Fat: All the fruits have small amount of protein and traces of fat, which are negligible.

Do You Know?

The study of fruits is called Pomology.

Table 9.2 Nutritive values of Fruits (per 100 g edible portion)

			Vitamins		Minerals			
Fruits	**Moisture (g)**	**Fibre (g)**	**Vitamin-C (mg)**	**Beta Carotene (µg)**	**Calcium (mg)**	**Phosphorus (mg)**	**Iron (mg)**	**Energy (kcal)**
Yellow & Orange fruits								
Mango	81.0	0.7	16	2743	14	16	1.3	74
Orange	87.6	0.3	30	1104	26	20	0.32	48
Papaya	90.8	0.8	57	666	17	13	0.5	32
Vitamin C rich fruits								
Amla	81.8	3.4	600	9	50	20	1.2	58
Guava	81.7	5.2	212	0	10	28	0.27	51
Lemon	85.0	1.7	39	0	70	10	0.26	57
Sweet Lime	88.4	0.5	50	0	40	30	0.7	43
Pineapple	87.8	0.5	39	18	20	9	2.42	46
Other fruits								
Apple	84.6	1.0	1	--	10	14	0.66	59
Banana	70.1	0.4	7	78	17	36	0.36	116
Custard Apple	70.5	3.1	37	0	17	47	4.31	104
Sapota	73.7	2.6	6	97	28	27	1.25	98
Pomegranate	78.0	5.1	16	0	10	70	1.79	65
Water melon	95.8	0.2	1	0	11	12	7.9	16

Source: Nutritive Value of Indian Foods, National Institute of Nutrition, (ICMR), Hyderabad

Vitamins: Fruits are an excellent natural sources of vitamins. The citrus fruits are especially rich in vitamin C and other fruits contain only small amount. Guava (212 mg / 100 g) and amla (600 mg / 100 g) are the excellent and cheap sources of vitamin C. The yellow and orange fruits such as mango, papaya, and orange contain vitamin A in the form of beta-carotene in large amounts.

Fibre : Most of the fruits are rich sources of fibre.

Minerals: Some of the fruits are fairly good source of mineral. Watermelon and custard apple are rich source of iron. Dry fruits such as apricots, dates and figs are rich sources of calcium and iron.

9.2 A Importance and uses in diet:

- Fruits are a good source of different vitamins and minerals, which help to protect the body from infections and diseases. (known as body protectants)
- Fruits are useful in making colourful and attractive dishes like salads, juices, puddings, fresh fruits cake, jam, jelly, smoothies, etc.
- Fruits contain various aromatic components, which give a pleasant flavour for the preparations like milkshakes, fruit cocktail, ice-cream, *shrikhand, burfi* and other such sweets.
- Fresh cut fruits or fresh juices are refreshing and provide vitamin, minerals, and energy to the diet.

- Fruits provide fibre and pomace which help in normal digestion and faecal excretion.

9.3A Colour pigments and flavouring Compounds:

Pigments: Fruits contain colour pigments such as chlorophyll (green), carotenoids (orange) and flavonoids and undergo changes during processing and preparation.

a) Chlorophyll: Chlorophyll gives green colour to the fruits. Unripe fruits contain more amounts of chlorophyll e.g. green grapes, raw mango etc.

b) Carotenoids : Carotenoids are present in yellow and orange coloured fruits. It is not much affected by acid and alkali during processing e.g. papaya, mango etc.

c) Flavonoid: It is a group of pigments, commonly found flavonoids in fruits such as anthocyanins and anthoxanthins.

i) Anthocyanins

Anthocyanins pigment gives red, purple or blue colour to the fruits, e.g. black grapes, jamun etc. These pigments are soluble in water. Alkali changes red colour to bluish green, whereas acid enhances red colour of the fruits. Anthocyanins reacts with metals like aluminium, tin, iron to give a blue, greenish blue or greyish blue colour to the fruits. Thereafter fruit juices need to be stored in non-reactive materials like glass, pet bottles etc.

ii) Anthoxanthins

Anthoxanthins pigments imparts white or cream colour to the fruit e.g. banana, custard apple and guava etc.

Do You Know?

Purple and blue fruits help to enhance memory.

Table 9.3 Colour pigments in fruits

Pigments	Colour	Name of Fruits
1. Chlorophyll	Green	Raw guava, raw mango, green grapes and Indian gooseberry (amla)
2. Carotenoids	Yellow and orange	Ripe mango, orange, papaya, etc.
3. Flavonoids		
a) Anthocyanins	Red, purple or blue	Cherry, jamun, black grapes, mullberry, pomegranates strawberry, plums, kokum, water melon, etc.
b) Anthoxanthins	White or cream	Banana, apple and guava

Flavouring Compounds:

- Fruits have their characteristics flavor due to the presence of many aromatic compounds like organic acids, sugar, esters, essential oils and minerals.
- Orange and lemon contains some essential oils in the outer covering or skin (oil glands), which can be extracted to prepare essence or emulsion.
- Fruits contain various acids, which contribute to their typical flavour. The most common acids present in fruits are malic acid, citric acid, tartaric acid etc. Grapes contain tartaric acid and malic acid.
- Sweet flavour of fruits is due to the presence of sugar.
- Tannins are usually present in immature fruits and give a bitter or astringent flavour.

Ways to retain colour pigments and flavours:

- Fruits may be stored at a particular optimum temperature.
- Storage temperature varies with the type of fruit. Apple can be stored for a longer period in cold storage. Bananas can remain well at room temperature for few days and turn brown in cold storage at ripening stage due to chilling injury.

- Fresh fruits absorb and emit odours when refrigerated.
- Strong flavoured fruits if cut and kept in the refrigerator, must be stored in airtight containers or polyethylene bags to preserve the natural flovour e. g. guava.
- Fruit juices and cut fruits should be stored or served in non-reactive containers like stainless steel, glass or good quality plastic (food grade) to retain its colour, taste and flavor.
- To prevent browning (discolouration) of cut fruits, use sugar syrup, lemon juice or KMS / NaMS solution, e. g. cut apple piece.

9.4A Changes during ripening and cooking:

Various changes occur in the fruits during ripening and cooking. These include changes in colour, texture, flavour, soluble solids, juiciness, appearance and taste.

A. Changes during ripening:

- **Changes in colour:** Most of the fruits contain both chlorophylls and carotenoids in their peels. In raw stage they appear green in colour because the chlorophylls are predominate pigment at this stage. During ripening, the chlorophyll pigment may be broken down and carotenoid pigment will get synthesized in some fruits. Thus the green pigment tends to disappear and the yellow, orange and red colour of carotenoid pigment becomes more dominant e.g. ripe mango. In some fruits anthocyanins are synthesized during ripening. Anthocyanins pigments give red purple and blue shades to the ripe fruits e.g. jamun, black grapes etc.
- **Changes in texture:** All the fruits contain pectic substances, which are the cementing substances in between the cell walls. The immature or unripe fruits contain protopectin, which is converted to pectin during ripening by the action of enzyme pectinase. Pectin has gel-forming ability and hence ripe fruits are used for gel / pulp making e.g. ripened guava. In over ripe fruits the pectin gets converted to pectic acid, which does not have same gelling ability. These changes also affect the texture of the fruits as the flesh becomes soft.

$$\underset{\text{(Raw fruit)}}{\text{Protopectin}} \xrightarrow[\text{enzyme}]{\text{Pectinase}} \underset{\text{(Ripe fruit)}}{\text{Pectin}} \xrightarrow[\text{enzyme}]{\text{Pectinase}} \underset{\text{(Over Ripe Fruit)}}{\text{Pectic Acid}}$$

- **Development of flavour:** The development of characteristic flavour in ripe fruit involves a decrease in acidity and increase in sugar content. This will also result in production of certain complex mixture of volatile substances and essential oils, which gives the characteristics pleasant sweetness to the fruits. The flavour also indicates the degree of ripeness of the fruits.
- **Changes in soluble solids and taste:** The sweetness of the fruits increases as it ripens because most of the starch is converted to sugar and also the acidity decreases e.g. ripe banana, mango, etc. Tannins, which have astringent properties, become more insoluble. Hence the fruit does not taste astringent anymore and tastes sweets as it ripens.

B. Changes during cooking: Cooking results changes in colour, flavour, texture, taste, appearance and nutrients. The following changes are observed during cooking

- Starch undergoes gelatinization and thickening takes place due to high temp.
- Cooking results in extraction of pectin from the fruit tissue, which helps in gel formation. This is observed in the preparation of jam or jelly.

- Cooking makes the commodity soft, palatable and digestible. Cellulose present between the cell walls softens hence the fruit becomes soft e.g. cooked apple, guava, mango pieces.
- Loss of water and air results in shriveling of the fruits.
- While cooking, there is loss of vitamin C, therefore, fruits should be preferably eaten without cooking.
- Colour pigments of the fruits usually get oxidised, darkens and becomes dull due to cooking temp. Anthocyanins leaching in water which gives a bluish purple colour to the preparation due to oxidation e.g. addition of black grapes to apple jam, orange, marmalade, etc.
- Flavour of fruits enhances due to cooking but overcooking may result in loss of Flavour, therefore optimum cooking should be done.

Why raw fruits are green?

Vegetables

Vegetables are called protective foods as they are rich in vitamins and minerals.

Fig. 9.2 Vegetables

Definition: Vegetables are those plants or parts of plants that are served either raw or cooked as part of main course of meal.

9.1 B Classification and composition:

Classification of vegetables:

Vegetables are classified according to the part of the plants consumed

1. Green Leafy Vegetables (GLV) :

- Green Leafy Vegetables have a high water content.
- They are fresh and crispy.
- They are low in calories and proteins.

Examples : Spinach, fenugreek leaves, colocasia leaves, amaranth leaves, radish leaves, cabbage, celery, coriander, dill leaves (shepu), etc.

2. Roots, tuber and bulbs:

- These vegetables are rich in carbohydrates.
- They provide good amount of calories due to presence of carbohydrates (starch).
- They can be preserved for a longer time due to low moisture content.

Examples : Beetroot, carrot, colocasia, turnip, potato, sweet potato, yam, tapioca, onion, garlic.

3. Fruit vegetables:

- These vegetables have high amount of moisture and hence are highly perishable and tender.
- They are rich in fibre.

Examples : Cucumber, tomato, gourds, ladies finger, brinjal, pumpkin, capsicum, green chilli, raw jackfruit, drumstick, etc.

4. Seeds:

- Tender seeds of leguminous family are used as vegetables.
- The mature dry legumes are rich in protein as compared to the fresh seeds.

Examples : Peas, beans, tender legumes.

5. **Flowers, stem and shoots:**
   - These vegetables add variety in the diet.
   - These also provide a variety of vitamins and minerals especially when used in the raw forms as salads, *koshimbir or raitas*.

   Examples : Flowers - cauliflower, broccoli, drumstick flower, banana flower, stems and shoots – lotus stem, colocasia stem, etc.

Table 9.4 : Classification of vegetabes

Sr. No.	Parts of Plant	Examples
1.	Leaves	Spinach, fenugreek, colocassia amaranth, radish, cabbage, celery, coriander, shepu
2.	Roots, tubers and bulbs	Beetroot, carrot, colocasia, turnip, potatoes, sweet potato, yam, tapioca, onion and garlic
3.	Fruits	Cucumber, tomato, gourds, ladies finger, brinjal, pumpkin, capsicum, green chilli, raw jackfruits, drumstick.
4.	Seeds	Peas, beans, tender legumes
5.	Flowers, stem and shoots	Flowers - cauliflower, broccoli, drumstick flower, banana flower, stem and shoot- lotus stem, colocasia stem, etc.

Composition : Composition of vegetables are as follows and nutritive values are given in table 9.5.

1. **Water:** Most of the vegetables have a high water content. Vegetables remain fresh and crispy due to the presence of water, mostly greater than 75 %.

Do You Know ?

Broccoli is a very good source of protein.

2. **Protein:** Vegetables provide less protein. Seeds of leguminous family (peas and beans) are important source of protein in vegetarian diet.
3. **Carbohydrates:** Carbohydrates provided by vegetables are starch, pectin, fibre (celluless) and sugar in variable amounts. Roots and tubers contain a high amount of starch and as they mature, starch get converted into sugar. Vegetables fibres and pectin helps in digestion of food.
4. **Fats:** Vegetables have negligible amount of fat.
5. **Vitamins:** In green leafy vegetables vitamin A and vitamin C are abundant. Green leafy vegetables, yellow and orange coloured vegetables provide vitamin A in the form of beta-carotene. Vitamin C and beta-carotene content depends upon freshness of leaves.
6. **Minerals:** Vegetables provide good amount of minerals. Green leafy vegetables provide calcium and iron in sufficient quantity.

9.2B Importance and uses in diet:

- One of the best reasons for including vegetables in the diet is to ensure a natural ample source of vitamins, fibre and minerals.
- Vegetables are important protective foods and are highly beneficial for the maintenance of health and prevention of diseases.
- They contain valuable nutrients, which can be utilized for bodybuilding and repair.
- They add variety to the diet, increase palatability and prevent constipation due to their high fibre content.
- While cooking vegetables, their nutritive value should be preserved to the maximum level.

Table 9.5 Nutritive value of vegetables (Per 100 g edible portion)

Vegetables	Fibre (g)	Moisture (g)	Protein (g)	Fat (g)	Energy (KCal)	Calcium (mg)	Iron (mg)	Beta Carotene (µg)	Vitamin C (mg)
Leafy Vegetables									
Amaranth	1.0	85.7	4.0	0.5	45	397	3.49	5520	99
Coriander	1.2	86.3	3.3	0.6	44	184	1.42	6918	135
Colocasia	2.9	82.7	3.9	1.5	56	227	10.0	10278	12
Fenugreek	1.1	86.1	4.4	0.9	49	395	1.93	2340	52
Drumstick	0.9	75.9	6.7	1.7	92	440	0.85	6780	220
Lettuce	0.5	93.4	2.1	0.3	21	50	2.4	990	10
Radish	1.0	90.8	3.8	0.4	28	265	0.09	5295	81
Shephu	1.1	88.0	3.0	0.5	37	190	17.4	7182	--
Cabbage	0.6	91.9	1.8	0.1	27	39	0.80	120	124
Spinach	0.6	92.1	2.0	0.7	26	73	1.14	5580	28
Roots and Tubers									
Beetroot	0.9	87.7	1.7	0.1	43	18.3	1.19	--	10
Carrots	1.2	86.0	0.9	0.2	48	80	1.03	1890	3
Potato	0.4	74.7	1.6	0.1	97	10	0.48	24	17
Onion	0.4	86.6	1.2	0.1	50	46.9	0.60	--	11
Radish	0.8	94.4	0.7	0.1	17	35	0.4	3	15
Sweet Potato	0.8	68.5	1.2	0.3	120	46	0.21	6	24
Other Vegetables									
Brinjal	1.3	92.7	1.4	0.3	24	18	0.38	74	12
Cauliflower	1.2	90.8	2.6	0.4	30	33	1.23	30	56
Cluster beans	3.2	81.0	3.2	0.4	16	130	1.08	198	49
French Beans	1.8	91.4	1.7	0.1	26	50	0.61	132	24
Cucumber	0.4	96.3	0.4	0.1	13	10	0.60	--	07
Tomato	0.8	94.0	0.9	0.2	20	48	0.64	351	27
Pumpkin	0.7	92.6	1.4	0.1	25	10	0.44	50	02
Capsicum	1.0	92.4	1.3	0.3	24	10	0.57	427	137
Fresh Peas	4.0	72.9	7.2	0.1	93	20	1.5	83	09
Bottle Gourd	0.6	96.1	0.2	0.1	72	20	0.46	--	--
Bitter Gourd	0.8	92.4	1.6	0.2	25	20	0.61	126	88
Tinda	1.0	93.5	1.4	0.2	21	25	0.90	13	18
Ladies Finger	1.2	89.6	1.9	0.2	35	66	0.35	52	13

Source : Nutritive Value of Indian Foods, National Institute of Nutrition, (ICMR), Hyderabad.

Do You Know? Eating foods with carotenoid can lower the risk of cancer.

9.3B Colour pigments and flavouring compounds :

Classification of Pigments :

Vegetables, apart from their nutritive value are important for their bright colours. The colours results from the various pigments present in their tissues. These pigments are classified as following on the basis of colour and solubility

a) On the basis of colour :

Pigments are classified into three categories.

Chlorophyll - Green colour

Carotenoids - Yellow / orange colour.

Flavonoids i) Anthocyanin - Red purple

ii) Anthoxanthin - Yellow white

Do You Know ?

Colour is also used as a guide in quality control and harvesting maturity index.

b) On the basis of solubility :

The plant pigments are classified into two groups.

1) Fat soluble pigments – Chlorophyll and Carotenoid
2) Water soluble pigments – Flavonoids

Pigments in detail:

1) **Chlorophyll:** Chlorophyll is the green pigment present in plants. It enables the plants to synthesize carbohydrates by photosynthesis in the presence of sunlight and oxygen. Chlorophyll is mostly concentrated in green leaves, which give a green colour to leaves. Chlorophyll is insoluble in water and soluble in fat.

Effect of acid, alkali and heat on Chlorophyll:

Effect of acid: When vegetables are cooked in acidic medium like lemon or tomato, the green colour changes to the Olive green. Due to the action of acid, Chlorophyll changes to Pheophytin.

Chlorophyll (Green)	Acid / On heating →	Pheophytin (Dull olive green)

Effect of alkali: While cooking the green vegetables, if cooking soda (sodium bi carbonate) is used, green colour changes to bright green colour due to formation of Chlorophyllin and if excess soda is added the vegetables tends to be mushy in texture.

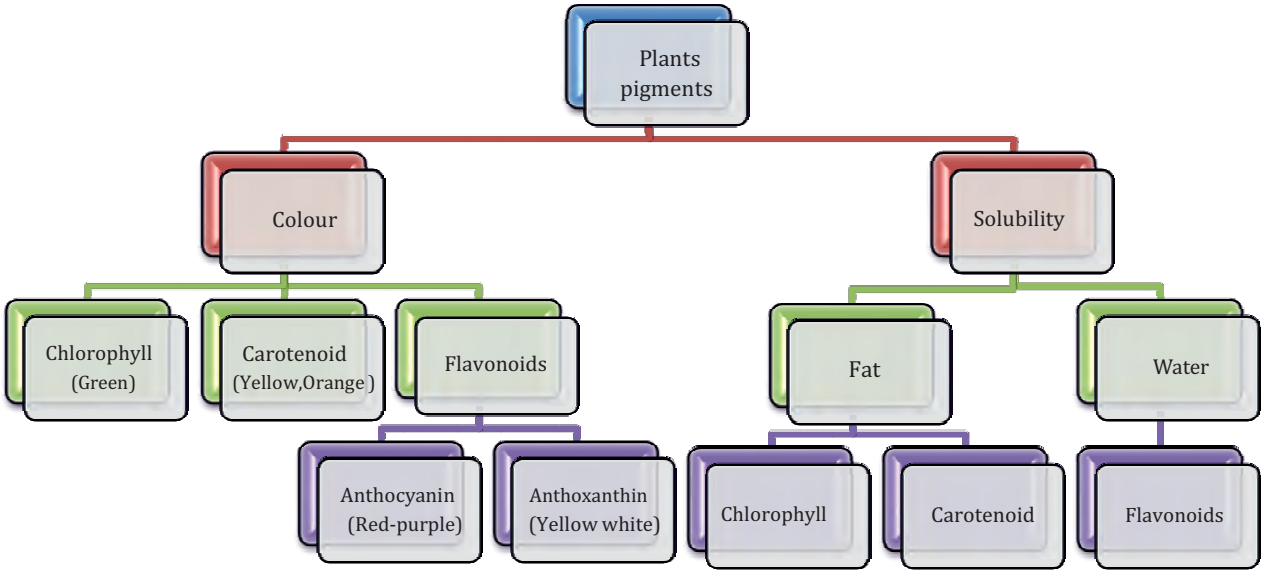


Fig. 9.3 Classification of plants Pigments

Chlorophyll (Green) —Soda, On heating→ Chlorophyllin (Bright green)

Effect of heat: Chlorophyll pigment is affected by heat. On heating, green colour becomes bright green. On further heating, acids are liberated and the colour changes to dull olive green.

Chlorophyll (Green) —on heating→ Bright green —On further heating→ Dull Olive Green

2) **Carotenoid:** Carotenoids include yellow, orange, and red orange pigments. They are fat-soluble pigments. The name carotenoid is derived from the pigment carotene, which is present in carrots. The red pigment in tomato called lycopene is included in carotenoids.

Effect of acid, alkali and heat on carotenoids :

Effect of acid and alkali The presence of acid and alkali have very little effect on the colour of carotenoid pigments.

Carotenoid (Yellow orange) —Acid and Alkali, On heating→ Very little effect

Effect of Heat: On excess heating, yellow orange colour changes to greyish orange.

Carotenoid (Yellow orange) —On heating→ Greyish Orange

3) **Flavonoids:** Flavonoids are water soluble pigments which include Anthocyanins and Anthoxanthins.

a) Anthocyanins :

Anthocyanins are red colour pigments, which are easily soluble in water. They are present in beetroot in the form of Betanin. It is highly water soluble so the colour is leached in the water. Therefore the vegetable should be cooked in the whole form with the skin.

Effect of acid, alkali and heat on Anthocyanin: In acidic medium colour changes to bright red.

Anthocyanin (Red) —Acid, On heating→ Bright Red

Effect of Alkali: In alkaline medium colour changes to bluish purple.

Anthocyanin (Red) —Alkali, On heating→ Bluish Purple

Effect of Heat: Heating has very little effect on Anthocyanin.

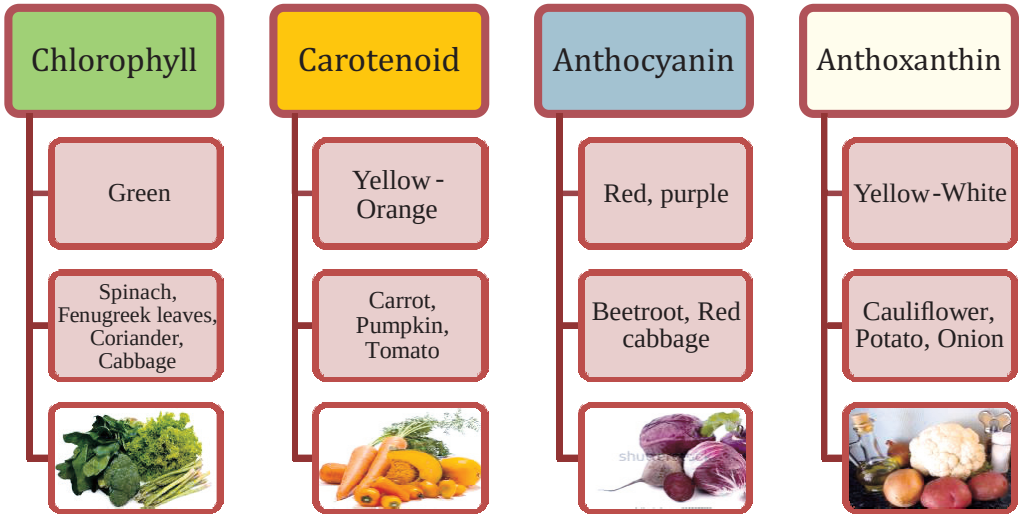


Fig. 9.4 Classification of pigments according to colour

Table 9.6 : Effect of Acid, Alkali and Prolonged heat on the colour pigments

Sr. No.	Name of the pigment	Solubility	Acid	Alkali	Prolonged heating
1.	Chlorophyll	Fat	Olive Green	Intense Green	Olive Green
2.	Carotenoid	Fat	Little Effect	Little Effect	Little Effect, may darken if excess
3.	Flavonoids				
a.	Anthocyanins	Water	Bright red	Purple or Blue	Little Effect
b.	Anthoxanthins	Water	White	Yellow	Darkens if excess

b) Anthoxanthins:

Anthoxanthins are water soluble and colourless pigments. They include two pigments i.e Flavones and Flavonols. These pigments are present in potatoes, onion, cauliflower and others.

Effect of acid, alkali and heat on Anthoxanthins :

Effect of acid: There is no change in colour in acidic medium and remains white in this medium.

Anthoxanthin (white) —Acid, On heating→ No change

Effect of alkali: In alkaline medium, colourless vegetables change to yellow colour.

Anthoxanthin (White) —Alkali, On heating→ Yellow

Effect of heat: There is no effect of heat on this pigment. If heating is excessive it darkens.

Tannins :

Some of the vegetables may become dark or brown when cut or exposed to air due to the presence of colourless phenolic substance called Tannin e.g. potato, brinjal, raw banana. Vegetables when exposed to air, convert tannin (colourless) to melanin (brown) with the help of enzyme phenolase in the presence of oxygen.

Tannin —Phenolase + O_2, Enzymatic Browning→ Melanin (Brown)

This change in colour is known as enzymatic Browning.

To prevent enzymatic browning:

- Vegetables like potatoes should be cooked in the whole form with the skin.
- Vegetables should be chopped and immediately dipped in water.
- Chopped vegetables should be cooked immediately.

Fig. 9.5 Browning Reaction

Flavouring Compunds

Vegetables have different characteristic flavours, which would add to the palatability of the food. Some of them have mild flavour and others have strong distinctive flavours. Carrots give sweet taste and flavour because of their

high sugar content. Spinach has a slightly bitter flavour. Similarly certain vegetables such as onion, cabbage, cauliflower and mustard leaves have strong flavours. The natural flavour of these vegetables may be due to the presence of many compounds such as sulphur compounds, volatile oils, aldehydes, alcohols, ketones, and organic acids. Each vegetable has its unique individual flavour as a result of mixture of many of these compounds in varying combinations and amounts.

Mild flavoured vegetables: The vegetables such as carrots, peas and potatoes are mild in flavour and will become strong with prolonged cooking**.** Even slight overcooking of mild vegetables may cause loss of flavour and nutrients. Cooking should bring out or enhance the flavour of vegetables. Improper methods or overcooking may result in loss of flavour or may develop an undesirable flavour.

Vegetables having strong flavour in the raw state: Vegetables like onions and garlic have strong flavour and tend to lose the strong flavour when they are cooked in water. When onions are peeled or cut, they produce certain volatile compounds, which irritate the eyes and cause their watering. This is due to the conversion of sulphur compounds to volatile sulphur compounds due to enzyme action in tissues. These vegetables may be cooked in such a way so as to retain desirable amount of flavour after cooking. If mild flavour is required, then the onions should be cooked in plenty of water, without covering the pan. If strong flavour is desired, then onions should be cooked in minimum amount of water in a covered pan.

Why do our eyes water while cutting onions?

Vegetables having mild flavour in the raw state: The vegetables like cabbage and radish have a mild flavour in the raw state and may develop a strong flavour when overcooked or improperly cooked. On cooking volatile sulphur compounds are formed which should escape in order to maintain the flavour. Hence, these vegetables should be cooked without a cover and must not be pressure cooked.

Why Cauliflower should not be pressure cooked or cooked without cover?

9.4 B Changes during cooking:

(a) Changes in nutrients, flavour and colour pigments:

Vegetables are cooked to soften the cellulose and to increase the digestibility of starch. Cooking may change the flavour of vegetables and make them more palatable.

➢ **Changes in nutrients :**

i) Changes in carbohydrates:

- Cellulose absorbs water and becomes soft on cooking.
- Presence of acidic medium toughens cellulose whereas cooking soda softens it.
- On application of moist heat, starch present in vegetables undergoes partial or complete gelatinization.
- On application of dry heat or frying, dextrinization takes place as seen in potatoes, which are deep fried.

ii) Changes in Proteins:

- Though vegetables are not rich source of proteins, whatever little protein is present it undergoes coagulation.

iii) Changes in vitamins: Loss of vitamins may take place due to the following reasons.

- **Exposure to heat**: Many vitamins such as Vitamin C and thiamine are susceptible to heat so cooking destroy these vitamins to some extent.
- **Oxidation**: Vitamin C rich vegetables

when cut and exposed to air undergoes oxidation, hence these vegetables should not be cut and kept for a longer period.

- **Due to solubility in water**: Vegetables, rich in water soluble vitamins are cooked in water, may lose vitamin significantly.
- **Use of cooking soda:** Results in loss of B complex vitamins.

iv) Changes in water content:

- If moist heat method of cooking is used, water is absorbed by the vegetables.
- Dry heat methods like baking result in dryness due to loss of water to some extent.
- In high moisture vegetables like tomatoes, leafy vegetables, water is released from the cells due to cell breakdown.

➢ **Changes in flavour:** Change in flavour of vegetables may occur during cooking depending on the types of vegetables used.

➢ **Changes in colour pigments:** Table 9.6 shows effect of various factors on the colour pigments during cooking.

Why vegetables are important?

Vegetables are good sources of

- Carbohydrates
- Protein
- Vitamins
- Minerals
- Fat (little amount)
- Water

Fig. 9.6 Importance of Vegetables

(b) Ways to minimize quantitative and qualitative losses during cooking of vegetables:

While cooking vegetables the main objective is to minimize losses of natural flavours, colours and nutrients so that their quality as well as the nutritive value can be maintained. Following are the ways to minimize losses while cooking vegetables:

1. Wash the vegetables thoroughly before peeling and cutting.
2. Peel the vegetables as thinly as possible to preserve the nutrients present under the skin.
3. In order to avoid nutrient losses, do not finely chop the vegetables.
4. Raw vegetables can be used in the form of salads, *raitas* to add colour, texture to the meal and also to prevent the loss of nutrient during cooking.
5. Salads should be prepared just before serving.
6. Acid foods such as lime juice, tomato, vinegar and curd can be used as salad dressings to prevent browning and prevent loss of vitamin C from the vegetables.
7. Vegetables should be cooked in just enough liquid.
8. Cut vegetables should be added to the boiling water to reduce the cooking time.
9. All vegetables except strong flavoured vegetables should be cooked in a closed pan to minimize the nutrient losses.
10. Development of strong flavour of sulphur containing vegetables and discolouration of green leafy vegetables can be prevented if they are left uncovered for few minutes of cooking.
11. Vegetables should be cooked until just done and should not be overcooked.
12. Avoid contact with acid foods like lime juice, tomatoes for green leafy vegetables and alkaline substances such as soda for red vegetables to preserve the natural colour of the vegetables.

13. Do not use soda to retain the green colour of leafy vegetables as it results in loss of vitamin C and B complex vitamins and makes the vegetables mushy.
14. Cook roots and tubers like potato, sweet potato and beetroot with the skin to retain the colour, flavour and nutrients.
15. Do not discard the cooking water if vegetables are properly washed as it can be used for soups or gravies.

Do

Wash vegetables before cutting.

Don't

Cutting the vegetables before washing results in loss of vitamins.

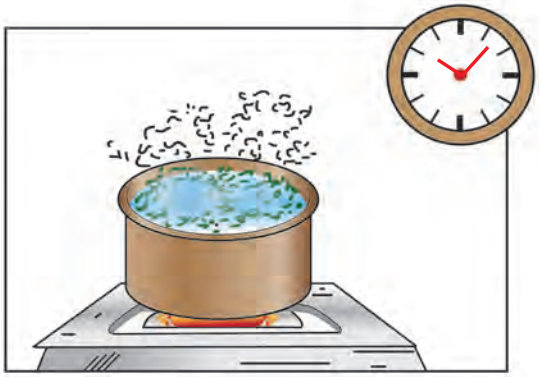
Use a sharp knife.

Use of blunt knife results in loss of vitamins.

Use hot water.

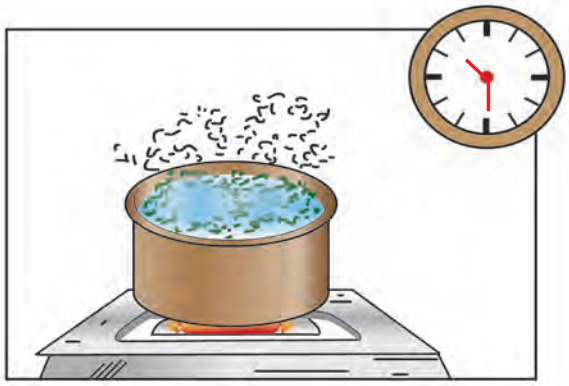
Use of cold water increases cooking time.

Do

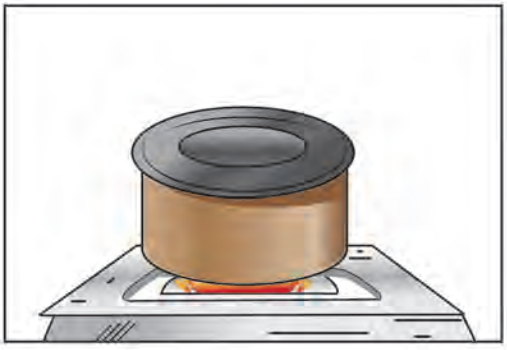


Use correct temperature and time for cooking.

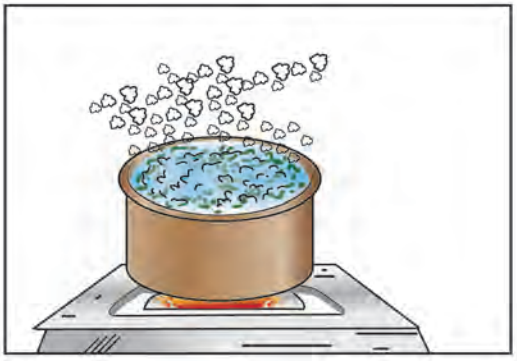
Don't



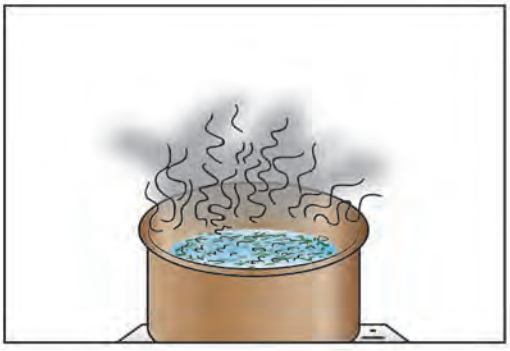
Over cooking.



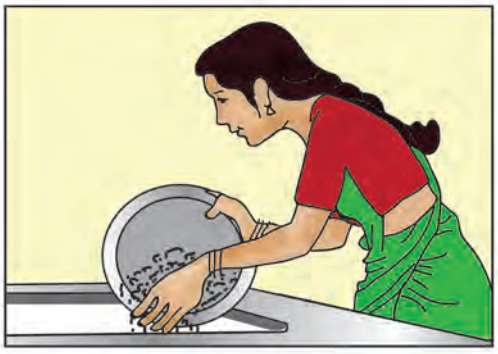
Cover and cook.



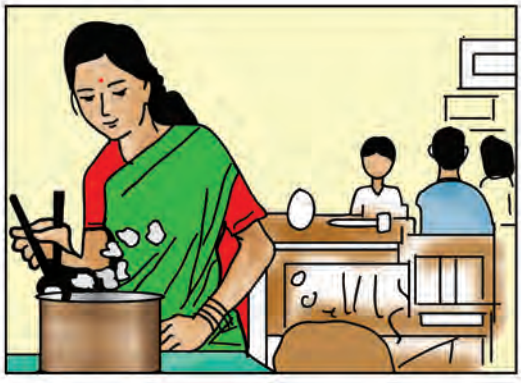
Uncovered cooking.



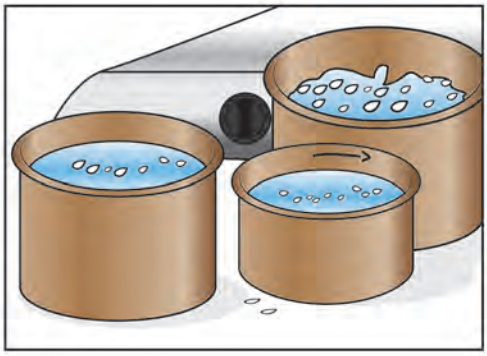
Use just enough water.



Discarding the left over water.



Cook food just before serving.



Bulk cooking.

Points to remember

For Fruits

- Fruits can be classified on the basis of shape, cell structure, type of seed, or natural habitat.
- Fruits are good source of water, carbohydrates, fibre vitamins and minerals
- They contain colour pigments such as chlorophylls, carotenoids and flavonoids.
- Fruits contain flavor compounds such as organic acids, sugars, tannins, minerals salts and essential oils.
- During ripening, fruits undergo changes in colour, texture, flavour and taste.
- Some fruits turn brown when cut and exposed to air. This can be prevented by addition of acid, sugar or cream to the fruits.
- Cooking results in changes in colour, flavor, appearance and nutrients present in fruits.

For Vegetables:

- Vegetables are different parts of the plants that are used as food either in raw or cooked form.
- Vegetables are classified on the basis of the part of the plant used.
- The dark green leafy vegetables have high water content and are rich sources of beta carotene, vitamin C, iron, calcium and fibre.
- The roots and tuber vegetables mainly provide calories due to their starch content and have a small amounts of vitamins and minerals except carrots, which are an excellent source of beta carotene
- Other vegetables have small amount of vitamins, minerals and fibre.
- The colour of vegetables is due to the presence of various colour pigments namely chlorophyll, carotenoids and flavonoids
- Vegetables such as potato turn brown when cut and exposed to air due to enzymatic browning
- Selection of cooking method is important to retain the colour, flavour and nutrients of vegetables.
- Consumption of raw vegetables in the form of salads is advisable to minimize the loss of nutrients.

Exercise

Q.1 (a) Select the most appropriate option:

i. Overripe fruits contain pectic substances in the form of _____
(Pectic acid, Protopectin, Pectin)

ii. Loss of water and air results in _____ of fruits.
(Expansion, shriveling, remain same)

iii. Citrus fruits contain vitamin _____
(A, C, D)

iv. Black grapes contain _____ Pigment.
(Chlorophyll, Carotenoids, Anthocyanin)

v. Chlorophyll is _____ pigment present in plant.
(Green, Red, Brown)

vi. _____ are fat soluble pigments.
(Anthocyanins, Carotenoids, Anthoxanthins)

vii. The green leafy vegetable are a good source of_____
(Vitamin A, Vitamin E , Vitamin K)

viii. _____ enzyme causes browning of vegetables
(Phenolase, Melanin and Rennin)

ix. Roots and tubers are rich in _____
(Starch, Vitamins, Iron)

x. Anthoxanthins are water soluble and _____ pigments.
(Colourless, Odourless, Tasteless)

(b) Match the following:

A	B
i. Chlorophyll	a. Indian Gooseberry (Amla)
ii. Fruit Juices	b. Raw mango
iii. Vitamin C	c. Ripe Jamun
iv. Anthocyanin	d. Ripe Mango
v. Carotenoid	e. Non Reactive Containers
vi. Flavouring Compound	f. Anthoxanthin
	g. Essential oil

ii. Match the following:

A	B
i. Red Cabbage	a. Anthoxanthin
ii. Spinach	b. Vitamin C
iii. Lemon	c. Strong flavoured
iv. Radish	d. Vitamin A
v. Garlic	e. Anthocyanin
vi. Carrots	f. Carotenoid
	g. Onion

(c) State whether the following statements are true or false:

i. Banana is an excellent source of Vitamin C.

ii. Dry fruits are rich sources of minerals.

iii. Fruit juices should be stored in aluminium container.

iv. Orange and Papaya contains Vitamin A.

v. Chop the vegetables before washing.

vi. Salads should be prepared just before serving.

vii. Addition of soda to vegetables while cooking increases vitamin B content.

viii. Cooking water should be discarded.

ix. Cook vegetables in just enough water.

Q.2 Name the following :

i. Pigment present in black grapes

ii. Flavour compound in fruits

iii. Pigment present in carrot

iv. Pigment present in green leafy vegetables

v. A flavouring compound in vegetable

vi. Compound formed when green leafy vegetable are cooked with acid

vii. The pigment present in cauliflower.

viii. Browning reaction in fruits and vegetables

Q.3 Short answer questions

(a) Write short notes on the following

i. Chlorophyll in fruits

ii. Ways to retain colour pigment and flavor in fruits

iii. Importance of fruits in diet

iv. Changes during cooking of fruits

v. Carotenoids

vi. Flavonoids

vii. Changes during cooking of vegetables

viii. Tannins

(b) Give reasons

i. Fruits become soft on ripening

ii. Raw Amla (Indian Gooseberry) is astringent

iii. Fruits when cut turn brown

iv. Sweetness increases on ripening of fruits

v. Cauliflower should not be pressure cooked

vi. Sweet potatoes should be cooked with skin

vii. When onions are cut the eyes start watering

viii. Soda should not be used while cooking green vegetables

Q.4 Long answer questions

i. Explain in detail the changes taking place during ripening of fruits.

ii. Name the colour pigments present in fruits and explain the effect of acid or alkali on the pigments.

iii. Explain in details the precautions to be taken to avoid quantitative and qualitative losses during and before cooking the vegetables.

iv. Name the colour pigments present in vegetables and write the changes during cooking.

❖ Project:

i. Select five recipes using fresh fruits and five recipes of preserved fruit products and prepare an attractive booklet.

ii. Select three recipes for each colour pigment. Prepare an attractive booklet of these recipes.

10 Cereals, Pulses and Oilseeds

Contents at a glance

Cereals

Cereals are a rich source of starch and are obtained mainly from seeds of grass family. Cereals are classified into two groups namely Major (fine) and Minor (coarse) cereals (Table 10.1).

Table 10.1 Classification of Cereals

Major Cereals		Minor Cereals	
English name	**Common name**	**English name**	**Common name**
Wheat	Gahu	Pearl Millet	Bajra
Rice	Tandul, Chawal	Sorghum	Jawar
Maize	Maka	Finger Millets	Ragi
		Barley	Jav

Note : Coarse cereals are also known as millets.

Cereals are major staple food in Indian diet. These are relatively inexpensive and are cheapest source of energy. Cereals especially millets are easy to grow and have a high keeping quality and satiety values. Cereals are mainly used as flours and a wide variety of cereals are processed into breakfast foods and ready to eat snacks.

Do You Know ?

The word cereal is derived from the Greek Word "Ceres" which means goddess of Agriculture.

CERES

- Roman name : Ceres
- Greek name : Demeter
- Domain : Goddess of grain, fertility
- Symbols : Torch, corn, wheat

Fig. 10.1 Greek Goddess of Agriculture

10.1 Composition and nutritional values of cereals:

Carbohydrate: Cereals contains 65 to 75% of carbohydrate, therefore, it is an important source of energy. 100 g of cereals approximately provide 350 calories energy. This energy is mainly supplied from starch. Carbohydrates are present in cereals in the form of crude fibre and soluble carbohydrates (Sugar).

Protein: Cereals provide 6 to 12% proteins. Oats contains 24% proteins. Since cereal is a staple diet in India, it contributes substantial amount of proteins in the diet.

Fat: Fat content of cereals is quite low (1 to 5%)

Minerals: Cereals contains 2% minerals. The important minerals present are iron, phosphorous and calcium.

Vitamins: Whole grains provide B-Complex vitamins especially thiamine, riboflavin, and Niacin.

Water: Cereal grains are mature seeds, which are dehydrated, therefore have a low moisture content of 10 – 12% , hence have a longer shelf life.

Table 10.2 Nutritive values of cereals and cereals products

Name	Energy KJ	Moisture %	Carbohydrate (g)	Protein g	Fat (g)	Fibre (g)
Rice raw milled	1491	9.93	78.24	7.94	0.52	2.81
Rice Parboiled milled	1471	10.09	77.16	7.81	0.55	3.74
Rice Flakes	1480	10.36	76.7	7.44	1.14	3.46
Rice Puffed	1514	9.40	77.68	7.47	1.62	2.56
Wheat, whole	1347	10.58	64.72	10.59	1.47	11.23
Wheat flour Atta	1340	11.10	64.17	10.57	1.53	11.36
Wheat flour (Refined)	1472	11.34	74.27	10.36	0.76	2.76
Jawar	1398	9.01	67.68	9.97	1.73	10.22
Bajra	1456	8.97	61.78	10.96	5.43	11.49
Ragi	1342	10.89	66.82	7.16	1.92	11.18
Maize, dry	1398	9.26	64.77	8.80	3.77	12.24

Source: Indian Food Composition Tables, National Institute of Nutrition (ICMR) Hyderabad

10.2 Value added products from cereals:

In our diet, cereal grains may be added in the whole form in certain preparations like *pulao*. The grains may be processed to prepare various cereal products like wheat flour, puffed rice, cornflakes, noodles and others, which give variety to our diets. The various cereal products are as follows :

Wheat :

Wheat products: Wheat is one of the most commonly cultivated cereals in the world. We use most of the wheat in the form of flour to make *chapati, puri and paratha*. Wheat is process into various products by the process of milling.

Do You Know ?

The nutritive value of the product decreases as the extent of milling increases.

Whole Wheat: Whole grains are either soaked or germinated and added to preparations such as nutri-bhel, porridge and salads. However, the use is very limited. Nowadays whole puffed wheat is used in *chivda* and other such products.

Broken Wheat (Dalia): Whole wheat undergoes milling to get dalia. This is generally used in porridge and *khichadi*.

Semolina (Rawa): Coarse rawa and fine rawa are used in various preparations like *sheera*, *upama* and *laddu*.

Whole wheat flour (Atta): This is the most widely used wheat product to prepare *chapatti, phulka, puri and paratha*.

Refined Wheat Flour (Maida): This is white in colour and has a bland flavor. Maida is mainly used in fancy preparation such as bread, cake, biscuits, *shankarpali*, *bhatura*, covering of *samosa* and *karanji*.

Pasta Products: Pasta is a universally enjoyed food all over the world. Hard variety of wheat is used to prepare these products, which include macaroni, spaghetti, noodles and other similar products.

The main steps of pasta production are:

i. **Selection of raw material:** It is usually made from Durum wheat or flour of other grains and cereals.

ii. **Dough Mixing**: Flour is mixed with water. It is important that water is evenly distributed into the dough, to be well absorbed by starch granules and allow gluten net formation, which will give structure of pasta. During dough mixing, following points should be kept in mind:

   a) Amount of water

   b) Temperature of water

iii. **Dough Extrusion:** The dough is transferred into a cylinder, the lower end of which is fitted with special disc with different shaped openings like round, star, shell, spiral and bow. These give a desirable size and shape to the products. The dough is forced through the openings by applying high pressure, so that the product obtained is in various shapes according to the disc used. Cutting blades cut the different shaped strands to desired length.

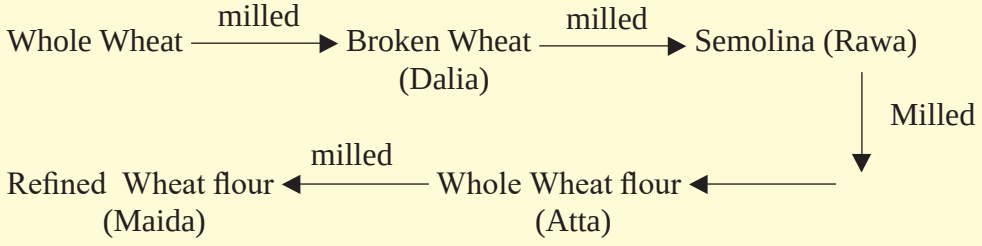


Fig. 10.2 : Wheat and its products formed during milling

iv. **Drying:** It is a crucial part of the process for production of high quality pasta products.

v. **Packaging:** After drying, pasta is cooled, cut and packed in sutaible packaging material.

Fig. 10.3a : Pasta making machine (Extrusion of Pasta)

Fig. 13.3 b Steps in pasta production

Do You Know ?

Pasta is a staple Italian food.

According to the length and shape pasta products are named as follows:

i. Macaroni: Usually in shell and tube form.

ii. Lasagna: Flat strips, about 2 - 3 inch wide.

iii. Spaghetti: Thin round strands, tube or rod shaped

iv. Fettucine: Flat strips, about 1/4 inch wide.

iv. Vermicelli: Traditional Indian product (Thin, round and string type). Made in same way as pasta. It may be hand made or machine made. It is used for making *kheer, sheera* and *upma*.

Spaghetti Lasagna Macaroni Fettuccine

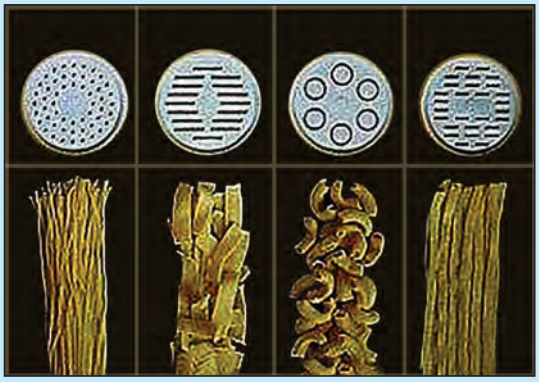


Fig. 10.4 : Pasta products

Lets Discuss: What is a Die in Pasta production?

Die is a mould or shape through which pasta dough is passed and gets converted into the desired shape of die.

Fig. 10.5 Types of die (mould or shape)

Rice :

Rice is the second most common cereal consumed in India. Many varieties of rice are produced throughout the world. In broad terms, they are classified into fine, medium and coarse.

Rice is marketed in different forms like brown rice, unpolished rice, polished rice, parboiled rice, flaked rice and puffed rice. Rice has to undergo certain processing like 'Milling' to obtain these different forms.

Rice Products:

Brown Rice: Brown rice are fed into stone or rubber disc to remove the husk. This rice is brown in colour, has high fibre content, therefore taking a longer time to cook. Shelf life of brown rice is low.

Unpolished Rice: Rice is milled to certain extent, however polishing is not done. It is whitish but has a dull appearance. These grains are prone to insect infestation.

Polished Rice: During milling, grains are passed through a brush machine and polished. They are later coated with sugar and talc, making them white and bright. Polished rice is most commonly used rice because of its appearance and typical flavour according to its variety e.g basmati rice.

Parboiled rice: Paddy (rice with its outer bran) is soaked in water for a few hours. Then it is steamed for a few minutes and dried. Parboiled rice has a better nutritive value compared to normal rice. Its cooking time is less as it is partially boiled and starch is partially gelatinized. It has a typical flavour and is suitable for fermented products like idli, dosa etc.

Puffed Rice: Dry paddy is soaked in hot water for 2-3 minutes. The water is drained off and grains are roasted. Due to heat, water is converted to steam resulting in puffing of the grain. Puffed rice is very light and easy to digest. It can be eaten without any cooking as in bhel or is added to certain preparations like *chivda* and puffed rice *laddu*.

Flaked Rice: Paddy is soaked in water for 2-3 days, followed by boiling and draining the water. The grains are heated and passed through rollers to flatten them. Flaked rice is rich in B-Complex vitamin and iron. It requires minimal or no cooking, and is light and easy to digest.

Instant cereal mixes

Some cereals and millets are pre-gelatinised and dehydrated. Other ingredients like vegetables, spices, preservatives, enzymes, acids and leavening, colouring and flavouring agents are added to prepare instant mixes e.g. instant pulao mix, pudding mix, idli mix, upma mix and many others. The major advantage is that the cooking time is very less as compared to normal cooking. However they are more expensive.

Variety of instant breakfast cereals are nowadays available in the market. Some of these cereal products like oat flakes are ready to cook breakfast cereals which require less cooking time. Other cereal products like cornflakes, wheat flakes are ready to eat breakfast cereals, which do not require cooking. In these breakfast cereals, other ingredients like sugar, honey, dry fruits, chocolate, fruit puree may be added to bring variety and make it more nutritious.

Fig. 10.6 a. Masala oats

Fig. 10.6 b Instant Cereal Mix

10.3 Principles involved in cereals cookery:

The major nutrient present in cereals is starch hence cereal cookery is mainly starch cookery. The principles involved in cereal cookery are as follows :

(a) Effect of dry heat on starch- Dextrinization :

Dextrinization: We are all familiar with the characteristic aroma and change in colour of rawa when it is roasted for preparation of *sheera* or *upma*. These changes are due to the breakdown of starch in rawa, into another polysaccharide called Dextrin.

Definition: Dextrinisation is a process, in which on application of dry heat, some starch granules break down into dextrin, a brown colour, a typical flavor and a slightly sweet taste develops e. g. *chapati*, toast, *sheera, upma*

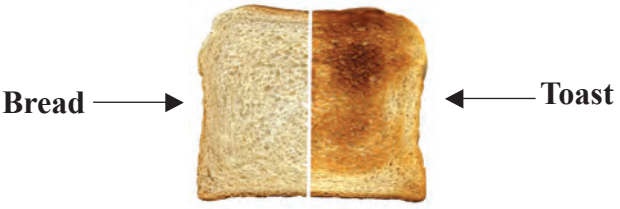


Fig. 10.7 Dextrinisation in toasting of bread

(b) Effect of moist heat on starch- Gelatinization :

Gelatinization: When water is added to rice, rice flour, corn flour and cooked to prepare dishes like boiled rice, steamed modak and custard, thickening takes place. This thickening is due to starch present in these foods.

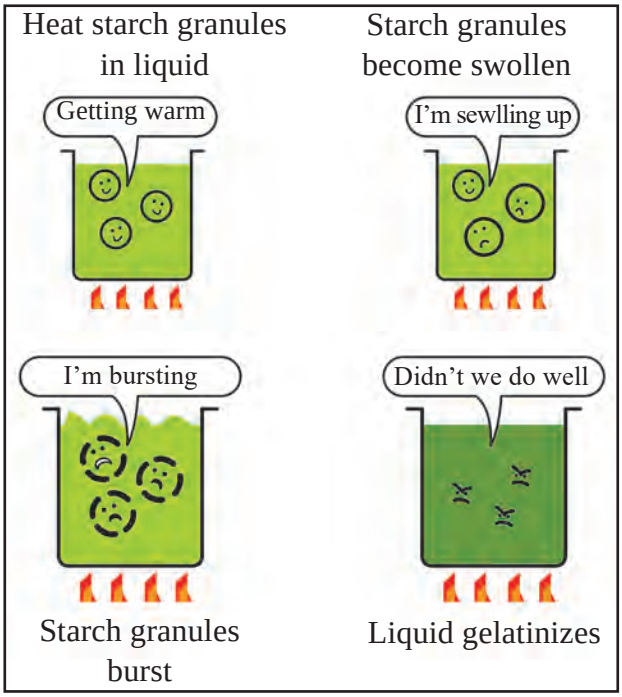


Fig. 10.8 Gelatinization process

Definition: Gelatinization is a process, by which, starch granules, when heated in water, absorb water and swell up making the solution thick and translucent.

(c) Identity of grain : In many cereal preparations like *pulao, biryani, upma, sheera,* the palatability is more if the cereal grains or particles do not stick to one another and remain separate. This is called maintaining of identity of grain.

(d) Gluten formation: Wheat protein has two important constituents namely **glutenin** and **gliadin.** When water is added to wheat flour, kneaded and manipulated, Glutenin and Gliadin form a three dimensional network called the **gluten network.**

This mesh like network holds starch granules, air bubbles and water. A properly developed gluten in a dough makes the dough elastic and springy and easy to handle. The dough is able to retain gases and expand when heat is applied. Chapatis prepared from dough where gluten is well formed puffs up easily and remain soft. Gluten formation is desired in products such as *chapatis* and bread and is minimized in *puris, karanji* etc.

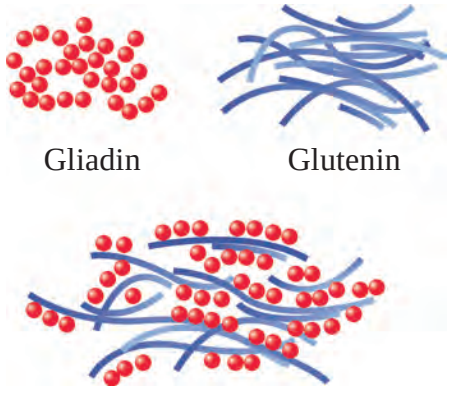


Fig. 10.9 Gluten formation

Can you tell?

Why chapatis swell and puff up on heating?

(e) Fermentation: Fermentation refers to breakdown of carbohydrates, under aerobic and anaerobic conditions. Some common fermented products made from cereals are *idli, dosa dhokla* and bread.

Activity:

Aim: Preparation of Dosa batter.

Materials needed: 1cup-black gram dal, 2 cups- rice, 4-5 fenugreek seeds.

Method:

1. Wash and soak the dal and rice separately for 6-8 hours or overnight.
2. Add fenugreek seeds to rice
3. Now grind the rice and dal and mix them together.
4. Keep them for 6-16 hours to ferment at a tempearture of about 25 - 30^0 C

Observations :

The batter becomes light and fluffy and a sour flavor and taste develops.

Conclusion: These changes are due to fermentation. The batter is ready to use.

Fig. 10.10 Steps of Fermentation

Fermentation results in the following Physical and chemical changes in the batter:

- Multiplication of micro-organisms
- Increase in acidity
- Development of sour flavour and taste
- Production of carbon-dioxide gas
- Increase in volume of batter

Uses:

Process of fermentation is used to prepare some baked products like bread, pizza base, buns and doughnuts. This process is also used to prepare *bhatura, idli, dosa, jalebi* and other such products

Advantages:

1. It improves the texture and flavour of the products.
2. Increases vitamin C and vitamin B complex
3. Easy to digest.

Pulses :

Pulses are edible fruits or seeds of leguminous plants. Pulses are the cheapest and rich source of protein, which can be considered as a lifeline for the vast vegetarian population of India. Apart from being the good source of protein, pulses also contain substantial quantity of minerals, vitamins, fibre etc. Amino acid composition of pulses is complementary to that of cereals. Mixed diet of cereals and pulses, which form staple balanced diet to majority of Indian population. It gives superior biological value than either taken separately.

Fig. 10.11 Name of the Pulses (English Name and Common Name)

India is the largest producer of pulses in the world. The common pulses grown in country are chickpea or bengal gram, pigeon pea or red gram, black gram, green gram, lentil, moth bean, horse gram, kidney beans and lathyrus, etc.

10.4 Composition and nutritional values of pulses:

The composition of pulses depends on the species. Generally protien content of the pulses are almost high as compared to cereals.

Protein: Usually pulses contains about 20% of the dry weight of the seeds. Some legumes contain upto the 40% of the protien e.g. soybean.

Carbohydrates: Food pulses contain about 55-60% of total carbohydrates including starch, soluble sugar and fibre etc.

Lipids: Generally pulses contain about 1.5% of lipids except groundnut and soybean etc.

Minerals: Pulses are important source of calcium, phosphorous, zinc, iron and potassium.

Vitamins: Pulses are fairly rich in niacin, thiamine, folic acid, pantothenic acid and vitamin C (germinated). They are poor in riboflavin and caroten (Provitamin-A), and dry legumes are almost devoid of ascorbic acid.

10.5 Processing of legumes and pulses:

a. **Decortication –** The removal of seed coat is known as decortications. A number of methods are available for decortications. A simple method is to soak the seeds for short time, the husk takes up more water than the seeds and may be easily separated by rubbing while still moist. The soaked grains may be dried and the husk removed by pounding and winnowing. Roasting is also another method of separating husk from seed.

Advantages:

1. Increases digestibility.
2. Helps in removing anti-nutritional factors.
3. Improves appearance, texture, cooking quality and palatability.
4. Reduces cooking time.

Red Gram Dal

Bengal Gram Dal

Fig. 10.12 Types of dal

b. **Soaking -** Soaking in water is the first step in most methods of preparing pulses for consumption. The pulses absorb water and increase in size during cooking. Some water soluble nutrients will leach out into the water. This water can be used in cooking to minimize these losses.

Advantages:

Soaking makes pulse tender due to water absorption. It reduces cooking time.

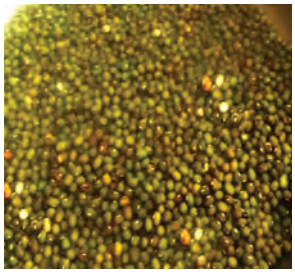


Fig. 10.13 Soaking of pulses

c. **Germination –** Whole legumes are soaked in water for about 6-8 hours. The excess water is drained and grains are wrapped in a wet muslin cloth or placed in a basket and covered and allowed to germinate for 12 hours or more.

Table 10.3 Nutritive value of Pulses (per 100 gm)

Sr.No	Foods	Protein (g)	Fat (g)	Carbohydrates (g)	Energy (Kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
1	Bengal Gram (Whole) Harbara	17.1	5.3	60.9	360	202	312	4.6
2	Bengal Gram Dhal (Harbara dal)	20.8	5.6	59.8	372	56	331	5.3
3	Bengal Gram, roasted (Phutana)	22.5	5.2	58.1	369	58	340	9.5
4	Black Gram, dhal (Uddachi dal)	24.0	1.4	59.6	347	154	385	3.8
5	Cow PEA (Chavli)	24.1	1.0	54.5	323	77	414	8.6
6	Field Bean, dry (Papta)	24.9	0.8	60.1	347	60	433	2.7
7	Green Gram, whole (Mug)	24.0	1.3	56.7	334	124	326	4.4
8	Green Gram, dhal (Mug dal)	24.5	1.2	59.9	348	75	405	3.9
9	Horse Gram, whole (Kuleeth)	22.0	0.5	57.2	321	287	311	6.77
10	Khesari, dhal (Lakh dal)	28.2	0.6	56.6	345	90	317	6.3
11	Lentil (Masur dal)	25.1	0.7	59.0	343	69	293	7.58
12	Moth Beans (Matki)	23.6	1.1	56.5	330	202	230	9.5
13	Peas green (Vatana)	7.2	0.1	15.9	93	20	139	1.5
14	Peas dry	19.7	1.1	56.5	315	75	298	7.05
15	Peas roasted	22.9	1.4	58.8	340	81	345	6.4
16	Rajma (Shravangheveda)	22.9	1.3	60.6	346	260	410	5.1
17	Red gram, dhal (Turdal)	22.3	1.7	57.6	335	73	304	2.7
18	Redgram (tender)	9.8	1.0	16.9	116	57	164	1.1
19	Soyabean	43.2	19.5	20.9	432	240	690	10.4

Source : Nutritive Value of Indian Foods, National Institute of Nutrition, (ICMR), Hyderabad.

Water is sprinkled twice or thrice a day, because humidity and warmth are essential for germination. The most popular preparation made from germinated legumes is *usal*.

Advantages:

1. It reduces cooking time.
2. Starches and proteins are converted to simpler substances, thereby improving the digestibility and availability of nutrients.
3. Vitamin B complex and vitamin C content increases.
4. Germinated pulses add variety to diet.
5. Germination imparts sweet taste and soft texture, hence the sprouted legumes like green gram can be consumed raw or slightly cooked.
6. It does not produce gas or flatulence.

Disadvantages:

1. The nutrients loss may take place if the water in which the pulses are soaked is not used.
2. Over sprouting may result in the development of unpleasant flavour or taste.

Fig. 10.14 Sprouted Legumes

d. Fermentation – Soybean is the important example of fermentable pulses. Some fermented products of soybean are soya sauce, soybean paste, tempeh and natto.

Fig. 10.15 Tempeh

Advantages:

1. Increases in vitamin C and vitamin B Complex.
2. It improves the texture and flavour of the products.
3. Increases the digestibility, palatability and nutritional value of the product.
4. Toxic substances can be eliminated by fermentation.
5. It also imparts specific aroma and taste to the product.
6. It makes the product light and fluffy.

Disadvantages:

1. Store-bought items lose beneficial bacteria.

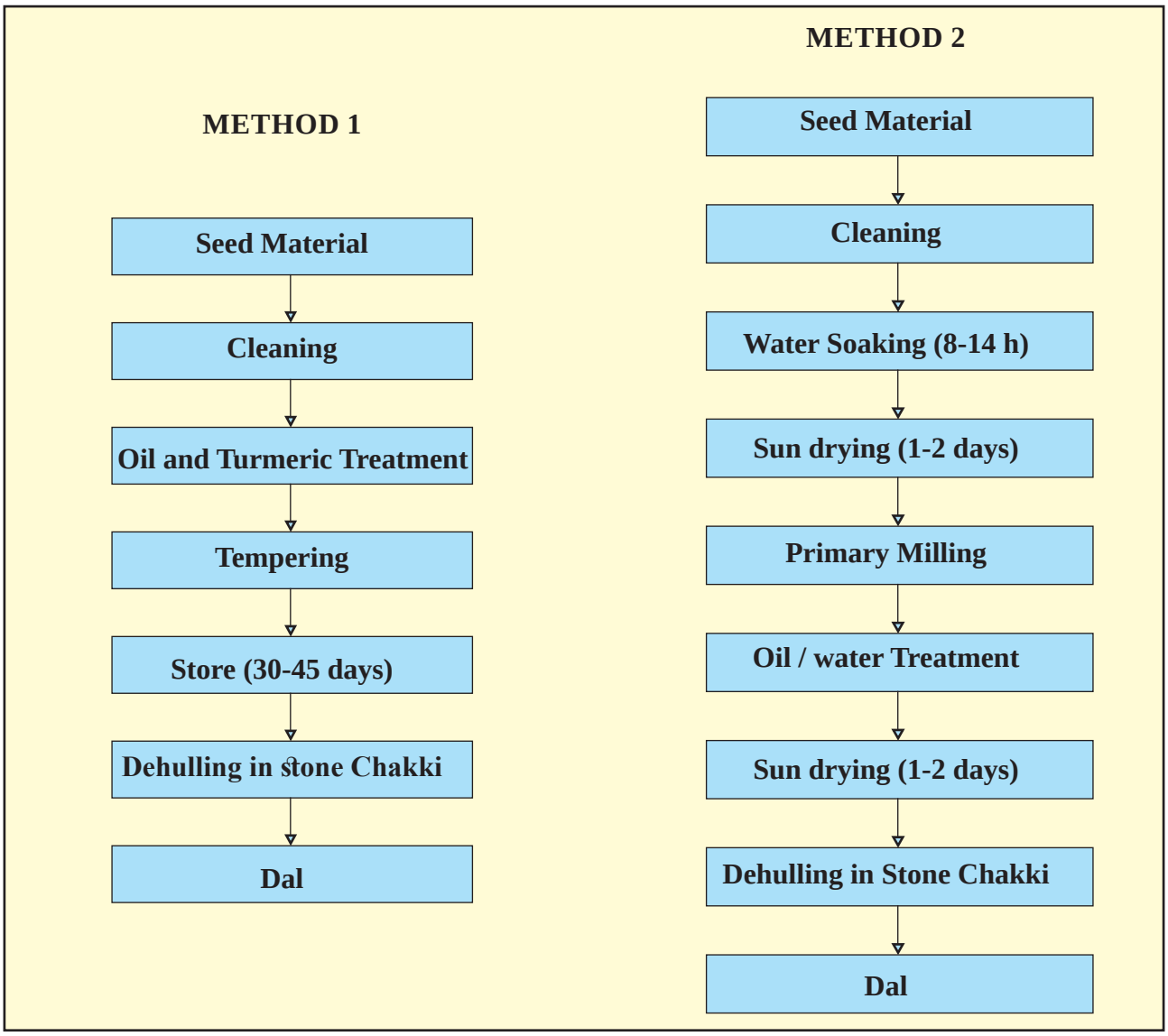
10.6 Use of pulses in cookery:

a. Thickening: Thickening agents give body, consistency and palatability when used. Pulses are used as thickening agent and prevent curdling e.g. bengal gram flour in *kadhi*, *pithala* and vegetable curries.

Fig. 10.16 Pithala (Thickening agent)

b. Binding: Binding agents are used to form a mixture of ingredients into a cohesive mass. They are used in desserts, potato and *mirchi bhajiya*. Bengal gram flour is used in preparation of leafy vegetables e.g. *sambharvadi*.

Fig. 10.17 Sambharvadi (Binding)



Source : Indian Institute of Pulses Research, Kanpur

Fig. 10.18 : Dal making process developed by Andhra Pradesh and Maharashtra (Method 1) and Madhya Pradesh and Maharashtra (Method 2)

c. **Coating:** It helps to give a coating to the food items and prevent them from disintegrating. Bengal gram flour is used in preparation of fried groundnut snacks, fried fish, *potato wada, Paneer Pakoda,* Mushroom *Pakoda and cutlets.*

Fig. 10.19a. Fried Fish

Fig. 10. 19 b. Bhajiya

d. **Flavour Dispersion –** Pulses improve flavor and consistency of dal. Some amount of dal is added in *masala powders*, which helps in uniform dispersion of flavour in the preparation like *sambhar*.

Fig. 10.20 Sambhar

e. **Garnishing –** Sev is prepared from besan which is used for garnishing *pani puri*, *pohe*, *upama*, *sevpuri* and *misal*.

Fig. 10.21 (a) Garnishing of panipuri

Fig. 10.21 (b) Garnishing of Shevpuri

ACTIVITY – 1

Aim: - To find out the effect of suitable condition on seeds

Materials needed:- Jars, wet paper towel or cotton, seeds ,water

Method:-

1. To start, fill a jar with wet paper towels.
2. Make sure to wring out the paper towels so there is no excess water in the jar.
3. Then place seeds in the jar, near the bottom half of the jar.

Observations:- Check the seedlings for their germ length and determine the germination time. For further experiments you can compare germination characteristics for different seeds types.

Conclusion:- Germination is a process, which not only reduce cooking time but increases the nutritive value, appearance and texture.

10.7 Anti-Nutritional factors of pulses and their elimination:

Anti-nutritional factors are natural chemical compounds which reduces bioavailability of vital nutrients. These are generally found in legumes and pulses. Details of anti-nutritionl factors and their elimination techniques are given in table below :

Table 10.4 Anti nutritional factor of pulses and their elimination

Sr. No.	Anti-nutritional Factor	Effect of Anti-nutritional factor	Pulses in which it appears	Detoxification Technique
1.	Lectins	Reduce the bioavailability of nutrients, which is due to direct action of lectin on digestive enzymes	Lentil, pea, pigeon pea, rice bean	Preliminary soaking prior to autoclaving cooking
2.	Tannins (Polyphenol)	Responsible for low protein digestibility and decreased amino acid availability	Cow pea, chickpea, pigeon pea, mung bean urd bean and pea	Tannins mainly appears in seed coat so that dehulling can reduce tannins.
3.	Protease inhibitors	Inhibit the activity of proteolytic enzymes.	Pigeon pea, kidney bean, lentil, chick pea	Heating, germination autoclaving and soaking
4.	Phytic acid	Affects the mineral bioavailability	Chinas legumes, pea, faba pea, dry bean, lentil and black bean	Roasting, germination, soaking, cooking
5.	Lathyrogen	If consumed in excess quantity for long time, it causes paralysis in the legs.	Lathyrus	Soaking, parboiling, roasting, germination
6.	Saponins	Saponin reduces the nutritive value of pulses	Chickpea, mung bean and pigeon pea	Soaking, germination, cooking
7.	Oligosaccharides	Accumulation of flatulence(gas disorder) in the intestinal tract results in discomfort, abdominal rumblings, cramps, pain, diarrhoea etc.	Red gram, chick pea, black gram and green gram	Soaking, germination, cooking

Oilseeds :

Oil seeds are the seeds from which oil can be extracted. Oilseeds constitute a very important group of commercial crops in India. The residue extracted after oil that is oil-cake, used as protein rich food and cattle feed, etc.

10.8 Composition and nutritional values of oilseeds:

Due to high quality protein, fat, oil soluble vitamins like vitamin A, vitamin E, oilseeds add important nutritional value to diet. Oilseeds are considered as the main source of high quality vegetable oils. Oilseeds have high fat content and many of them are rich in protein. They are considered as concentrated source of energy. Groundnuts are particularly rich in B-complex vitamins. Soybeans are rich in protein (Table 10.5).

10.9 Uses of oilseeds and nuts in cookery:

1. **Decorating:** Oilseeds and nuts are used for decoration purpose in many preparations. Cashew nuts, pista, almonds are used in *halwa, kheer, sheera, laddus, shrikhand,* ice cream etc., coconut on *poha,* cashew nut on *pulav,* sesame seeds on buns and *bhakri*.
2. **Thickening:** Coconut, gingelly seeds, ground nut, cashewnut are ground and used as thickening agent in the preparation of gravies.
3. **Flavourings:** They impart as desirable flavour to products like soups, porridge and kheer.
4. **Identity of grain:** While preparing *sago khichadi* or *sago wada*, it is difficult to maintain the identity of grain and prevent sogginess without adding crushed groundnuts to it.
5. **Extraction of oil:** Vegetables oils are extracted from oil seeds which are used as cooking media e.g. groundnut, soybean, coconut, sunflower, gingelly seeds etc.
6. **Snacks:** Roasted or fried and salted groundnuts and cashew nuts are used as snacks e.g. salted cashew nuts and groundnuts.
7. **Sweets:** Groundnut, sesame seeds and cashew nuts are roasted, powdered and used for sweet preparations like *chikki, burfi, halwa, groundnut laddu, til vadi til laddu* etc.

Fig. 10.22 : Major oilseeds of India

Do You Know ?

Soy products such as tofu, tempeh, etc. are among the richest sources of protein in a vegetarian diet.

Table 10.5: Nutritive values of Major Oilseeds (per 100 gram)

Name	Moisture (g)	Protein (g)	Ash (g)	Total Fat (g)	Total Fibre (g)	Carbohydrate (g)	Energy KJ
Ground nut	6.97	23.65	2.11	39.63	10.38	17.27	2176
Mustard seed	5.67	19.51	3.73	40.19	14.10	16.80	2132
Linseed or Flax	5.48	18.55	3.15	35.67	26.17	10.99	1857
Sesamum or Gingelly seed	3.30	21.70	4.13	43.05	16.99	10.83	2174
Soybean seed	5.51	35.58	4.74	19.82	21.55	12.79	1596
Sunflower seed	3.53	23.53	3.44	51.85	10.80	6.85	2453
Coconut, kernel, dry	3.97	7.27	1.61	63.26	15.88	8.01	2611
Garden cress seeds	4.60	23.36	6.37	23.74	8.27	33.66	1863

Source: T. Longvah, R. Anathan, K. Bhaskarachary and K. Venkaiah (2017), Indian Food Composition Tables, National Institute of Nutrition, Hyderabad, India.

Points to remember

- Cereals are classified into two groups namely Major (Fine) and Minor (Coarse)
- Coarse cereals are also known as millets.
- The nutritive value of the product decreases as the extent of milling increase.
- When dry heat is applied to cereals (starch) dextrinization takes places.
- When moist heat is applied to starch, gelatinization takes place.
- When water is added to wheat flour and kneaded, an elastic soft dough is formed that gives a soft texture due to gluten formation.
- Pulses are an important source of protein in Indian diet.
- Processing techniques like soaking, germination, fermentation improve the quality of pulses.
- Pulses are used in cookery as a thickening, binding, coating, dispersion and garnishing purposes.
- Oilseeds are rich in protein, fat & B-Complex vitamins.
- Oilseeds are used to extract oils.
- Oilseeds are used in cookery for decorating, thickening, flavouring, snacks and sweets.

Exercise

Q. 1 (a) Select the most appropriate options:

i. Cereal word is derived from greek word 'Ceres' which means goddess of _____.

(Air, Agriculture, Water).

ii. As the extent of milling increases, nutritive value of product _____.

(Increases, Decreases, Remain the same.)

iii. _____ is formed when Dalia is milled.

(Semolina, Wheat, Pulses).

iv. _____ is a process of passing dough from a cylinder by applying high pressure and getting various desired shape and length of product.

(Drying, Packaging, Extrusion).

v. Dextrinization is a process in which _____ heat is applied to starch.

(Moist, Steam, Dry).

vi. _____ is the process in which moist heat is applied to starch.

(Dextrinization, Gelatinization, Fermentaion)

vii. _____ are the cheapest and rich source of protein.

(Cereals, Pulses, Oilseeds)

viii. _____ are the seeds from which oil can be extracted.

(Cereals, Pulses, Oilseeds)

(b) Match the following:

A		B	
i.	Dextrinisation	a.	Custard
ii.	Gelatinisation	b.	Fermented food
iii.	Gluten network	c.	Toast
iv.	Parboiled rice	d.	Glutenin and gliadin
v.	Dosa	e.	Idli
vi.	Oilseed cake	f.	Germination
		g.	Cattle feed

(c) State whether the following statements are true or false:

i. Cereals are rich source of starch.

ii. Application of moist heat is known as dextrinization.

iii. Pulses are main sourcs of fat.

iv. Germination decreases nutritive value of pulse.

v. Fermentation improves the texture of the product.

vi. Oil seeds have high fat content and many of them are rich in protein.

Q. 2 Short Question

i. Why *atta* is better than *maida*, explain?

ii. Why do *chapatis* swell on heating?

iii. How do we get different shapes and lengths of pasta?

iv. What are the different sources of vegetable oils?

v. Enlist the oilseeds, which are rich in protein.

Q. 3 Short answer questions

i. What are the various products formed during milling of wheat?

ii. Draw the flowchart of steps of pasta making.

iii. List the various types of rice.

iv. Define Dextrinization.

v. Define Gelatinization

vi. Give physical and chemical changes in batter during fermentation.

vii. Advantages of germination of legumes and pulses.

viii. Soaking process

ix. Process of decortication

x. Draw the flowchart of steps of *dal* making in A.P. and Maharashtra.

xi. Draw the flowchart of steps of *dal* making in M.P. and Maharashtra.

Q. 4 Long answer questions

i. Explain the various steps of making pasta with the help of flowchart.

ii. Explain gluten network with the help of diagram.

iii. What do you understand by fermentation? Give its uses and advantages.

iv. Explain the uses of pulses in cookery.

v. Explain the functions of oilseeds in cookery.

❖ Project:

i. Select any ten recipes where cereal / pulses / oilseeds is used as the main ingredient. Prepare an attractive booklet of these recipes with their ingredients, amounts used and method of preparation.

ii. Collect information about various pasta products available in the market. Select five recipes in which these products are used and prepare an attractive booklet.

iii. Collect information about the latest breakfast cereals available in the market and prepare an attractive booklet.

11 Spices and Condiments

Content at a glance

India is considered to be the 'Home of spices'. Traders and business persons from various parts of the world heard about a variety of spices available in India and so they visited India. Even today, spices are a valuable source of getting foreign exchange.

In Indian diet spices and condiments play an important role. A well cooked garnished and nutritionally balanced diet without spices may not be acceptable, because of its insipidity. Same diet, if it is improved by adding various flavouring agents and spices will be highly appreciated by majority of the people. It will become more acceptable and palatable.

Fig. 11.1 Spices

Definition : Spices and Condiments are those substances such as natural plants or vegetable products (any part of plant) or their mixture in whole or ground form, which impart flavour, aroma and pungency to the food preparation.

Fig. 11.2 Parts of plants used as spices

11.1 Importance of spices and condiments in diet

- Spices impart flavour and colour to the food and therefore increases the palatability.
- Use of different spices in food preparation brings variety in the diet and avoids monotony e.g. cumin seeds in *jeera* fried rice, saffron in sweet coconut rice, *biryani masala in biryani* and others.
- Some spices stimulate secretion of digestive enzymes and helps in digestion.e.g. ginger.
- Some spices like garlic when consumed in diet reduce serum cholesterol levels and may decrease the risk of heart disease.
- Some spices in diet act as antioxidants whereas others have antibacterial properties e.g. asafoetida, nutmeg, clove and turmeric.
- Now a days, variety of readymade spice mixes are available in the market e.g. *pulao masala, sambhar masala,* and *milk masala etc.*

Fig.11.3 Whole spices

11.2 Use of spices and condiments in cookery

i) **Colour Improver:** Pleasant, colourful, well arranged buffet table attracts people and stimulates them to eat food. Different colours improve the appearance of food and hence the food becomes more attractive and appealing. e.g. turmeric in savoury dishes, red chillies in pickle, saffron in sweets and coriander in green chutney.

ii) **Decorating Agent:** Indian cooks are artists in using spices and condiments as a decorating agent. A seasoning of mustard seeds on dhokla, cardamom seeds on burfi and shrikhand, clove on betal leaf or coriander leaves on *raita*, *dal*, vegetable are some of the examples where spices make the dishes more attractive.

iii) **Flavouring Agent:** The primary function of spices is to improve the flavour of food. Many spices such as cloves, coriander, cumin seeds, cinnamon etc, because of their volatile oil content impart various flavours to the food. These flavouring compounds are soluble in fat, therefore spices should be added to hot oil as a seasoning. Spices appeal to the sense of smell and food is not accepted unless it is adequately spiced e.g. cardamom, saffron, nutmeg is used in sweet preparations such as shrikhand and burfi, vanilla essence is used in cake mixes and asafoetida is used as seasoning in preparations such as *kadhi*, *dal* and vegetables.

iv) **Appetizers:** Some spices and condiments stimulate the digestive juices which work as an appetizer or produce the hunger pangs. An aroma of a simmering curry serves this purpose.

Spices like pepper, mint, cumin seeds, ginger are used in various appetizing beverages like

soup and *jaljira*. These should be used in limited amounts. If they are used in excess, they may depress the hunger, instead of stimulating it due to the strong flavour.

v) **Thickening Agent:** Some spices and condiments contain carbohydrates especially starch, hence they give thickness to gravy. Onion, poppy seeds, coconut, garlic and ginger paste are used to thicken the gravies.

vi) **Food preservative:** Apart from other functions, some spices and condiments are helpful for preserving the foods. They are used widely in commercial as well as home scale production of sauces, ketchups and chutneys.

vii) **Digestibility improver:** Spices and condiments have physiological action beneficial to our digestive system. They act as stimulus to the digestive system and help digestion in many ways. e.g. use of ginger and asafoetida in buttermilk, omum (ajwain) in bhajiya or pepper in soup increases the digestibility.

viii) **Medicinal use:** The therapeutic value of spices is well known. Spices and herbs play a very important role in some of the simple but effective home remedies. Almost every spice has medicinal properties. e.g. garlic is used in treatment of numerous diseases such as rheumatism, dermatitis, abdominal pain, cough, loss of appetite and hypertension.

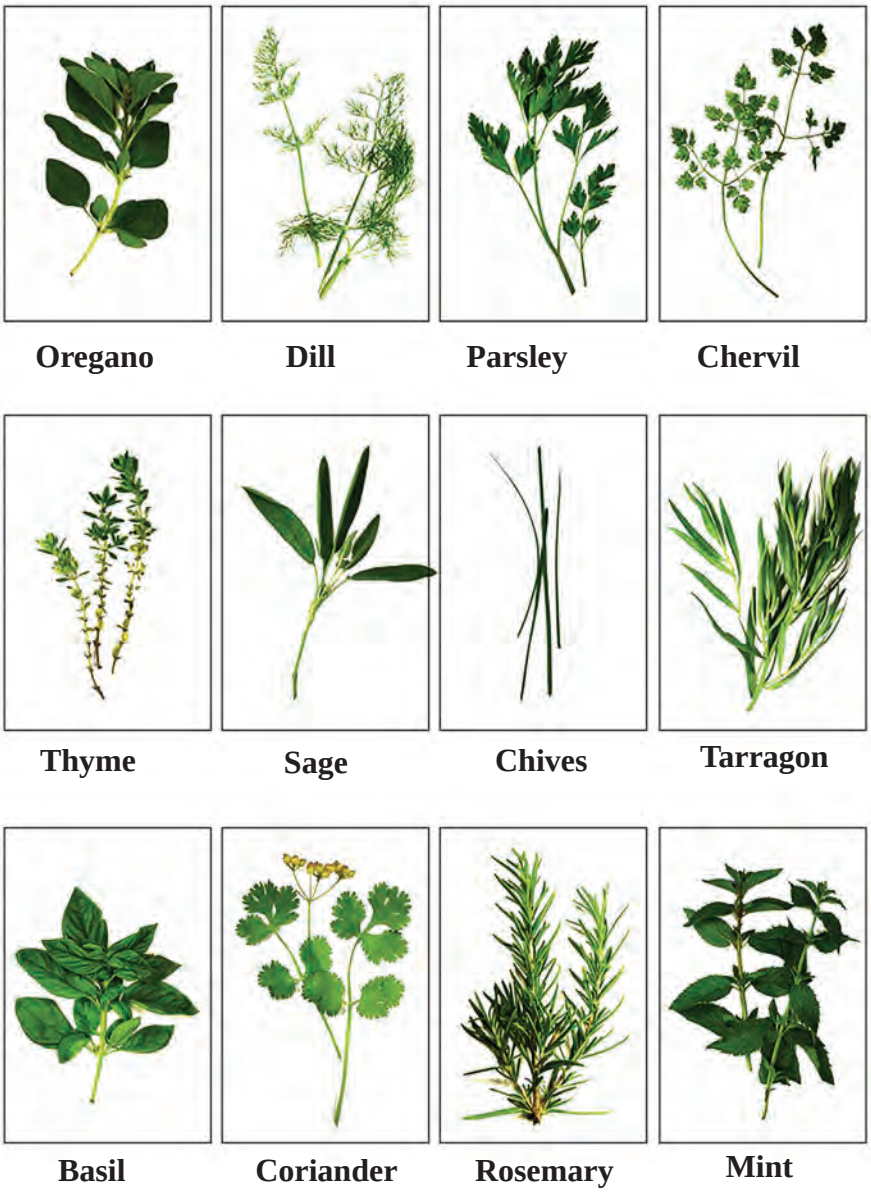


Fig. 11.4 Culinary Herbs

Studies of clove oil have shown that it stimulates the flow of gastric juices. Dry ginger, nutmeg, saffron helps in treating colds. Turmeric powder is used as an antiseptic agent.

Do You Know?

What is the difference between Spices and Herbs?

Spices are aromatic part of plant usually the dried buds, fruits, berries, roots or bark while Herbs are leaves of fresh and dried plants. Spices have stronger flavour than herbs. Since they are stronger they are used sparingly.

Activity- To make your own Masala

Each spice has its own peculiar taste and flavour. But these spices can be mixed or blended to make spice mixes or 'Masalas'. Great care has to be taken while blending the spice. It can be done through various ways such as broiling, frying in oil, grating and grinding the spice to a powder form

Here we are making the following masalas popularly used in cusines.

	Chaat Masala	**Chana Masala**	**Goda Masala**
Ingredients	Cumin, peppercorn, blacksalt, dry mint leaves, kasoori methi, green cardamom, cloves, cinnamon, asafoetida, tartaric acid, mace and dried mango powder	Coriander, cumin, red chillies, ginger powder, dried mango powder, cinnamon, black pepper, black cardamom, garlic, cubeb pepper (Pipli), nutmeg, clove, mace, dried pomegranate seeds.	Coriander, seasame, dry grated coconut, dried red chillies, cinnamon, asafoetida, star anise, bay leaf, pepper corn, saffron
Method	The masala is cooked by broiling the spices individually and grinding them to a smooth fine powder.	The spices are roasted and grinded to get the desired flavour.	The spices are lightly fried one by one by heating with little oil in a pan, and grind then into powder.
Use	1. Used mostly in *Chaats*. 2. Added to many other masala blends. 3. Sprinled on many snacks like *Paneer Pakodas, bhajiyas* etc.	1. Used mostly as a flavouring agent in chickpea curry in Punjab. 2. Also used in making pinde chole.	1. Regional masala of Maharashtra. 2. This spice blend is used to flavour meat and vegetables.
Example Application	 	 	 

Points to remember

- Spices and condiments impart flavour aroma and piquancy to food preparation
- Spices are colour improver
- Spices are used as decorating agent
- Spices also work as an appetizer.
- Spices increase the digestibility
- Spices also have medicinal value
- Herbs are leaves of fresh and dried plant

Exercise

Q. 1 (a) Select the most appropriate option:

i._____ improves the colour of the pickle.

(Coriander powder, red chilli powder, fenugreek seeds)

ii. In shrikhand _____ is used to enhance the flavour.

(Cardamom, cloves, cinnamon)

iii. In gravies,_____ is used as a thickening agent.

(Cumin seeds, cloves, poppy seeds)

iv. Spice that helps in treatment of cold is _____.

(Onion, dry ginger, garlic)

(b) Match the following:

A		B	
i.	Saffron	a.	Soup
ii.	Pepper	b.	Volatile oil
iii.	Cloves	c.	Wet Spices
iv.	Asafoetida	d.	Flavouring and colouring agent
v.	Onion	e.	Seasoning agent
		f.	Improve digestibility

(c) State whether the following statements are true or false:

i. Spices and condiments are mainly added to improve the nutritive value of food.

ii. Spices should not be used in limited amounts.

iii. Spices create variety in taste.

iv. Herbs are roots of plants.

Q. 2 Answer the following in one word

i. Name a spice that is used as an appetizer.

ii. Name the component present in spice which imparts flavour.

iii. Name a spice used as an antiseptic

.

Q. 3 Short answer questions

(a) Give reasons

i. Poppy seeds help in thickening the gravies.

ii. Pepper and mint help in increasing the appetite.

(b) Answer in brief

i. List the uses of spices in cookery.

ii. Define spices.

iii. Give the difference between Spices and Herbs.

iv. Give the importance of spices and condiments in diet.

Q. 4 Long answer question

i. Explain in detail all the uses of spices and condiments.

❖ Project

- Collect information about ten spices with their photographs and make an album of it.
- Visit to any manufacturing unit of 'Ready mix masala' and prepare a detailed report on it.

12 Tea, Coffee and Cocoa Processing

Contents at a glance

Nearly three quarter of the human body consists of water. Water keeps the body hydrated, helps in digestion and absorption of our food and transport throughout the body. The body continuously losses water through sweating, urination, etc. Therefore it is very important to replace this water otherwise it will disturb the body balance. We may replace this lost water through a drink. Beverages are of utmost importance to replenish the body.

Definition: Beverage is any kind of liquid intended for human consumption. In addition to their basic function of quenching thirst, they also play an important role in social culture. These include tea, coffee, cocoa, soft drinks, shakes and alcoholic beverages.

12.1 Tea:

Tea is the second most popular beverage in the world. Only water is rated higher in world consumption than tea.

Tea ia a beverage which is made from the processed leaf of a tea plant. The botanical name of this plant is *Camellia sinensis*

Tea is a very mild stimulant, since it contains caffeine. The caffeine content is lesser than coffee but more than cocoa. It also contains small amounts of tannin compounds, vitamin A, B_2, C, D, K, some minerals and aromatic oils.

The tannin compounds and essential oils are mainly responsible for flavour of tea, colour, astringency (slightly acidic or bitter) and the delightful aroma.

Fig. 12.1 (a) *Camellia Sinensis*

Fig. 12.1 (b) Tea Plantation

12.2 Process of manufacturing of tea:

1. **Plucking:** The tea leaves (top two leaves and the bud leaf) are first plucked from the end of branchlets. They are then bought to the tea factory where they undergo the following processes.

Fig. 12.2 Tea plant

Fig. 12.3 Plucking

2. **Withering:** The plucked leaves are placed on a withering rack (drying). The first stage of withering may take 10 to 20 hours under shade so as to reduce the internal moisture of leaf. This makes the leaf ready for the next step that is grinding.

Fig. 12.4 Withering

3. **Grinding:** The machines crush the leaf so that the enzymes inside the cells are exposed and come in contact with oxygen from the air.

Fig. 12.5 Grinding

4. **Fermentation and Oxidation:** The leaves are then spread on a thin platform and allowed to ferment for 2-6 hours. During this process the colour of leaf becomes green to reddish brown. After this phase the tea leaves are kept for drying.

5. **Drying:** When fermentation is completed. to the desired degree, then tea is dried for 30 minutes to several hours in a chamber of hot air. The drying operation is exceptionally important as it "seals in" all the flavours. This creates a difference between a mediocre tea and a superb tea.

Fig. 12.6 Drying process

6. **Screening:** After drying tea is cleaned and sorted into various grades.

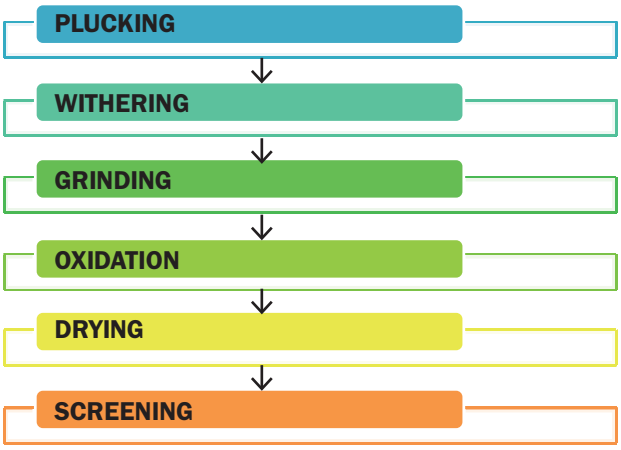


Fig. 12.7 : Steps of tea processing

12.3 Classification of tea :

a. **Green tea:** In this withering and fermentation steps are omitted. The aroma, flavour and colour of green tea is different from black tea. Green tea is a light, yellow green beverage having high number of polyphenols, caffeine content and Anti-oxidants, thus reduces the cancer risk and imparts many health benefits.

b. **Oolong tea:** Oolong tea is an intermediate between black and green tea in colour and taste characteristics. Its production method is similar to that employed for green tea, except that the leaf is slightly withered and light fermentation allowed before the leaf is dried.

c. **White tea:** It is made from young leaves that have not undergone oxidation. The buds may be shielded from sunlight to prevent formation of chlorophyll.

d. **Yellow tea:** It is high quality tea served usually to Royalty. Process similar to green tea but with a slower drying phase.

e. **Kukicha:** Also called winter tea and is made from twigs and old leaves of tea plants during its dormant season and dry roasted over a fire.

Activity 1. Ice tea

Aim: To make ice tea.

Materials: water- 1 glass, tea leaves – 1 tsp., ginger (grated) – 1/2tsp., mint leaves – 6-7, sugar – 3 tsp., lemon – 1/2 -1 (according to taste)

Method :

1. Add ginger, mint and sugar to water and boil it for 3-4 minutes.
2. Now add tea leaves and let it boil for few minutes.
3. Strain it and let it cool.
4. Add lemon juice
5. Add crushed ice to it
6. Decorate the glass with lemon rind and mint leaf.
7. Serve chilled.

Fig, 12.8 Ice tea

12.4 Coffee:

Coffee is an evergreen shrub or a small tree. There are many species of coffee, but most popular coffee are : *Coffea arabica and Coffea canephora (robusta*).

Fig 12.9 Coffea Arabica

Fig. 12.10 Coffea Plantation

12.5 Coffee production:

There are following steps through which a coffee bean passes from seed to cup.

a. Harvesting of beans
b. Processing of beans
c. Drying the beans
d. Hulling
e. Polishing
f. Grading and sorting
g. Tasting
h. Roasting
i. Grinding

a. Harvesting of beans : After three to four years, when they reach maturity, coffee trees bear fruits in lines or clusters along the branches. It is also known as berry or cherry. This fruit turns red when it is ready to be harvested. Coffee beans are actually the seeds of these ripened cherries. Harvesting time varies according to geographical zone, but typically there is only one harvest in a year.

Fig. 12.11 Harvesting

Fig. 12.12 Processing

b. Processing of beans: Processing of beans, or preparing them for roasting, done in two ways:

- **Dry method:** This is the simplest, cheapest and most traditional method of processing coffee. The harvested cherries are spread over a concrete or brick surface. They are kept in sunlight and raked at regular intervals to prevent fermentation.

After 7-10 days, the cherries become dry. The dried cherries are then stored in silos, where the beans continue to lose moisture.

Do You Know?

A silo is a metalic structure for storing bulk materials, used in agriculture to store grain or fermented feed known as silage. Silos are more commonly used for bulk storage of grains, coal, cement, woodchips, food products, sawdust, etc.

Fig. 12.13 Silos

- **Wet method:** This method requires greater investment and more care than the dry method, but it causes less damage and helps to preserve the intrinsic qualities of the beans. The main difference between the two methods is that wet method uses a procedure to remove the pulp from the bean within 12-24 hours of harvesting, instead of allowing cherries to dry.

Using a pulping machine, the beans are separated from the skin and pulp, which is washed away with water. The wet method gives better quality coffee with a bluish green colour (green coffee).

Fig. 12.14 : Pulping process

Fig. 12.15 Drying

c. **Drying the beans:** The beans are then dried in sun. The beans obtained after 7-15 days of drying are known as "Parchment coffee".

d. **Hulling:** In wet processed coffee, hulling is used to remove the hull (seed coat) or dried parchment immediately surrounding the bean. Husk or whole dry outer covering is removed.

Fig. 12.16 Hulling

e. **Polishing:** Polishing beans is an optional process that is not always done. During the polishing process any silver skin that remains on the beans after hulling is removed in a polishing machine.

f. **Grading and sorting:** Coffee beans are graded according to size firstly and then density.

g. **Tasting the coffee:** The tasting of coffee is referred to as "cupping". In this process coffee is tasted and evaluated by sensory experts. The taster (also known as liquorer) assesses the green beans for appearance. Small quantity is roasted and tested for colour, flavour and aroma.

Fig. 12.17 Tasting the coffee

h. **Roasting coffee:** Raw coffee has no flavour or aroma. Roasting is the heat treatment which transforms the green beans into the aromatic brown nuggets that is available in whole or powdered form. The flavour that develops during roasting is due to the organic compounds and volatile oils present in the beans.

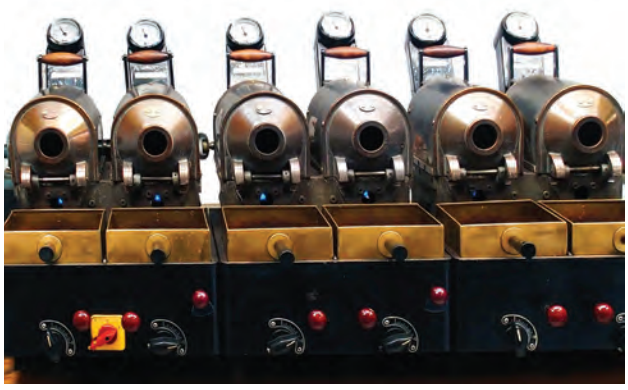


Fig. 12.18 Roasting

i. **Grinding coffee:** The objective of grinding the coffee is to get maximum flavour from the beans. Grinding is mostly done till beans turn into a fine powder, and is sold as ground coffee. Coffee grinding is of three types – fine, medium and coarse.

Fig. 12.19 Grinding

Fig. 12.20 Flow chart of coffee production

12.6 Methods of coffee making:

With the passage of time, the traditional pans used to make coffee were replaced by modern coffee making appliances. They come in variety of forms, from fully automatic to manual. Some common types of coffee making methods are:

1. Vacuum coffee
2. Drip coffee
3. Percolator coffee
4. Steeped coffee
5. Espresso coffee
6. Cappuccino coffee
7. French drip
8. French press
9. Cold water method
10. Iced coffee
11. Instant coffee
12. Filtered coffee

Activity 2 - Cold Coffee

Aim: To make cold coffee

Materials Needed :

Milk - 1 glass, Coffee – 1 tsp. (heaped), Sugar – 3 tsp., Chocolate syrup (for decoration), Chocolate powder, Chocolate sprinklers, Crushed ice

Method :

1. Take the coffee powder in a bowl and add lukewarm water to it and mix it well.
2. Now take a mixie jar, add full fat milk, coffee, sugar and ice, and if required then add some chocolate powder to it.
3. Blend it in a mixer till smooth and frothy.
4. Cold coffee is ready.
5. Spread chocolate syrup in the glass and pour coffee and froth in the decorated glass.
6. Sprinkle chocolate powder and chocolate sprinklers and garnish the coffee.

Fig. 12.21 Cold Coffee

12.7 Cocoa:

The cocoa plant is a small tree. Cocoa is made by grinding the seeds of the pods of the cacao tree (*Theobroma cacao*).

Fig. 12.22 Cocoa Tree

12.8 Production of cocoa:

The five steps involved in the manufacture of cocoa are given below:

a. **Harvesting** - Harvesting of right kind of cocoa fruit / pods is carried at yellow colour stage.

b. **Fermentation:** Generally the fruits are kept for natural fermentation. For this, they are first piled in heaps in perforated wooden boxes for 3-12 days. The time period depends on type of bean. No external heat treatment is required. A drop in temperature of the mass indicates that the fermentation is complete. Fermentation ends with the breakdown of pulp and change in colour of seeds. Seeds are removed by filteration process.

c. **Curing:** The fermented beans are now dried in sun or hot air dryers. This process changes the colour of the shell to dark brown

d. **Roasting:** Before roasting, the beans are screened for any unwanted foreign substances and sorted. After roasting the beans are passed through corrugated rollers to break the shells. The beans are baked in an oven at about 121^0 C for about 45 mins.

Fig. 12.23 Roasting

e. **Grinding and Defatting :** The roasted, dehulled bean are called “nibs”. The nibs are then put into stone mills (*chakki*) to make a fine paste. The friction between the two stones of the mill produces heat which melts the cocoa fat. The melted fat carries with it in suspension, finely ground particles of cocoa mass or chocolate liquor or bitter chocolate.

Before use, the cocoa mass is filter-pressed to separate out a major part of fat. The pressed cake is cooled, ground in special mills and passed through fine silk screens. The fine powder is mixed with flavouring materials and homogenized, which is utilised in the beverage and other products. It has characteristics flavour, taste and colour.

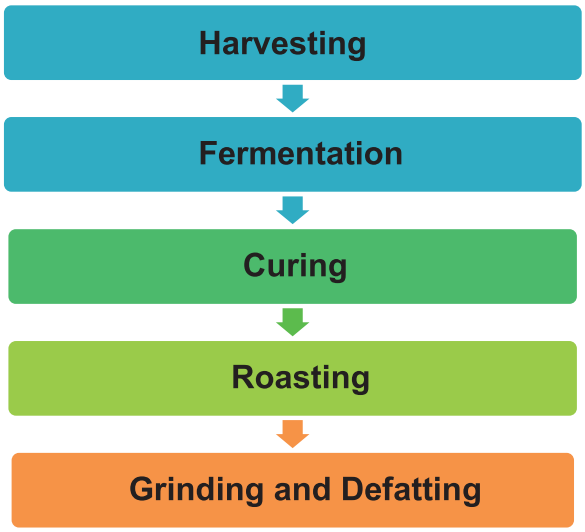


Fig. 12.24 : Steps in Cocoa production

Cocoa and chocolate, apart from their many uses in foods, find extensive use in preparation of beverages.

Points to remember

1. Tea is the second most popular beverage in the world
2. Botanical name of the tea plant is *Camellia Sinensis*.
3. Tea is classified into – Green, oolong, white, yellow tea and kukicha.
4. Most popular species of coffee are coffee arabica and coffee canephora (robusta)
5. Cocoa is made by grinding the seeds of the pods *theobroma cacao.*

Exercise

Q. 1 (a) Select the most appropriate option:

i. _____ is the second most popular beverage in the world.
(tea, coffee, cocoa)

ii. _____ is first step in process of making tea.
(grinding, plucking, withering)

iii. *Camellia sinensis* is the botanical name of _____ plant.
(coffee, tea, cocoa)

iv. The green colour of coffee changes to brown after the process of _____.
(drying, roasting, hulling)

v. Cocoa seeds after harvesting are left for natural _____.
(fermentation, curing, defatting)

(b) Match the following :

A		B	
i.	Tea	a.	*Theobroma cacao*
ii.	Coffee	b.	Health benefits
iii.	Cocoa	c.	Roasted dehulled beans
iv.	Green tea	d.	*Coffee arabica*
v.	Nibs	e.	*Camellia sinensis*
		f.	Fermentation

(c) State whether the following statements are true and false:

i. While plucking leaves for tea production top two leaves and the bud leaf are not most appropriate.

ii. Yellow tea is a high quantity tea.

iii. Vaccum coffee is a step in coffee production.

iv. The roasted dehulled beans (cocoa) are called nibs.

Q. 2 Write in short

i. Define beverage.

ii. Botanical name of tea.

iii. Steps of tea processing.

iv. Give the names of two species of coffee.

v. How many types of coffee are there after grinding?

vi. Give flow chart of coffee production.

vii. Name the methods of coffee making.

Q. 3 Write short note on the following

i. Roasting of coffee.

ii. Steps in cocoa manufacturing.

iii. Process of grinding and defatting in cocoa manufacture.

Q. 4 Long answer questions

i. Explain in detail the process of tea manufacturing.

ii. Give the classification of tea.

iii. Explain in detail the process of coffee production.

iv. Describe all the steps of cocoa production.

❖ Project:

Prepare an album of ten recipes each of tea, coffee and cocoa.

13 Sugar and it's Products

Contents at a glance

Sugars are simple carbohydrates which are classified as monosaccharides namely glucose, fructose, galactose and disaccharides namely sucrose, maltose and lactose. Sugar plays a very important role in any cuisine. Additionally it provides energy to the body as it is form of carbohydrate.

13.1 Sources and properties of sugars :

The main source of sucrose are sugar cane (10-12%), beetroot (12-18%), honey and some fruits and vegetable. Natural sources of monosaccharides and disaccharides are indicated in table 13.1.

13.1 Table: Natural sources of sugar

Sugar	Natural sources
Monosaccharide	
Glucose or Dextrose	Fruit and plant juices, honey, part of cane and beet sugar
Fructose or fruits sugar	Fruits, fruits juices, honey, part of cane and beet sugar
Galactose	Milk and milk poduct
Disaccharides	
Sucrose	Sugar cane, beet root, vegetables like carrots, ripe fruit
Lactose	Milk and milk products
Maltose	Wheat, barley, etc.

Properties of sugar

1. **Hygroscopic nature:** Sugars have the ability to absorb moisture from surroundings. So sugar should be stored in dry place, in airtight containers, thats why sugar based products become sticky if not properly stored. Fructose has the highest hygroscopic power.
2. **Solubility:** Sugars are soluble carbohydrates. Based on solubility the sugars can be arranged in descending order as- fructose, sucrose, glucose, maltose and lactose.
3. **Sweetness index:** All sugars differ in their sweetness from each other. Generally sucrose is considered as standard with value 1.0. All other sugars are compared with this standard and their sweetness index is considered as shown in figure Table 13.2.

Table 13.2 Sweetness index

Sugar	Sweetness
Sucrose	1.0 (Standard value)
Glucose	0.7
Fructose	1.7
Maltose	0.3 to 0.6
Sorbitol	0.5 to 0.6
Mannitol	0.4 to 0.6
Aspartame	200 times

4. **Fermentation:** Sugar (Sucrose) undergoes fermentation easily by the biological process. in which enzymes from yeast are involved to convert into glucose, fructose, or maltose, and last products carbon dioxide and alcohol. This property is very much important in bakery industry, alcoholic beverages, other fermented products like *idli, dosa,* etc.

5. **Hydrolysis reactions:** These reaction are categorized in two types

   A. **Acid Hydrolysis**

   Sugar on reaction with acids hydrolyses to a new product.

$$\text{Sucrose} + \text{Acid} \longrightarrow \underset{\text{(invert sugar)}}{\text{Fructose} + \text{Glucose}}$$

   Heat is accelerator in the hydrolysis by acid

   B. **Enzyme Hydrolysis**

   Sucrase enzyme hydrolyses sucrose to yield a liquid invert sugar.

$$\text{Sucrose} + H_2O \xrightarrow[\text{Enzyme}]{\text{Sucrase}} \underset{\text{(invert sugar)}}{\text{Fructose} + \text{Glucose}}$$

6. **Heat Treatment:** Sugar can be treated with heat in two ways either by dry heat (caramelization) or wet heat treatment. (Crystallization)

Do You Know ?

- Sugar, which is regularly used in sweet preparations is chemically known as sucrose.
- Molasses is the byproduct of sugar cane industry used for alcohol production.

13.2 Effect of dry heat on sugar-caramelization

Caramelization is the complex process in which when sugar is heated without any water or liquid where various physical and chemical changes take place.

Definition : When dry heat is applied to sugar crystals and it reaches a temperature above its melting point, the sugar melts and decomposes to form a colourless liquid which on continuous heating changes its colour to yellow, light brown and finally dark brown. This decomposed sugar is known as caramel and this process is known as Caramelization.

Characteristics:

- Caramel sugar is brown in colour.
- It has pungent and strong flavor and slightly bitter taste.
- It is less sweet than original sugar.
- It is in a crystalline state, which is soluble in water.

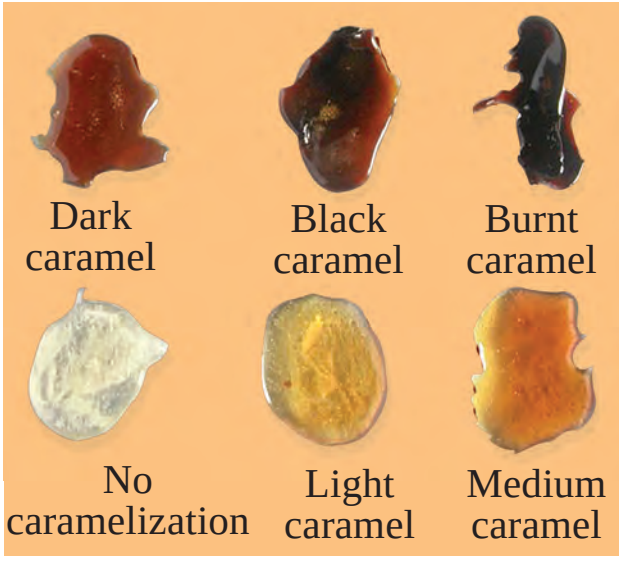


Fig. 13.2 : Caramelization of sugar

- On cooling, caramel turns solid and brittle and has transparent shiny appearance.
- Temperature of caramelisation depends on type of sugar. Fructose caramelizes at 110 ^{0}C, sucrose at 170^{0}C and maltose at 180^{0}C.
- It can be used as a flavouring in puddings and desserts, as a filling in bonbons, or as a topping for ice cream and custard.

Uses of Caramel in cookery

i. **Decoration**: Caramel is used to decorate desserts like custard and puddings. It s also used on cakes as a decorative agent.

ii. **Binding agents**: Since caramel solidifies on cooling, it can be used as a binding agent. When the hot liquid caramel is mixed with other food ingredients and allowed to cool it turns solid, thereby holding the ingredients together. This is seen in sugar brittles such as *til* or groundnut *chikki* where caramel acts as binding agent.

iii. **Flavour and Taste** : Addition of caramel to fruit cake and christmas cake imparts a desirable flavour and taste to the preparation.

iv. **Colour** : Since the caramel is brown in colour, it gives a brown natural colour to preparations like fruit cake, and christmas cake.

v. **Variations in texture** : Solid pieces of caramel in chocolates and ice creams brings variation in the texture of the products.

vi. **Coating agents :** In preparations like caramel popcorn, caramel acts as a coating agent and improves the appearance, colour and flavour.

Activity – 1

Aim: - To find out the effect of dry heat on sugar- caramelization

Materials needed:- Sugar, pan, burner

Method:-

1. Take a pan, add sugar to it.
2. Heat on a slow flame.
3. Sugar will start melting into a colourless liquid.
4. Slowly the colour will start becoming yellow and then darken.
5. Take out from flame and let it cool.
6. Crush the caramel into small chunks and use it for garnishing ice-creams, etc.

Conclusion: Caramel helps to improve texture

13.3 Effect of moist heat on sugar-crystallization:

Sugars are soluble in water due to which they impart various degrees of sweetness to different products like tea, coffee, syrups. etc. Solubility increases with increase in temperature. This property is extremely useful in preparation of sweets like *rawa laddu, burfi, balushahi* and sugar coated groundnuts.

In order to understand how and why crystals are formed in a sugar solution, let us first understand the types of solution.

Solution: Solution is made up of solute and solvent.

Solute + Solvent ⟶ Solution
Sugar Water Sugar water solution

Types of solution:

1. **Unsaturated solution:** When a solution has the capacity to dissolve more solute at the ambient temperature, then this type of solution is called as unsaturated solution.
2. **Saturated solution:** When a solution does not has the capacity to dissolve any more solute at the ambient temperature, then this type of solution is called as saturated solution.
3. **Supersaturated solution:** At a given temperature, if more sugar is added to a saturated solution, it will become supersaturated.

Definition: When a saturated sugar solution cools down to form a supersaturated solution, the extra solute precipitates in the form of crystals. This process of crystal formation is called Crystallization of sugar.

e.g. balushahi, sugar coated nuts and Fudge etc.

Factors affecting crystallization :

1. **Temperature of crystallization:** Temperature at which crystallization occurs, affects size of the crystals. Bigger crystals are formed if crystallization occurs at a higher temperature. At a lower temperature smaller crystals are formed.
2. **Agitation or stirring:** If a cooling supersaturated solution is not stirred at all and left to stand, crystallization starts, however, the crystals formed would be large and less in number. Stirring the solution favours the formation of small and more crytals. Therefore, stirring results in small sized more number of crystals resulting in soft and smooth products. Agitation also incorporates air and gives a light texture to the products.
3. **Interfering substances:** Substances such as glucose, honey, milk, fat, lemon juice, citric acid and enzymes decrease the process of crystallization. These substances are adsorbed by the surface of the crystals and retard crystal growth. This results in formation of tiny crystals and retard crystals but more in number which gives a soft and smooth product.

Do You Know ?

Sugar industry is the 2nd largest agro-processing industry in India. Maharashtra and Uttar Pradesh accounts for major sugar producing states.

13.4 Uses of sugar in cookery

a. **Sweetening agent:** Food preparation like tea, coffee, milk shake, *kheer, gulabjam* and puddings would not be palatable without sugar.

b. **Binding agent:** In preparation like r*awa-besan laddu* and *vadi*, saturated sugar solution is prepared. When this solution cools down, sugar crystals are formed. While crystallization is taking place, other ingredients are bound together to give a particular shape.

c. **Coating agent:** In preparation like sugar coated groundnuts, *balushahi*, sugar coated *shankarpali*, preparations are dipped in concentrated sugar solution. On cooling, crystals are formed which coat the surface of the products.

d. **Decorating agents:** Sugar is the one of the important ingredients used for the icing of cakes and pastries.

e. **Preservative:** In products like jam, jelly and *muramba*, sugar is added in sufficient amounts to preserve the products. About 70% sugar in the preparation is sufficient to preserve the product.

Points to remember

- Most commonly used sugar is sucrose
- Sugar is of very hygroscopic nature therefore it should be stored in airtight containers / bags.
- Fructose is the sweetest and most soluble sugar
- Effect of dry heat on sugar is known to form caramelization product.
- Effect of moist heat on sugar is known to develop crystallization product.
- Solution is made up of solute and solvent. Solution are of three types-unsaturated, saturated and super saturated

Exercise

Q. 1 (a) Select the most appropriate option:

i. _____is most commonly used sugar.
(Sucrose, Maltose, Glucose)

ii. Application of moist heat to sugar results in _____.
(Caramelisation, Inversion, Crystallization)

iii. …… is the byproduct of sugar cane industry used for alcohol production.
(Molasses, Oil, Water)

(b) Match the following:

A		B	
i.	Caramel	a.	Rawa laddu
ii.	Crystallisation	b.	Lactose
iii.	Least soluble sugar	c.	Sugar chikki
iv.	Sweetest sugar	d.	Alcohol making
v.	Molasses	e.	Sucrose
		f.	Fructose

(c) State whether the following statements are true and false:

i. Sucrose is the most regularly used sugar.

ii. Lactose is found in fruits and vegetables.

iii. By fermentation sugar is converted into alcohol and carbon dioxide.

iv. Effect of moist heat on sugar is known as caramelization.

Q.2 Give reasons

i. Why sugar is stored in air tight containers?
ii. How sugar helps in preserving jam?
iii. Which property of sugar is important in bakery and Why?

Q. 3 Answer the following in brief

i. Name the effect of dry heat on sugar?

ii. Name the effect of moist heat on sugar.

iii. Define caramelization.

iv. Define crystallization.

Q.4 Long answer question

i. Explain various properties of sugar.

ii. Explain uses of caramel.

iii. Explain various types of solution.

iv. Desribe the various factors affecting Crystallization.

v. Illustrate the uses of sugar in cookery.

❖ Project :

Select any ten recipes where Sugar is used as the main ingredient. Prepare an attractive booklet of these recipes with their ingredients, amounts used and method of preparation.

Unit - 5

Advances in Food Technology

Objectives

- To understand the importance and various types of packaging.
- To gain knowledge about the latest advances in packaging.
- To understand the tremendous opportunities in nano-techonology regarding the food processing and packaging.
- To create awareness about the functional food and its health benefits.

"The technological advances in the domain of food packaging and functional food in twenty first century are mainly chaired by nanotechnology."

Packaging of food is very important and essential operation in food processing, storage, distribution and marketing. It helps in preservation of valuable nutrients, extension of shelf life, reduction of handling losses, provide food safety, security and hygiene of the content. As the advancement of the time, food packaging plays a vital role in developing variety of foods such as ready-to-cook/ serve/ eat food items such as instant mixes, retortable pouch processed food, tetrapak processed food, vacuum and nitrogen flushed food items. Multilayer films, breathing films, antimicrobial, edible films, natural degradable films, etc. have made it possible to extend the shelflife of the highly perishable commodities.

In nanotechnology, advance food packaging technology offers tremendous opportunities for innovative development and packaging that can offer significant benefits to the consumers.

In recent years, advances in the functional food technology offers a better life style so as to minimize the health disorders through the product such as conventional modified, medical and special dietary foods.

14 Food Packaging Technology

Contents at a glance

The development of food packaging has evolved as man's life style has changed. The industrial revoluation brought the development of new manufacturing process and new packaging material.

14.1 Packaging developments - An histroical Perspective

The past two centuries most of the evolutions have been seen in food packaging. The change is from simply acting as a container to becoming an integral part of total product design e.g. presently, the tomato ketchup is packed in co- extruded multilayer plastic bottle instead of glass bottle. An overview of some developments in packaging is given below.

Do You Know?

Indian Institute of Packaging (IIP) is in Mumbai and sub-centers are at Kolkatta, Delhi, Hydrabad, Ahemadabad and Chennai. In these centers development of new packaging and its testing facilities are available.

- **Nicolas Appert, Scientist** preserved food in hermetically sealed glass jar in France during 1809. For this innovation he is known as the **"Father of canning".**

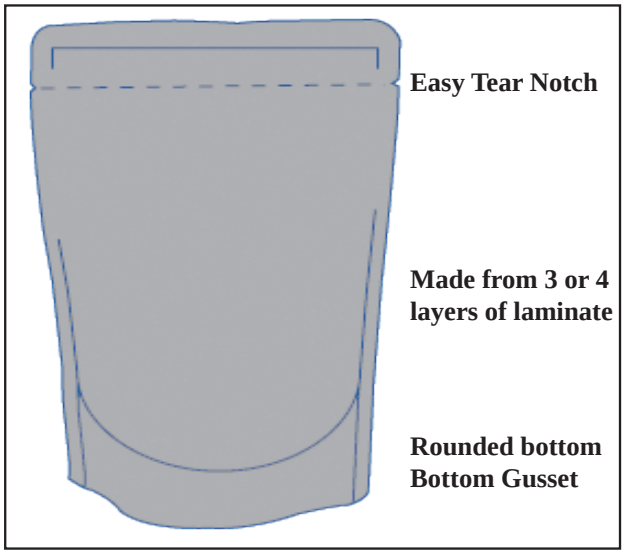


Fig. 14.1 : Retort pouch

- In 1950, US military developed a retortable pouch. Food product can be heated in packed condition. In 1956, Tetra Pak launched its tetrahedral milk carton.
- In 1970, the bar code system for retail packaging was introduced in the USA.
- In 1990, digital printing of graphics on carton sleeves and labels for food packaging was introduced in the UK.

Fig. 14.2 : Digital printing of graphic

Since the advent of the food can in the 19th century, protection, hygiene, product quality and convenience have been major drivers of food technology and packaging innovation. In recent years, there has been a rising demand for packaging that offers both ease of use and high quality food to consumers with busy lifestyles.

14.2 Types of packages

a) **Primary packaging:** These include the packages which come directly in contact with food materials e.g. tin can, pet bottles and LDPE pauches. etc.

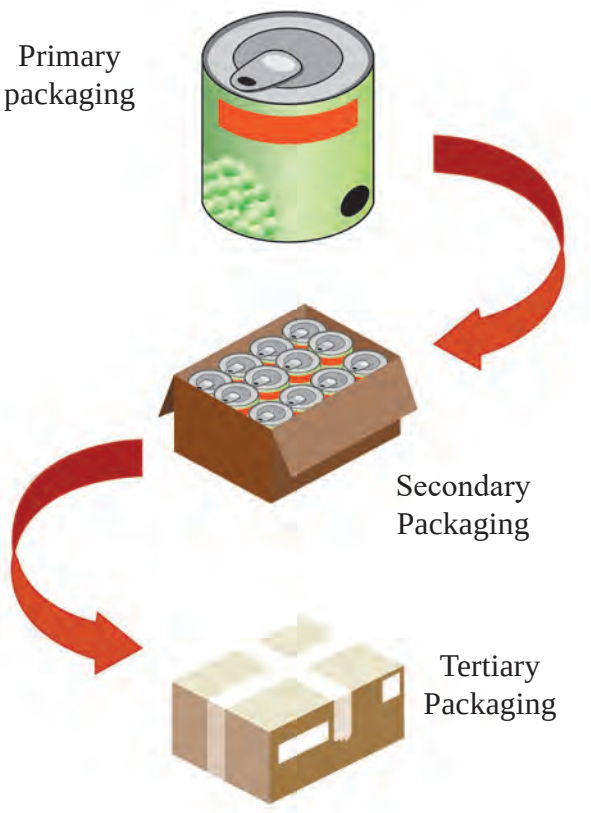


Fig. 14.3 : Primary, secondary and tertiary packaging

b) **Secondary packaging:** These packages hold primary packages to protect them from external damage. e.g. corrugated fibre box (cfb), cartons, plastic crates, etc.

c) **Tertiary packaging:** These hold secondary packages and give proper strength to the stored products e.g. wooden box, large size cb, cartons and containers.

14.3 Principles of food packaging

a) **Protection :** The package used for packaging material should protect product from physical, chemical and microbial hazards e.g. external scratches, oxidation and microbial spoilages like rotting or decay.

b) **Preservation :** It should act as preservative by retarding the entry of microorganisms.

c) **Presentation :** It should present the information about the content in the packet or can like nutritional value, manufacturing information, brand name, license numbers, date of expiry and other directives on labels.

14.4 Requirements of package

1. **Package should be non- toxic:** The package should not produce any toxic substance in the food during storage .

2. **Protect against microbial contamination:** Package should provide protection against microbial contamination in the food.

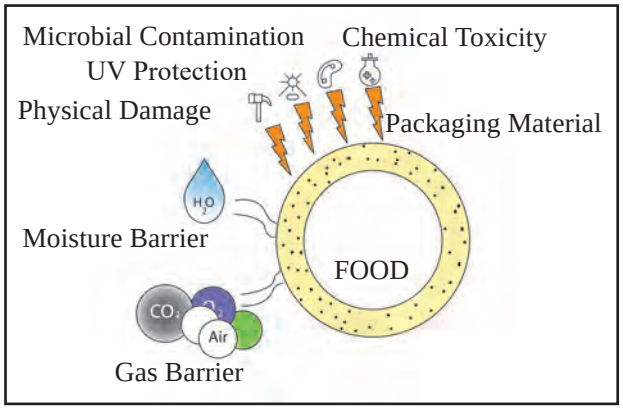


Fig. 14.4 Protection against contamination

3. **Act as moisture barrier:** Package should be barrier to moisture loss from the food.

4. **Act as gas barrier:** The package should protect the products from gas exchange.

5. **Protect against UV rays:** Package should provide protection to the processed food against UV rays of sunlight.

6. **Resistance to physical damage:** The package should protect the food products from physical damage and shocks arising from mishandling.

7. **Transparent:** The transparent packages are preferred to attract the consumers since it gives idea about product visual quality. Whereas colorful package give different perception regarding product appearance. and preference.

Fig. 14.5 : Different glass bottles

8. **Package should be tamper proof:** The tamper proof packages give confidence to the consumers regarding the quality of products as well as the product is free from the adulteration.

Fig. 14.6 : Tamper proof package

9. **Easy to open :** The package should be easy to open so that consumer can consume at any time and anywhere.

Fig. 14.7 : Easy to open package

10. **Dispensing and resealing :** The package should have the facility to reseal the products.

Fig. 14.8 : Reseal package

11. **Easy to dispose:** Packaging should be easily disposed without any environmental hazards

12. **Meet size, shape and weight requirements:** The package should fulfill all the regulatory requirements.

13. **Good appearance and printability:** The package should have good printability to attract the peoples.

Fig. 14.9 : Attractive package

14. **Low in cost:** It should be affordable to all and without increasing much of the product cost.

14.5 Packaging materials:

Various packaging materials such as glass, metal, paper, paper boards, plastics, wood, etc. are used in food packaging. However many packaging materials are used in different combinations at different proportions to improve barrier properties. These were also used in different forms of packages. The different packaging materials are as follows :

- Earthen pots
- Wood as packaging materials
- Glass
- Paper and paper based packaging materials
- Metal containers
- Plastic films
- Laminates
- Tetra brick aseptic packaging

Earthen Pots

The earthen pots are generally made by the combination of two types of mud clay: Mud from the surface of the earth and mud from 10 feet deeper into the earth are mixed together. The clay is mixed with water, shaped, finished, polished, dried and baked in a kiln. The earthen pots are commercially used for packaging of *dahi*, yogurt, ice cream and used as home water coder.

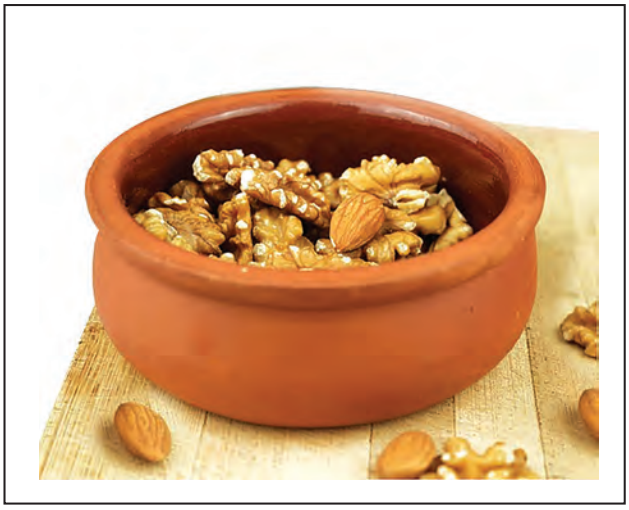


Fig. 14.10 : Earthen pots

Wood as packaging materials

Products derived from wood are widely used in the packaging of food. These are used for packaging of fresh fruits / vegetables as well as their processed products.

Fig. 14.11 : Wooden box

Glass

As related to food packaging, glass is chemically inert, therefore it is a safe packaging material. The glass is commercially used for many food products such as beverages, milk, ketchup, jam, etc.

Advantages

1. Inert in nature: It will neither react with food product nor food constituents.
2. Transparent in nature: The glass is crystal clear in nature so that one can see the inside product and assess quality of product.
3. Glass is resistance to high temperature and can sustain upto 500^0C temperature so that it can be utilized for the product where sterilization or processing is required after packaging e. g. canned products.
4. High strength

Disadvantages

1. Heavy in weight
2. High cost
3. Fragile in nature so break easily when used on high speed machines
4. Closures are main issue

Paper and Paper based packaging materials

The paper is obtained from the plant fiber (cellulose) and hence considered as renewable resource.

Types of papers

a) **Kraft paper :** It is strong paper and used for secondary and tertiary packaging. Generally it is brown in color.

Fig. 14.12 : Kraft paper

b) **Sulphited paper :** This paper is generally used for printing purpose as well as for the label preparation

Fig. 14.13 : Sulphited paper

c) **Grease proof or butter paper :** Butter paper is made from cellulose fiber. Butter paper is also resistant to absorb fats and oils. These papers can be used for the packaging of bakery products, butter, chocolates, pastries, etc.

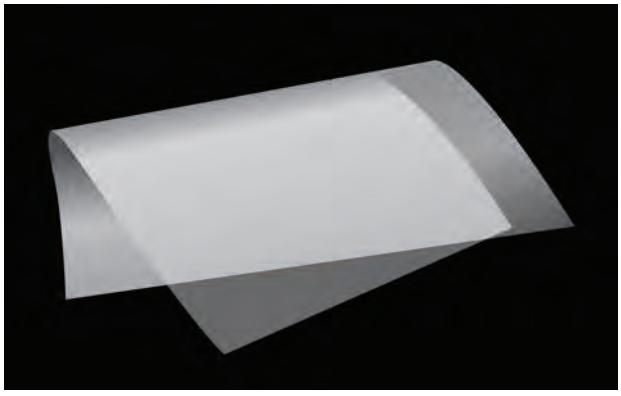


Fig. 14.14 : Grease proof paper

d) **Glassine paper :** The procedure for preparation of glassine paper is same as that of butter paper .

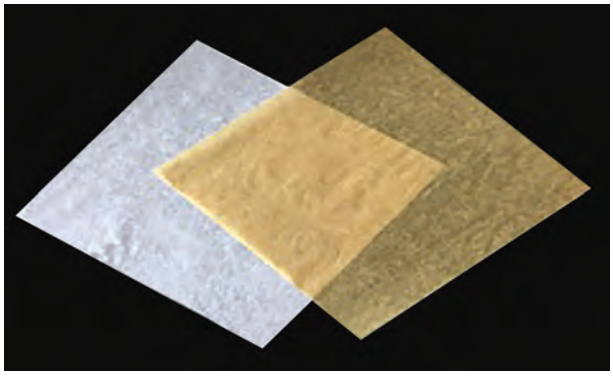


Fig. 14.15 : Glassine paper

e) **Parchment paper :** This paper is also called as vegetable parchment paper.

Fig. 14.16 : Parchment paper

f) **Corrugated fiber boards :** The paper having gram per square meter (GSM) more than 250 gms is generally called as paper boards. When these paper boards are lined with corrugated board then it is called as corrugated fiber board.

Fig. 14.17 : Corrugated paper board

Metal containers materials

In food packaging, four different metals i.e. Steel, Aluminum, Tin and Chromium, are commonly used. Aluminum is used in the form of purified alloys containing small and carefully controlled amounts of magnesium and manganese.

Fig. 14.18 : Metal container and can

Advantages

1. Light in weight
2. High mechanical strength
3. Low in cost
4. Can be used on high speed machine
5. Sustain high temperature
6. Environment friendly

Disadvantages

1. Rusting, denting, leakage and pinhole may occure.
2. Non visibility of the products.

Plastics

The word *"plastic"*is derived from the Greek *plastikos*, which means easily shaped or deformed. Basically plastics are petroleum by products of organic material of polymer group with long chain higher molecular weight compound.

The different plastics used for food packaging are as follows.

1. **Low density polyethylene (LDPE) -** LDPE film can be used for the packaging of milk, frozen foods, fresh fruits and vegetables, etc.
2. **Linear low density poly ethylene (LLDPE) :** These are used in preparing boil-in- bag pouches.

3. **High density polyethylene (HDPE) :** It is used as butter container, cereal boxes and bakery products, etc.

4. **Poly propylene (PP) :** PP bags are commonly used for packaging variety of food and food products including grain, spices, candied fruits, etc.

5. **Polyvinyl chloride :** It is used as a container (cup) for packaging of curd, ice-cream, spread, etc.

6. **Biaxially oriented poly propylene (BOPP) :** It is commonly used far packaging of bakery products, extruded food products, N_2 flushed and vacuum packaged products, etc.

Advantages

1. Durability.
2. Low cost.
3. Transparent / dark.
4. Used in combination with other layers.

Disadvantages

1. Plastic ability is to absorb flavours / odour.
2. Longevity / may get break / crack / tear during long period storage.
3. Create environmental pollution as they are not degradable.
4. Always use food grade plastic material.

Laminates

Combination of two or more webs by bonding them together are called **laminating** processes. These webs are comprised of films, papers, plastic aluminum foil, etc.

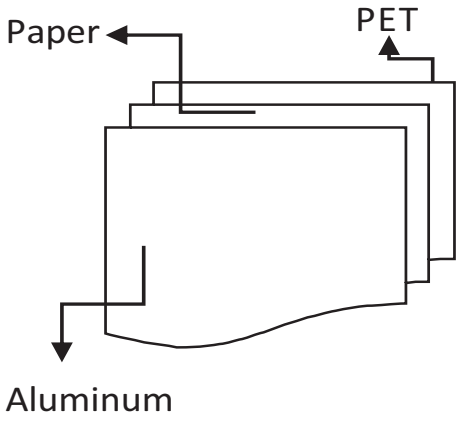


Fig. 14.19 : Laminating material

Tetra brik aseptic packaging

Aseptic packaging can be defined as the filling of a commercially sterile product into a sterile container under aseptic conditions and hermetically sealing the containers. This results in a product, which is shelf-stable at ambient conditions. The term "aseptic" is derived from the Greek word "septicos" which means the absence of putrefactive micro-organisms.

These pack consist of 6 layers such as polyethylene / polyethylene / aluminium – foil/ polyethylene/ Paper/ polyethylene.

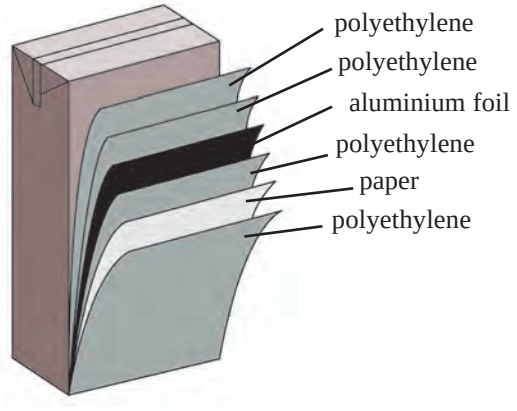


Fig. 14.20 : Tetra brik aseptic package

Advantages :

- Prevent spoilage due to aseptically processing.
- Extend the shelf-life of products at ambient.

Disadvantages :

- Expensive
- Special machine is required.

Edible Packaging

Edible films and coatings are those materials which can be directly consumed along with the fruit. They provide barrier and protection along with enhancing quality and safety of food products. The main advantages of edible packaging systems are integral part of the food product; they can be eaten, without the need to unpack or throwing the coated layer.

Edible films are in general good moisture barrier, able to inhibit moisture and gas exchange between food product and atmosphere. e.g. Bees wax, starch, alginate, gluten and casein based edible films.

Advantages :

1. Environment friendly, as fully consumed or biodegradable. Reduce the waste and solid disposal problem
2. Enhances nutritive values by supplementation of nutrients.
3. Individual packaging is possible for delicate fruits like strawberry, apple, etc.
4. Film can work as carrier of antimicrobial or antioxidant agents

Do You Know ?

Edible coatings are soluble formulations applied on food surfaces such that a thin layer of edible film is formed directly on the food surface or between different layers of components to prevent the migration of moisture, oxygen and solute into the food.

Drawbacks of edible packaging

1. The edible wrappers should not be used alone where unsanitary conditions during handling and processing may occur.
2. They would be used to wrap food inside a secondary synthetic packaging during distribution and storage.
3. Poor mechanical properties
4. High in cost than synthetic packaging

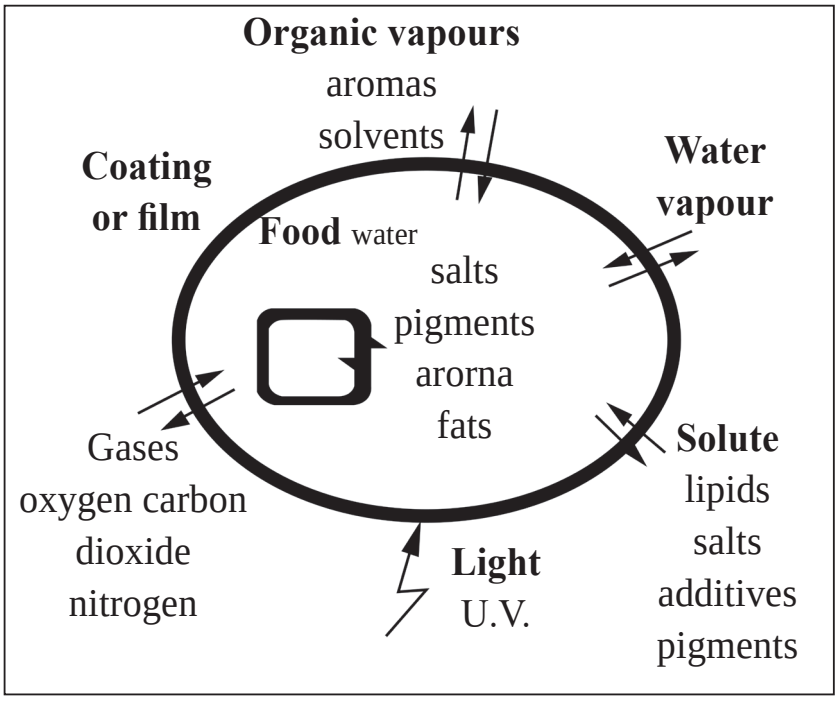


Fig. 14.21 : Functions of edible films

14.6 Bar coding

A barcode is a visual, machine-readable representation of data. The data usually describes something about the object that carries the barcode. Traditional barcodes systematically represent data by varying the widths and spacings of parallel lines, and may be referred to as linear or one-dimensional (1D). Later, two-dimensional (2D) variants were developed, using rectangles, dots, hexagons and other geometric patterns, called *matrix codes* or *2D barcodes*, although they do not use bars as such.

Benefits

In point-of-sale management, barcode systems can provide detailed up-to-date information on the business, accelerating decisions and with more confidence. For example:

- Fast-selling items can be identified quickly and automatically reordered.
- Slow-selling items can be identified, preventing inventory build-up.
- The effects of merchandising changes can be monitored, allowing fast-moving, more profitable items to occupy the best space.
- Historical data can be used to predict seasonal fluctuations very accurately.
- Items may be repriced on the shelf to reflect both sale prices and price increases.

Besides sales and inventory tracking, barcodes are very useful in logistics and supply chain management.

Commonly used barcodes are :

Name of Barcode	Example	Name of Barcode	Example
Linear Barcode	1. Codbar  2.  3. Universal Product 	Matrix (2D) barcodes	Aztec Code  QR Code  Data Matrix 

Points to remember

- Nicholas Appert is known as 'father of cannery'.
- The three main principles of packaging are : 1. Protection, 2. Preservation, 3. Presentation.
- There are three types of packaging : Primary, secondary and tertiary.
- There are various packaging material like - earthen pots, wood, glass, paper, metal containers, plastic, films, laminates, tetra brick aseptic packaging, etc.
- Bar-coding is visual machine readable representation of data.

Exercise

Q.1 (a) Select the most appropriate option:

i. _____ is fragile in nature.
(Glass, paper, metal)

ii. When two or more than two webs are combined then that film is termed as _____
(Laminates, edible film, earthen pot)

iii. _____ is the main function of packaging food.
(Protection, gurantee, reuse of packaging.)

iv. _____ is a visual machine readable representation of data.
(Code, barcode, edible film)

v. _____ layers are present in the tetrapak.
(6, 8, 10)

(b) Match the following:

A		B	
i.	Paper board	a.	Dahi
ii.	Barcodes	b.	Bonding of two or more web
iii.	Laminating	c.	More than 250 GSM
iv.	Wooden boxes	d.	Juice
v.	Earthen pots	e.	Fresh fruits
		f.	Machine - readable data

(c) State whether the following statements are true of false :

i. Nicholas Appert is known as father of canning.

ii. Protection, preservation and presentation are the main principles of food packaging.

iii. A package can be toxic.

iv. Earthen pots are suitable for all type of packaging.

v. LLDPE is used in preparing boil-in-bags pouches.

Q.2 Write in brief

i. Define packaging.

ii. Explain the types of packaging.

iii. Give any five requirements of packages.

iv. List the packaging materials

v. Explain earthen pot as packaging material.

vi. Give advantages of glass as packaging material.

vii. What are the advantages and disadvantages of plastic?

Q.3 Short answer question

i. Give advantages of metal as packaging material.

ii. Explain Tetra Brik Aseptic packaging with diagram

iii. Give advantages of edible films.

iv. Explain laminates.

Q.4 Long answer questions

i. Explain the principles of food packaging.

ii. Explain the types of paper

iv. Define barcode and give its benefits.

❖ Projects :

i. Preparation of album of different packaging material specimens.

ii. Preparation of label for any food products.

15 Nano Technology

Contents at a glance

Nanotechnology is the science of very small materials that has a big impact in food sector. It is newly emerging novel technique that can increase the shelf life of foods, minimizes the spoilage and ensures the food safety. Nanoparticles based food packages provide improved barrier, mechanical and antimicrobial properties that helps in preserving sensory qualities such as taste, colour, flavour, texture, apperance, consistency and also nutrients of food product. Edible nanolaminates could have applications in fresh fruits and vegetables, bakery products and confectionery, where they might protect the food from loss of moisture, lipids, gasses, off-flavours and odours. Food packages embedded with nanosensors can alert consumers when a product is no longer safe to eat. Intelligent food packaging, incorporating nanosensors, could even provide consumers with information on the state of the food inside.

Nanotechnology offers tremendous opportunities for innovative developments in food processing and packaging that can benefit both consumers and industry.

Definition:

Nanotechnology is defined as the study and use of structures between range of 1 nanometer (nm) and 100 nm in size, e.g. it would take eight hundred of 100 nanometer particles side by side to match the width of a human hair.

Do You Know ?

What is Nanotechnology?

"Nanotechnology is the science, engineering and technology conducted at nanoscale which is about 1 to 100 nanometers".

- Understanding and control of matter at nanoscale
- Nano: Derived from greek word 'nanos'-DWARF
- 1 Nano = billionth of a meter of 10^{-9} of a meter

Father of Nanotechnology: Richard Feynman

Researchers have been studying and working with nanoparticles for centuries, but the effectiveness of their work has been hampered by their inability to see the structure of nanoparticles. The following illustration provides a comparison of various objects to help to understand the size of nonomaterials. The chart starts with objects that can be seen by the unaided eye, such as an ant, at the top of the chart, and progresses to objects about a nanometer or less in size, such as the ATP molecule used in humans to store energy from food.

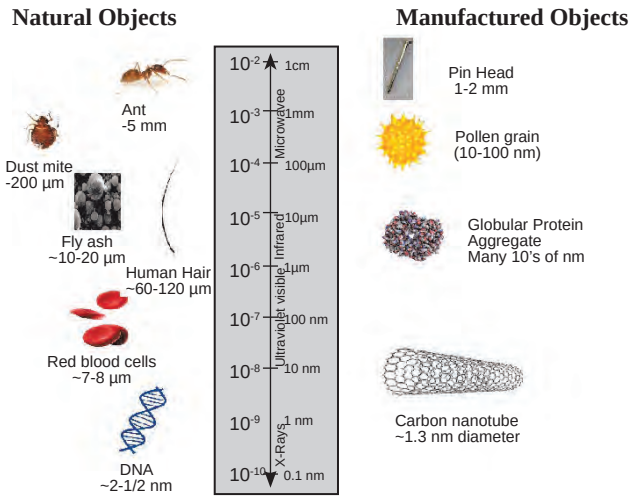


Fig. 15.1 : Visual display of natural and manufactured objects that fall in the "nano" (<100 nm) and "micro" (>100 nm) size ranges.

The ability to see nano-sized materials has opened up a world of possibilities in a variety of industries and scientific endeavours. Because nanotechnology is basically a set of techniques that gives opportunity to alter the properties at a very small scale and it can have plenty of applications.

15.1 Applications of nanotechnology in the food industry

Scientist specified some areas of food processing which are as follows:

Food security:

Nanotechnology provides better food security by application to all compentent of food chain from farm to fork. These component include farm inputs, farm production system, post harvest management, processing, maket and finally consumers.

Protection against spoilage:

Shelf life of food materials can be enhanced with the help of nanotechnology and helps to reduces wastage up to certain extent occurred due to microbial spoilage.

Development of innovative products:

Nanotechnology being applied in the formation of encapsulation, emulsions, biopolymer matrices, simple solutions, and association colloids offer efficient delivery systems with all the above-mentioned qualities. To improve taste, texture and consistency, numbers of nanostructured food ingredients are being developed.

Food processing:

The importance of nanotechnology in food processing can be evaluated by considering its role in the improvement of food products in terms of (i) food texture, (ii) food appearance, (iii) food taste, (iv) nutritional value of the food, and (v) food shelf-life. Texture, taste, and appearance of food nanotechnology provides a range of options to improve the food quality and also helps in enhancing food taste.

Nano additives:

Nano particles are being used as food additives which makes the food to stay away from microbial contamination hence lengthening the lifespan. Nanoscale food additives may be used to influence product shelf life, texture, flavor, nutrient composition, or even detect food pathogens and provide functions as food quality indicators.

Sensors for detection of contamination:

Nanotechnology is used to make nanosensors which will enable rapid testing of raw and processed food products in factory and during transportation. Nanosensors can be used to prove the presence of contaminants, mycotoxins, and microorganisms in food. Electronic nose recently available is the best example of nanotechnology based sensor.

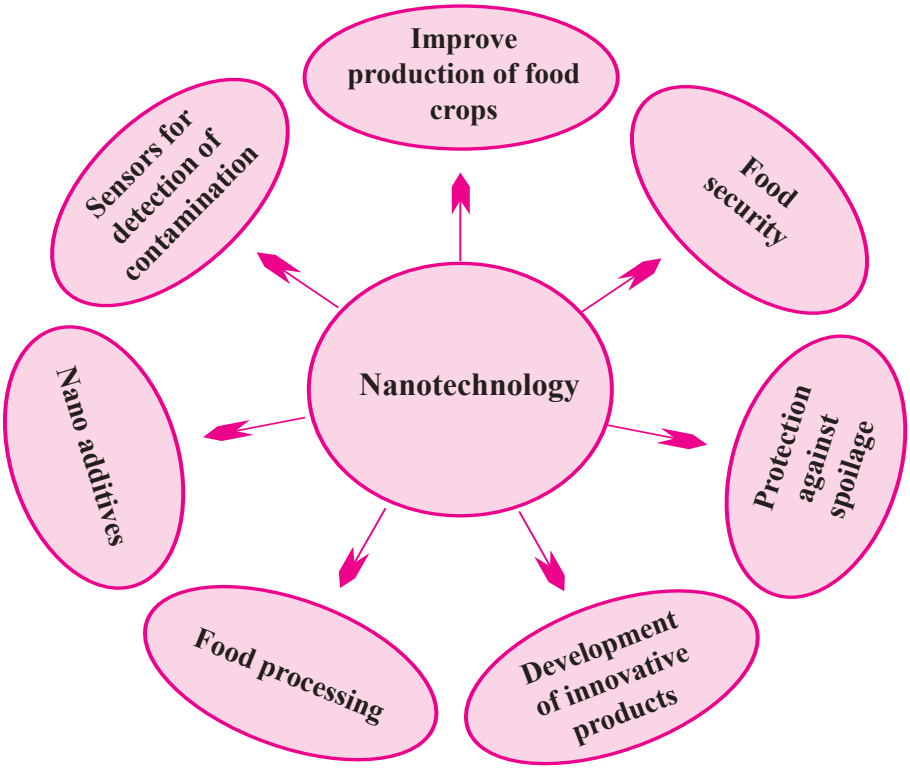


Fig. 15.2 : Applications of nanotechnology

Improve production of food crops:

Nanotechnology provides new agrochemical agents and new delivery mechanism to improve crop productivity and it reduces the pesticides use.

15.2 Applications of Nanotechnology in food packaging

Nano polymers are trying to replace conventional materials in food packaging. The ideal packaging material should have high barrier properties against gas and moisture along with strength and biodegradability (ecofriendly). A nano material helps to improves barrier properties along with improved mechanical strength. Nano-based "smart" and "active" food packagings confer several advantages than the conventional packaging from providing better packaging material with improved mechanical strength, barrier properties, antimicrobial properties to nanosensing for pathogen detection and alerting consumers to the safety status of food. Application of nano-composites as an active material for packaging and material coating can also be used to improve food packaging. Food nano packging classificaton and functions are indicated in Fig. 15.3.

Examples of nanotechnology in food packaging:

- Antibodies attached to nanoparticles to detect chemicals or food borne pathogens.
- Biodegradable nanosensors for temperature, moisture and time monitoring.
- Nanoclays and nanofilms as barrier materials to prevent spoilage and prevent oxygen absorption.
- Electrochemical nanosensors to detect ethylene gas liberated during ripening.
- Antimicrobial and antifungal surface coating with nanoparticles.

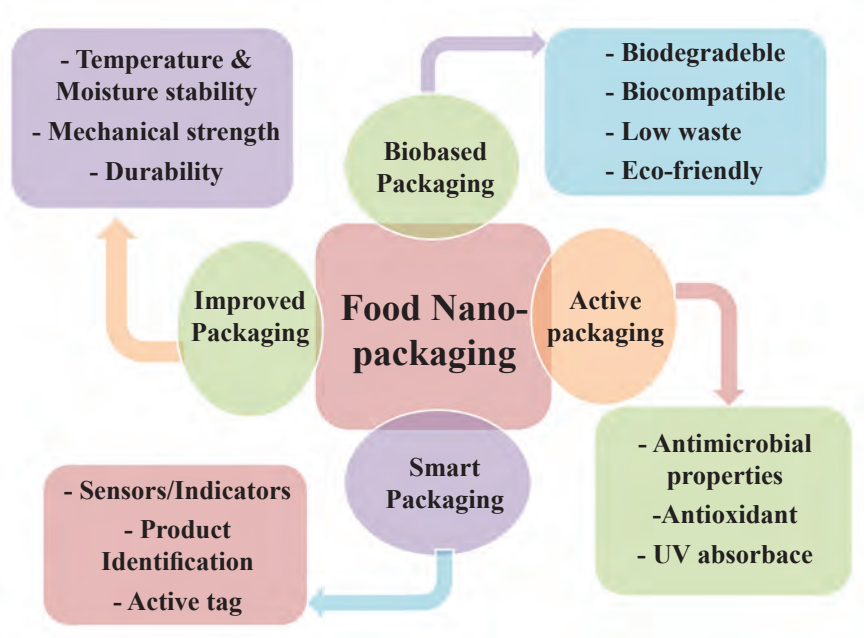


Fig. 15.3 Food nano-packaging classification and functions

Do You Know ?

- The ultra small has the potential to make enormous changes
- Nanotechnology is the technology of the future

Points to remember

- Nanotechnology has produced novel materials with interesting properties.
- Nanomaterial offer unique applications in food packaging & food safety.
- Nanotechnology offers tremendous opportunities for innovative developments in food processing and packaging
- Important application of nanoparticle in food industry such as food security, protection against spoilage, development of innovative products, food processing, nano additives, sensors for detection of contamination, improve production of food crops and advances food packaging

Activity

1. Collect the packaging materials having time temperature indicators and check its effect by changing environment of the wrapper.
2. Collect the color changing toys and record observation after change in temperature.

Exercise

Q.1 (a) Select the most appropriate option:

i. Size of Nano particles ranges from _____

(1-100 nm, 1-100 mm, 1-100 m)

ii. Father of nanotechnology is _____

(Nicolas Appert, Richard Feynman, Louis Pasteur)

iii. _____ of the food material can be enhanced with the help of Nano Technology

(Shelf life, spoliage, browning)

iv. Nano technology is used to make nenosensors for rapid testing of _____ food.

(Only raw, only processed, raw and processed)

(b) Match the following:

Component		Functions	
i.	Innovative Products	a.	Food Additives
ii.	Nanoparticles	b.	Encapsulation
iii.	Nanosensors	c.	Packaging
iv.	Nano polymers	d.	Testing of food
		e.	Food security

(c) State whether the following statements are true or false:

i. Nano technology is the science of very small materials that has a big impact in food sector.

ii. The size of nano materials are 100 m.

iii. Electric nose is the best example of nano technology based sensor.

iv. A nano material helps to improve barrier properties.

Q.2 Answer in brief

i. Enlist the applications of nanotechnology in food science and technology.

ii. Describe the nano additives.

iii. Explain the role of nanotechnology in food packaging.

iv. Enlist the nano food packaging.

Q.3 Short answer question

i. What is nano technology?

ii. Enlist the examples of nano technology in food industry.

Q.4 Long answer question

i. Desribe the nanotechnology in food industry.

ii. Explain the applications of nano technology in food packging.

❖ Project:

Collect the information on role of nanotechnology in day to day life food products.

16 Functional Food

Contents at a glance

Learning objectives :

Students will be able

1) To identify functional food products .
2) To critically analyze the health claims made on the labels of these products.
3) To learn and give examples of functional foods.
4) To learn the classification of functional foods.

Fig. 16.1 : Food as medicine

"Let your food be your medicine" said Hippocrates. Today food has become important beyond its basic nutrition, cultural pleasure of feeding a family and greeting friends in a social meeting. Products intended to cure diseases are medicinal products and not foods. But on the other hand, a healthy diet consisting of foods with functional properties can help to promote well-being and even reduce the risk of developing certain disorders like obesity, hypertension, heart related diseases, etc. World Health Organization (WHO) stresses the importance of a healthy diet in preventing non-communicable diseases. Healthy diet is not just about limiting certain components of concern such as saturated or trans fatty acids or simply delivering nutrient intake. It also includes those elements that may provide an extra benefit.

Need of functional food :

In the fast moving modern world of today, which is rapidly progressing towards industrialization and urbanization, need of functional food has become apparent due to drastic changes in lifestyle.

Definition of functional food :

Functional food is any fresh or processed food claimed to have a health promoting and/ or disease preventing property beyond the basic nutritional function of supplying nutrients.

16.1 Classification of functional foods

Functional food has been classified into four categories: conventional foods, modified foods, medical foods, and foods for health use.

1) **Conventional foods:** Conventional foods are the most basic of the functional foods because they have not been modified by enrichment or fortification. They are still in their natural state. Most whole fruits and vegetables fall into this category because they are rich in phytochemicals such as lycopene and lutein, fibre, as well as other beneficial compounds (vitamins, minerals and antioxidants) e.g. tomato is a functional food because it contains bioactive compound called Lycopene. Lycopene is associated with reduction of cancer. Traditional natural way of making curd in earthen pots gives probiotic effect.

2) **Modified foods:** Modified foods are enriched, fortified, supplemented or enhanced with nutrients or other beneficial ingredients. Calcium-fortified orange juice, folic acid enriched breads and margarine supplemented with plant sterols are the modified foods. Omega-3 enriched bread (adding flax seed) is also considered as functional food. High fibre biscuits fortified with oat flakes are good for cancer and diabetic patients.

3) **Medical foods:** These foods need a doctor's prescription and are not available over the counter to consumers but can be taken through medical representative. They are specially formulated foods given either orally or through tube feeding under medical supervision e.g. malted baby food, ORS preparations for diarrhoea patients.

4) **Foods for special dietary use:** Foods for special dietary use are similar to these medical foods, but they are available commercially and do not require the supervision of a health care provider. These foods fulfill special dietary needs that are due to specific health conditions, such as celiac disease, lactose intolerance, obesity, analmic condition, etc. Gluten-free foods, and other foods designed to for weight loss are considered for special dietary use. Infant foods are also grouped in this category. Lactating mothers are advised to have *shatavari* extract to get easy flow of milk.

Few examples of functional foods available in Indian market (Table 16.1) are such as gluten free *atta*, probiotic yoghurt, fruit juices (natural, ayurvedic and smoothies), green tea (rich of antioxidant), vegan milk (lactose free), Omega-3 fatty acids in flax seed, fish oil enriched breads, plant sterol and stanol-enriched margarine, calcium-enriched milk, caffeine-enriched beverages like sports drinks. Some examples of functional foods with their health claims and active ingredients are illustrated in table-16.2

Do You Know?

Dry pulses do not contain any ascorbic acid, while germinated/ sprouted green pulses do contain ascorbic acid which has a potential antioxidant property.

16.2 Health benefits of functional foods

Functional foods have numerous health benefits and disease preventive effects e.g. treatment of cancer, atherosclerosis and cardiovascular disease (CVD), anti- ageing, immune boosting as well as managing diabetes. The health promoting effect is because of the presence of bioactive constituents.

Functional foods offer great potential to improve health and/or help prevent certain diseases when taken as part of a balanced diet and healthy lifestyle.

Probiotics :

Probiotic bacterial are beneficial or friendly bacteria that are naturally present in some of our foods or are added to processed foods for their health benefits.

By probiotics, we mean beneficial bacteria like *Lactobacillus* species found in the intestine which combat harmful pathogens and provide additional health benefits.

Benefits of probiotics:

1. Reduce diarrhoea and irritable bowl syndrome
2. Reduce symptoms of colds
3. Improves digestion

Sources of probiotics:

Fermented milk products such as curd, yogurt and buttermilk.

Prebiotics :

Prebiotics are special indigestible soluble fibres present in plant foods that support the growth of probiotic bacteria without being affected by cooking or digestive processes.

Benefits of prebiotics:

Indirectly prebiotics confer numerous health benefits.

1. Reducing prevalence of infectious diseases
2. Reduces antibiotic associated diarrhoea.
3. Reduces risk of CVD and colon cancer.
4. Prebiotics provide satiety, reduce weight and thus helps in prevent of obesity.

Sources of prebiotics:

Whole grain specially oats, wheat bran, soyabean, flax seeds, carrots, citrus fruits, etc.

Table 16.1 : Functional foods available in Indian market.

Name of the product	Health claim	Examples
Gluten free atta/Low gluten atta	Good for patients with gluten protein allergy or celiac disease	Brown rice, jowar, wheat free atta flour
Probiotic drinks	Improves digestion, immunity gives longer life	Live bacteria of *lactobacillus* species.
Multigrain cereals	Cholesterol management	Rich in fiber, bran and resistant starch
Vegan milk e.g almond, soya	Weight management	Rich in protein and calcium
Beverages like green tea and smoothies	Good for nervous system, Rich in vitamin and minerals	Green tea, fruit, rich source of mineral, vitamins, antioxidant and polyphenols.



16.3 Examples of functional foods :

Some examples of functional food are presented in table 16.2

Do You Know ?

To treat gastro-intestinal health complaints probiotcs and prebiotics foods are well known options.

Table 16.2 : Foods with functional component along with their potential health benefits.

Functional food	Functional component	Potential health benefits
Tomatoes, watermelon	Lycopene (as antioxidant)	Lower risk of prostate cancer
Citrus fruits	Flavanones (as antioxidant)	Reduced risk of some cancers
Soy-based foods	Isoflavones (as polyphenols)	Lowers LDL, total cholesterol and triglycerides, and improves HDL
Cranberries	Proanthocyanidins (as antibacterial agent)	Lower risk of urinary tract infection
Fatty fish	Omega-3 fatty acids Polyunsaturated fatty acids	Reduced risk of cardiovascular disease
Whole grain foods/ multigrain foods	High bran/fiber	Reduced risk of cardiovascular disease, cancer, and mortality from all causes, diabetes and constipation patients
Ginger	Gingerol and shogaol (as antioxidant, antibacterial agent)	Reduces throat infection.
Turmeric	Curuimin (as antioxidant, antibacterial, natural colourant)	Reduces skin diseases and used in cosmetics

Points to remember

- Functional foods provide additional health benefits that may reduce disease risk and promote optimal health.
- Examples of functional food might include many fruits and vegetables, enriched bread, calcium-fortified orange juice, oats (lower cholesterol), fatty fish (omega-3 fatty acids), margarines with plant stanols and special foods for allergies or health conditions etc.
- Conventional foods are unmodified whole foods, including fruits, nuts and vegetables
- Modified foods are modified through fortification, enrichment or enhancement, such as calcium-fortified orange juice, folate-enriched bread, margarines with plant stanols or sterol esters
- Medical foods are used under physician supervision for a specific medical condition, e.g. special dietary formulas for diabetes or liver conditions
- Special dietary foods are used for specific conditions, such as infant formulas, allergies, gluten free and lactose free.
- Some benefits of functional foods are to reduce the risk of certain diseases, lower cholesterol, risk of heart disease and may help with weight control.

- Probiotics are beneficial bacteria found in the intestine which combat harmful pathogens and provide additional health benefits.
- Prebiotics are special indigestible soluble fibres present in plant foods that support the growth of probiotic bacteria without being affected by cooking or digestive processes.

Exercise

Q.1 a) Select the most appropriate option:

i. Conventional foods is a type of _____ food.
(functional, junk, fast)

ii. _____ has been enriched, fortified, supplemented or enhanced with nutrients or other beneficial ingredients.
(modified, medical, conventional)

iii. _____ is an example of modified food.
(Tomato, omega-3 fatty acid enriched bread, plain bread)

(b) Match the following:

A		B	
i.	Watermelon	a.	Flavanones
ii.	Citrus	b.	Omega-3 fatty acids
iii.	Fatty fish	c.	Lycopene
iv.	Curd	d.	Prebiotic
v.	Oats	e.	Probiotic
		f.	Antioxidant

(c) State whether the following statements are true or false:

i. Functional food have health promoting properties.

ii. Lycopene lowers the risk of cancers.

iii. Prebiotics are not at all useful.

iv. Medical food has to be given under the supervision of a physician.

Q.2 Answer in brief

i. Name the classification of functional foods

ii. Modified foods

Q.3 Short answer questions

Define

i. Functional foods

ii. Conventional food

iii. Probiotics

iv. Prebiotics

Q.4 Long answer question

i. Explain the classification of functional foods in detail

❖ **Project :**

i) Classify functional foods in different way (enriched foods, modified foods, health claims, etc.)

ii) Prepare a recipe for breakfast rich in probiotics and lunch enriched with prebiotics and healthy functional dinner.

iii) Choose one particular type of functional food sold in your local supermarket. Find two other products in that range and describe the information that is on the label for consumers. Use the computer to help you list and compare the nutritional information on a chart. Do any of these foods have 'warning' statements?

Glossary

Absorption: The uptake of the end products of digestion through the cell membrane of digestive tract into blood and lymph circulation

Acceptability: Able to be accepted

Adulteration: Addition of substance resulting in a poorer quality

Aerobic: Reaction in presence of oxygen

AGMARK: A standard mark on agricultural products ensuring their quality, purity and wholesomeness

Anaemia: Reduction in number of red blood cells or circulating haemoglobin resulting in paleness

Anaerobic: Reaction in absence of oxygen

Antioxidant: Substance which retards rancidity and deterioration from exposure to oxygen

Appetizers: Substances which increase hunger pangs

Balanced diet: Diet supplying all the nutrients in adequate amounts

BMR: Basal Metabolic Rate

Beri-Beri: Disease affecting the nervous system due to thiamine deficiency

BIS: Bureau of Indian Standards

Blanching: Dipping food in boiling water for a few minutes

Braising: Method of cooking where two different medias are used

Caramelization: Formation of a caramel on application of dry heat to sugar

Carbohydrate: Organic compound containing carbon, hydrogen and oxygen

Cluster: A group of food industries formulated by government

Coagulation: Chemical irreversible change in protein due to effect of heat, light or change in pH

Cooking: Use of heat to bring about desirable changes in food

Crystallization: Process of crystal formation.

CVD: Cardiovascular disease

Dehydration: Removal or loss of large amount of water from a substances or a body.

Denaturation: Physical reversible change in protein due to effect of heat, light or change in pH

Dextrinisation: A process in which on application of dry heat to foods containing starch, starch granules break into dextrin resulting in a brown colour, a typical flavor and a sweet taste.

Disaccharide: Carbohydrate consisting of two monosaccharide units.

Discoloration: Loss of colour

Emulsifiers: Substances which help in preparation of an emulsion

Emulsion: A dispersion of two immiscible liquids.

Fats: Esters of fatty acid and glycerol

Fermentation: Decomposition of dietary substance with or without oxygen where CO_2 is formed.

Fibre: Component of dietary plant material that cannot be digested by enzyme in the human intestinal tract.

FIFO: First in first out

Flavour: Combined effect of taste and smell sensation produced by food.

Fortifiers: substances added to improve the nutritive value.

FPO: Fruit Product Order-A standard mark on fruits and vegetable products to ensure their quality.

Food: Solid, semi solid and liquid material which can be consumed to sustain body and keep it healthy.

Food additives : Substance added intentionally in small quantity to improve the functional, physical and sensory properties of food.

Food pyramid : Food group based structure used in planning of blanced diet.

FSSAI: Food Safety Standard Authority of Indian, 2006

Gel: A semi solid which has a particular shape

Gelatinization: A process in which when starch granules are heated in water swell up resulting in thickening.

Germination: Development of sprout in grain.

Gluten: Protein present in wheat which gives elasticity to dough.

GLV: Green leafy vegetable

Goiter: Enlargement of thyroid gland due to iodine deficiency.

Grilling: Directing heat downward for cooking food.

HDL : High density lipoprotein.

Homogenization: Processing of milk to break the fat globules into uniform size.

Hygroscopic: A substance which easily absorbs water.

Identity of grain: Grain do not lump together and remain separate.

Inversion: Hydrolysis of sucrose into equal amount of glucose and fructose due to action of acid or enzyme.

ISI: Indian Standard Institute-an act formulated in 1952

Kwashiorkor: Disease due to deficiency of protein in children.

LDL : Low density lipoprotein

Maillard reaction: Non-enzymatic browning due to sugar – amino acid reaction.

Malting: Germination under controlled conditions

Marasmus: Disease due to deficiency of protein and calorie in children showing emaciation

Monosaccharides: One carbohydrate unit.

Myoglobin: Red colour pigment in muscle of meat.

Nutrient: A chemical substance in food essential for maintain the functions of the body.

Nutrition: Scientific study of nutrients

Obesity: When the body weight is more than twenty percent of the ideal body weight

Oedema: An excess of watery fluid in the cavities of tissues of the body

Oils: Lipids at room temperature

ORS: Oral Rehydration Solution

Osteomalacia: Weakening of the skeletal system in adults due to deficiency of vitamin D, calcium and phosphorus.

Oxidation: Reaction involving combination of oxygen.

Palatability: Acceptability of food in terms of flavor, taste, texture, colour and temperature of food by human sensory organs.

Pasteurization: Mild heat treatment to kill pathogenic bacteria.

Pectin: Cementing substances in cell walls of fruits.

Pellagra: Deficiency disease of niacin affecting digestive system, nervous system and skin.

Perishable: Which spoils easily.

Pesticides: Substance for destroying insects or pests.

PFA: Prevention of Food Adulteration Act-a food law formulated in 1954.

Polysaccharides: Carbohydrates consisting of more than two monosaccharide units.

Prebiotics: Special indigestible soluble fiber present in plant foods which stimulate the growth and/or activity of bacteria in our digestive system.

Precursor: A compound that can be used by the body to form an essential nutrient.

Preliminary treatment: Special treatments before cooking the food.

Preservatives: Substance which increases the shelf life of food.

Probiotic: Probiotic bacterial are also known as beneficial bacterial or friendly bacteria and are naturally present in some of our foods or are added to processed to processed food for their health benefits.

Protein: Complex organic nitrogenous substances.

QA: Quality analyst

REE: Resting Energy Expenditure

Rickets: Deficiency disease of vitamin D associated with skeletal malformation

Sauteing: To fry quickly in a small amount of fat

Sensory: Related to sensation or the five human sence (touch, smell, taste, hearing and sight)

Scurvy: Vitamin C deficiency leading to swelling, bleeding of gums and prone to internal haemorrhage.

Serving: Amount of food served to a person at a time e.g. one medium size chapatti.

Shortening: Addition of fat to dough to make the product crisp.

Tannins: Phenolic substance responsible for enzymatic browning in vegetable and fruits.

Taste: Sensory property evaluated by tounge (sweet, sour, salty and bitter)

Texture: The feel, appearance or consistency of food.

UHT: Ultra high temperature

Vitamin: Vital organic substances necessary in small amounts for growth, reproduction and maintenance of health.

Viz. : Namely

Some important abbreviations :

Abbreviations		Approximate Weight
Cupful	C	150 gm or ml
Tablespoon	T/tbsp	20 ml or gm
Teaspoon	t/tsp	5 gm or ml
Kilogram	Kg.	1000 g
Litre	Lt./lit.	1000 ml
Gram	g.	1000 mg
Millilitre	ml.	1000 µl

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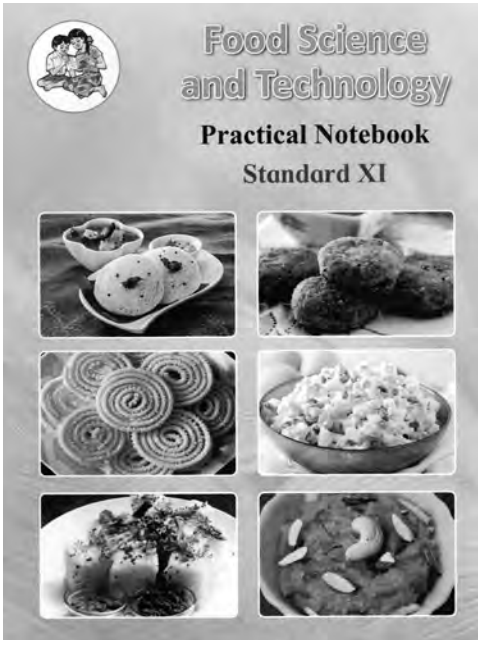

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