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BHHM-06

Vardhaman Mahaveer Open University, Kota

Food Science and HACCP

BHHM-06

Vardhaman Mahaveer Open University, Kota

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Unit – I : Introduction To Food Science

Structure of Unit:

1.0 Objective

After completing this unit you will be able to**:**

- Understand the meaning and definition of food science.
- Explain the scope of food science.
- Know relationship with other subject.
- Know about the food processing.
- Know about the Nutrients and Nutrition.
- Know about the Function of food.
- Know about food intake and its regulation.

1.1 Introduction

Food is basic necessity of life. Everybody eats food and most people enjoy it. Food is intimately woven in to the physical, economic, psychological, intellectual and social of life man .it is a part of his culture and is filled with many different meanings and symbolisms for all individuals at various ages and stages of their maturity. From the beginning, scientists were curious about the food they consumed, its passage in the body and its effects. This curiosity led to the development of the science of nutrition. Nutrition is defined as the scientific study of food and its relation to health. It can also be defined as the science which deals with hose processes by which body utilizes food for energy, growth and maintenance of health. Agriculture produce, such as cereals, pulse, fruits and vegetables, and rare animals for slaughter, milk, eggs, etc., are foods or food raw materials. When consumed, foods undergo digestive and other change to supply the body its requirements. After

production and before consumption, foods are subjected to numerous adverse physical, chemical, microbial or parasitic factors which may cause their spoilages or cause disease when consumed. To prevent these and prepare food for immediate or future use require processing, preservation and storage. Food for consumption should have the proper appearance, colour, juiciness, texture, odour and taste.

Food science draws from many disciplines such as biology, chemical engineering, and biochemistry in an attempt to better understand food processes and ultimately improve food products for the general public. As the stewards of the field, food scientists study the physical, microbiological, and chemical makeup of food. By applying their finding, they are responsible for developing the safe, nutritious foods and innovative packaging that line supermarket shelves everywhere. During the past few decades great advances have been made in the study of the whole field of the properties, preservation and processing of raw food and of the behaviour of finished food products. If we look in to the recipes that have been used for generations, we find that a majority of them are nutritionally well balanced and season oriented. Today, in the light of nutrition education and scientific knowledge, we must appreciate the instinctive approach of our ancestor towards food.

In the beginning of this century, interest in nutrition was mainly related to the energy need of the human body, i.e. how much energy is obtained from different constituents of food like carbohydrates, protein and fats. Now nutrition is an important part of our life. We have realize d that quality of our health depends upon the nourishment that we provide our life. However our dietary habits influenced by many factors like family, religion, age, culture, tradition etc.

Most people eat what they like or because it is norm or our out of habit. Their food of choice is not influence by the awareness of its nutritive value. Few people know the way body utilizes food. It is also necessary to understand that a delicious dish is not necessarily a nutritious one.

1.2 Definition

Food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrate, fats, protein, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, or stimulate growth.

1. Nutrition is the combination of processes by which living organism receives and utilizes the material necessary for the maintenance of its functions, growth and renewal of its component.

D.F Turner

2. Food is the basic necessity of life. Food nourishes the body

Subhangini joshi

3. Food is that which nourishes the body. Different foods are alike in their ability to nourish, because each food does not contain identical amount of nutrients.

Usha Tandon

4. What one feeds on, what can be digested and which sustains or promote growth is called 'food'

Chamber's Twentieth Century Dictionary

5. All solid and liquid food which is eaten or drunk by us, edible, easily digested by the body; gives energy and heat, promotes, growth, repairs tissues and nourishes our body called food.

6. Nutrition is the science of foods, the nutrient and other substances there in, their action, interaction and balance in relationship of health and disease, the process by which the organism ingests, digests, absorbs, transports, and utilizes nutrients and disposes of their end products. In addition, nutrition must be concerned with social, economic, cultural and psychological implication of food and eating.

Robinson .W.D.

7. The study of various nutrients, their functions, food sources, and their effect in human well being is called nutrition.

S.Mudambi & Shalini Roa

Food Science Food is mixture of many different chemical components. The study of food science involves an understanding of the changes that occur in these components during food preparation whether natural or induced by handling procedures. Many physical and chemical reactions occur during food preparation. These reaction may be a result of the interaction between components , with the medium of cooking, and the environmental conditions like heat, cold, light and air to which they are subjected during cooking. Study of food science also includes understanding the nutritive value of different foods and method of preservations them during cooking. This information provides a foundation of theory and method on which to build the study of food preparation.

1.3 What is Nutrition

Nutrition is the science of food and its interaction with an organism to promote and maintain health .thus, nutrition is a combination of processes by which all parts of the body receive and utilize the materials necessary for the

performance o their functions and for the growth and renewal of all the components.
Food is the substance taken in to the body that will help meet the body's needs for energy, maintenance of health, growth and reproduction.

Optimum nutrition means that a person is receiving and utilizing essential nutrients in proper proportions as required by the body while also providing a 'reserve'.

Nutritional status is the condition of the body as it relates to consumption and utilization of food. The nutritional status of a person may be either good or poor.

Good nutritional status refers to the intake of a well-balanced diet, which supplies all the essential nutrients to meet the body's requirements. .such a person may be said to receiving optimum nutrition.

Poor nutritional status refers to an inadequate or even excessive intake or poor utilization of the nutrients to meet the body's requirements. Overeating can also result in poor nutritional status of a person.

Malnutrition refers to the physical effects on the human body of a dietary intake inadequate in quantity and quality.

Under nutrition refers to low food intake. Basel Metabolic Rate (BMR) is the minimum energy expenditure necessary for body maintenance at rest with no physical activity.

1.4 Food As A Source Of Nutrient

Food is more basic need of man than shelter and clothing. It provides adequately for the body's growth, maintenance, repair and reproduction. Food furnishes the body with the energy required for all human activities – it provides material required for the building and renewal of body tissues and the substance that act to regulate body processes. An individual food, such as milk, may fulfil all these function or, as in the case of sugar, ay one function. However, all the above functions of food must be served by the diet in order to maintain the body in good health. Most foods fulfil more than one function as they are complex mixtures o a number of chemical substances.
Foods are composed of dozens or even hundreds of different kinds of substances- the 'nutrient; which when consumed in adequate amounts, fulfil all the function of the body .six general classes or kinds o nutrients found in all food are carbohydrate, fats, protein vitamin, minerals and water.

Carbohydrates make up the bulk of our diet. They are our chief source of energy. About 70 percent of the energy requirements for all body functions is obtained from carbohydrates. Carbohydrates also help in the utilization of fat

and protein. Carbohydrates when consumed in excess are converted in to fats to be used when needed. The main sources of carbohydrate in the diet are starch and sugar.

Fats and lipids are the most concentrated from energy in the food. They furnish more than twice the number of calories per gram by carbohydrate or protein .when compared to carbohydrates; fats contain a less percentage of oxygen and more of hydrogen, and consequently on oxidation yield more energy. Generally about 30 per cent of human energy requirements are met by fat. Fats are abundant in both plant and animal materials.

Protein is the major source of building materials for the body. They play an important role as structural constituents of cellular membranes and function in the maintenance and repair of body tissues. Proteins also function as biocatalysts. The food value of the protein depends upon the nature and content of its amino acid, which are its structural units. The excess of protein not required for building may be used as a source of energy. Proteins are found in both animal and plant tissues.

Vitamins are "accessory nutrients." They are required for the proper utilization of the bulk food of the diet- carbohydrates, fats and proteins, and for the maintenance of good health. Vitamins to gether with minerals are involved in small quantities in the regulation of body processes. They are constituents of enzymes, which function as catalysts for many biological reactions in the body. Vegetables and fruit are good source of vitamins.

Minerals are found in foods from animal and plant sources. The mineral content of plant foods varies depending upon the mineral elements present in different tissues. Mineral, as vitamins, are added to enrich it.

Water is second only to oxygen in importance for the body. It is an ideal medium for transporting dissolved nutrients and wastes throughout the body.

1.5 Function of Food

Foods are classified according to their function in the body.

Energy yielding

This group includes foods rich in carbohydrate, fat, and protein. One gram of carbohydrate gives 4 calories. One gram of proteins gives 4 calories. One gram of fat gives 9 calories. This group broadly divided in to two parts:

- Cereals, pulses, nuts and oil seeds, roots and tubers.
- Pure carbohydrate likes sugar and fats and oils.

Cereals provide in addition to energy large amounts of proteins, minerals and vitamin in diet. Pulses also give protein and B vitamins besides giving energy

of the body. Nuts and oilseeds are rich in yielding as they are good sources of fats and proteins. Roots and tubers though mainly provide energy; they also contribute to some extent mineral and vitamins.

Pure carbohydrate like sugars provide only energy (empty calories) and fats provide concentrated source of energy and fat soluble vitamins.

Body building

Foods rich in protein are called body-building foods. They are classified in to two groups:

- Milk, egg, meat, and fish: They are rich in proteins of high biological values. These proteins have all the essential amino acids in correct proportions for the synthesis of body tissues.
- Pulses, oilseeds and nuts: they are rich in protein but may not contain all the essential amino acid required by the human body.

Protection and regulation

Foods rich in protein, vitamins and minerals have regularly functions in the body e.g. maintaining the heart beat, water balance, temperature. Protective foods are broadly classified in to two group.

- Foods are rich in vitamins and minerals and proteins of high biological value e.g. milk, egg, fish, liver.
- Foods are rich in certain vitamins and minerals only e.g., green leafy vegetables and fruits.

Maintenance of health

Foods contains certain photochemical and antioxidants which help in preventing degenerative diseases. Foods play an important role in the prevention of cancers, heart diseases and in controlling diabetes mellitus.

Some examples for functional foods are whole grains, soya bean, green leafy vegetables, coloured fruits and spices.

1.6 Food Intake and Its Regulation

All animal must eat to live and all have mechanisms that direct them to take food. In almost every case some control is exerted over the amount and kind of food that is taken. When hungry the animal responds by locating and ingesting foods and eating stops when hunger is satisfied.

Hunger, Appetite and Satiety

Hunger is usually an unpleasant sensation that compels a person to seek food and eat it. It is a physiological, condition which is associated with the

contraction of the stomach. The contractions are forceful and occur for a period and then die away as the stomach passes in to a resting stage. Hunger conditions that subside without eating will reappear later with greater intensity. In addition to stomach contractions resulting in tenseness, rumbling and a feeling of emptiness, a hungry person may experience certain general sensation, e.g. weakness, irritability, occasional headache or even nausea.

Appetite is most people is a pleasant sensation that causes a person to desire and anticipated food. An appetite can be for a certain kind of food. Appetite also has physiological components but is basically a psychological

1.7 Scope of Food Science

Food science is simply the study, production and distribution of food. Improvement, preservation, packaging and distribution of foods is the focus of a food scientist. Of late, people have become actually conscious about and quality plus nutritional values of food, giving a much needed boost to this field.

Food services: This can include a number of facilities in the commercial sector like food manufacture, catering services and restaurants where nutrition professional can do anything from menu planning to meal preparation to promotion of the food products.

Health care: this is one of the largest and well known functions of nutrition in hospitals and clinic. Dietician assists in treating patients with some big hospitals also providing scope for research, food administration, teaching etc.

Dissemination: The entails books, articles, promotions, television programmes on optimum dietary practise, since the present era is highly health conscious.

Institutional catering: nutrition and dietetics professional are needed to plan prepare nutritious and well balanced meals for school, colleges, factories, offices, canteens etc.

Research and development: R&D, as it is called, deals with conducting research projects on various food items to ensure welfare from both the commercial food services viewpoint, plus that of the health care provision.

Social welfare: Run by governmental organizations, this section is busy in improving the eating habits and consequently, the health of the less- fortunate groups in society.

1.8 Its Relationship with Food Chemistry

Food chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods. The biological substances

include such items as meat poultry lettuce beer and milk as examples. It is similar to biochemistry in its main components such as carbohydrates, lipids and protein but it also includes areas such aswater, vitamins, minerals enzymes food additives flavours and colour. This discipline also encompasses how products change under certain food processing techniques and ways either to enhance or to prevent them from happening. An example of enhancing a process would be to encourage fermentation of dairy products with microorganisms that convert lactose to lactic acid; an example of preventing a process would be stopping the browning on the surface of freshly cut Red Delicious apples using lemon juice or other acidulous water. Food chemistry is concerned with analytical, biochemical, chemical, physical, nutritional, and toxicological aspects of foods and food ingredients. The long-term goals of research in food chemistry are to understand relationships between the structure and functional properties of food molecules and to improve the nutritional, safety and organoleptic aspects of food.

Students of food chemistry must have a strong background in the basic sciences and should specialize in one or more of the following minor areas: organic chemistry, biochemistry, nutritional biochemistry, physical chemistry, toxicology, analytical chemistry, and chemical engineering.

Opportunities for research projects in food chemistry include structure/function relationships in food molecules (rheology, emulsions, foams, gels); computer modelling of food molecules; effects of processing, fortification, and packaging on nutritional quality of foods; food toxicology; and flavour chemistry of fruits and vegetables.

1.9 Its Relationship with Food Microbiology

Microbiology is important to food safety, production, processing, preservation, and storage. Food microbiology students use a wide variety of modern technologies from fields including immunology, microbiology, and molecular biology. Microbes such as yeasts, moulds, and bacteria are being used for the production of foods and food ingredients. Beneficial microbes are exploited in the fermentative production, processing, and preservation of many foods and beverages. Spoilage microorganisms cost food producers, processors, and consumers millions of dollars annually in lost products. Lost productivity resulting from illness caused by food borne microorganisms is an enormous economic burden throughout the world. The study of food microbiology includes understanding not only the factors influencing the growth of microorganisms in food systems but also the means of controlling them.

Students who specialize in food microbiology are expected to have sound undergraduate training in microbiology, physics, chemistry, organic chemistry, and biochemistry.

Possible research projects include the genetic control of microorganisms important to foods, the genetics and biochemistry of bacteriophage, site-directed mutagenesis to improve catalytic functions of enzymes, the spoilage bacteria in fruit products, factors influencing growth of human pathogens in foods, and rapid methods for detecting food borne pathogens

1.10 Food Processing

Food processing is the transformation of raw ingredients into food, or of food into other forms. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life food products. Similar processes are used to produce animal feed. Processed foods have been altered from their natural state, either for safety reasons or for convenience. The methods used include canning, freezing, refrigeration, dehydration and aseptic processing.

We tend to think of them as bad, like most high-fat, high-calorie snack foods or even those pre packaged meals you fix in a skillet, but it turns out that some of these foods are not bad for your health at all. For example, milk would be considered a processed food because it's pasteurized to kill bacteria and homogenized to keep fats from separating. Some people prefer raw milk, but it can lead to lead to food-borne illness, so most of us are happy to consume the healthy processed milk we find in our grocery stores.

Freezing vegetables preserves most vitamins and minerals and makes them convenient to store, cook and eat all year around. Fruit and vegetable juice is also an example of a healthy processed food -- usually. In fact, some orange juice is fortified with calcium to make it even more nutritious. Oatmeal, unbreaded frozen fish fillets, canned salmon, frozen berries and 100-percent whole grain bread are also examples of processed foods that are good for you.

Processed foods often have long ingredient lists that usually include some type of vegetable oils, such as corn oil, cottonseed oil, soybean oil, canola oil or safflower oil. Unlike olive oil, avocado oil and nut oil, which can be simply obtained with a cold-press, other vegetable oils need to go through many processing steps, including chemical extraction, bleaching and deodorizing. These oils, and foods containing them, are highly processed. Trans fat, which is the result of the hydrogenation of vegetable oils, is also a processed food. Avoid these foods since their fats are almost always damaged and can negatively impact your health. Apart from olive oil, avocado oil and nut oil, butter, ghee, lard and extra-virgin coconut oil are considered better fat options because they go through minimal processing that you can even do yourself at home without special equipment.

Low-Fat Products

Food manufacturers are now offering a variety of low-fat products, from low-fat breakfast cereals and low-fat cookies to low-fat ice cream and low-fat frozen entrees. Many of these foods contain chemical ingredients to simulate the flavor and texture of fat. Low-fat cheese, yogurt and milk also go through extensive processing to remove natural fat. The rich flavor of real, unprocessed food is more satisfying. Enjoy small amounts of full-fat cheese or yogurt instead of choosing the low-fat variety and ending up eating more because of its low satiating power.

Sugars

Sugars like honey and maple syrup have been used in small amounts for centuries in the human diet. Table sugar, brown sugar and high-fructose corn syrup, on the other hand, are the results of modern food manufacturing practices and are considered processed ingredients. If you are trying to eat a clean diet by avoiding processed foods, eliminate soft drinks, candies, sweets, desserts and all other foods and beverages containing sugar. Sugar substitutes, such as aspartame, sorbitol and sucralose, are also processed ingredients, which means that you should even avoid sugar-free or diet products if you want to stay away from processed foods.

Grains

Although many people believe that grains are natural and healthy, most grain products have to go through extensive processing before they end up on your plate. Humans are not able to digest grains harvested right out of the field, which is why they were not part of the human diet in such large amounts as they are now before the recent advances in food manufacturing. Bread, pasta and other flour-based foods found at the grocery store also contain a lot of extra processed ingredients that qualify them as processed foods. Get your carbs from fruits, tubers and vegetables if you want to avoid processed foods.

Canning

It is a method of preserving food in which the food contents are processed and sealed in an airtight container. Canning provides a typical shelf life ranging from one to five years, although under specific circumstances a freeze-dried canned product, such as canned, dried lentils, can last as long as 30 years in an edible state. The packaging prevents microorganisms from entering and proliferating inside.

To prevent the food from being spoiled before and during containment, a number of methods are used: pasteurisation, boiling (and other applications of high temperature over a period of time), refrigeration, freezing, drying,

vacuum treatment, antimicrobial agents that are natural to the recipe of the foods being preserved, a sufficient dose of ionizing radiation, submersion in a strong saline solution, acid, base, osmotically extreme (for example very sugary) or other microbially-challenging environments.

Other than sterilization, no method is perfectly dependable as a preservative. For example, the microorganism *Clostridium botulinum* (which causesbotulism), can only be eliminated at temperatures above the boiling point.

From a public safety point of view, foods with low acidity (a pH more than 4.6) need sterilization under high temperature (116-130 °C). To achieve temperatures above the boiling point requires the use of a pressure canner. Foods that must be pressure canned include most vegetables, meat,seafood, poultry, and dairy products. The only foods that may be safely canned in an ordinary boiling water bath are highly acidic ones with a pH below 4.6,such as fruits, pickled vegetables, or other foods to which acidic additives have been added.

1.11 Summary

Good nutrition is a goal which can be achieved by anyone who desires it. Moderation in everything that we eat is the key success. It is necessary to select wisely from the different foods available in the market. A large variety of convenience foods are meant to ease the burden of the modern housewife who may also be a working woman.

1.12 Review Questions

Q 1. What is the nutrition?
Q 2. What is the scope of food science?
Q 3. Discuss about relationship with food microbilogy?

Q 4. Discuss about the function of foods?

Q 5. Write a note on food as source of nutrient?

1.13 Reference

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Unit - 2 : Carbohydrate

Structure of Unit:

2.0 Objective

After completing this unit you will be able to:

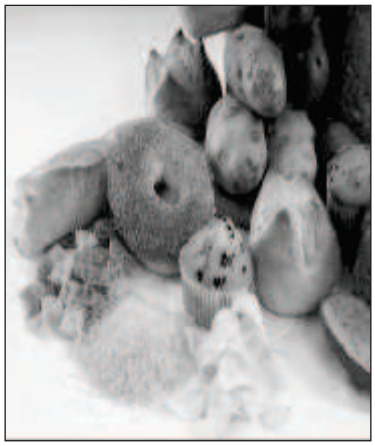
- Understand the basic structure of carbohydrate.
- Understand the types of carbohydrate.
- Know what the effect of heating on carbohydrate is.
- Know about the factors affecting texture of carbohydrate.
- Know about the functional properties of carbohydrate.
- Know about uses of carbohydrate in cooking.

2.1 Introduction

Foods are complex substances composed of chemical constituents. Carbohydrates are one of the three macronutrients, a group that also includes protein and fat. This information can be used to understand the complexities of carbohydrates and their role in the body, and to support your discussions with parents on the value of this important nutrient as well as healthy food sources. Carbohydrates play a crucial role in a healthy, balanced diet. For example, without carbohydrates, our body would lack a key fuel source. Similar to fats, the role and value of carbohydrates is often misunderstood, which can lead to a diet that restricts this important nutrient rather than including healthy food choices to provide carbohydrates in recommended amounts. Carbohydrates are the body's primary source of energy, and provide about 4 calories per gram. This nutrient category includes sugars, starches, and fibre. The American Dietetic Association (ADA) recommends that for children 2–11 years of age, carbohydrates should make up 45–65% of total energy intake each day. Following these recommendations, approximately one half of total daily

energy intake comes from carbohydrate, with the other half from protein and fat. A principal role of carbohydrate is to supply energy in the form of glucose. Glucose is a simple sugar and is often called blood sugar, since it is the main carbohydrate found in the blood of mammals. The health and functioning of every cell relies on blood glucose. Carbohydrates are made up of units of sugar (also called saccharides), and are classified as either simple or complex, depending on the number of sugar units they contain.

2.2 Types of Carbohydrate



Carbohydrates are a component found in many foods that is converted into sugars during the digestive process. You might hear that carboyhydrates, or carbs, are bad for you, but this is not always the case. Carbs are divided into three groups: simple carbohydrates, complex carbohydrates and fiber. The three different types of carbohydrates vary nutritionally and are broken down in different ways during digestion. Learning about the three kind of carbs can help you make wise food choices in order to stay healthy.

Simple Carbohydrates

Simple carbohydrates are sometimes called simple sugars, mainly because they contain either natural or added sugar. Kellogg's Nutrition describes simple carbohydrates as foods that satisfy your sweet tooth, because they taste sweet and usually contain such sweeteners as honey, sugar, molasses or corn syrup. Dairy products and some fruits and vegetables are also classified as simple carbohydrates because they contain natural sugars.

Complex Carbohydrates

Complex carbohydrates, called starches, are carbs that are made from several linked strings or chains of sugars. Complex carbs are often healthier than simple carbs because in addition to being starchy, they also provide you with some of your dietary fiber. Examples of complex carbs are corn, bread, cereal, pasta and rice. Complex carbohydrates are also converted into glucose during digestion, according to the Harvard School of Public Health's "The Nutrition Source." Like simple carbohydrates, complex carbs can cause a spike in your blood glucose levels that, in some people, can lead to insulin resistance.

Fiber

Fiber is the third type of carbohydrate. Although it is categorized as a complex carbohydrate, fiber does not act like the other two forms of carbs. Your body can't completely digest fiber, so it can't be broken down into sugars. Fiber, in fact, can help regulate blood glucose levels, as well as lower cholesterol levels and promote regular digestion and excretion of waste. Whole grains and many fruits and vegetables, including dark leafy greens and orange-colored fruits and vegetables, are rich in fiber. Whole grains are not processed as fully as the flours used to make foods that fall into the simple carbohydrates; the refinement process of white flours removes fiber. Lentils, peas and dried beans are also fiber-rich foods that can contribute to a healthy digestive system.

Starch

Starch is a form of carbohydrate that is made up of long, complex chains of simple sugars. Starch must be broken down through digestion before your body can use it as a glucose source. Some starches actually have a higher glycemic index than some sugars. In this sense, they are not "complex" for very long at all. Since most starchy foods are rapidly broken down into sugar, people who are sensitive to sugar should avoid most starchy foods. Examples of starchy complex carbohydrates are corn, bread, cereal, rice, beans, pasta, wheat, grains, potatoes, etc.

Based on Chemical Composition

Carbohydrates are the most easily available and the largest set of compounds found on Earth. Based on their chemical composition, there are four major classes of carbohydrates. These are described in brief as follows.

Monosaccharides

These are the basic compounds with a cyclic structure consisting of carbon, hydrogen, and oxygen in the ratio of 1:2:1. 'Mono' refers to single and saccharides means sugar. Glucose, fructose, galactose, arabinose, and xylose are common types of monosaccharides.

Chemical Properties

Monosaccharides are aliphatic aldehydes or ketones.They contain one carbonyl group and one or more hydroxyl group.They commonly contain either five carbons (pentose) or six carbons (hexose).

Physical Properties

Crystalline, Soluble in water, Sweet-tasting

Disaccharides

Disaccharides contain two sugar molecules. Ideally, they come under oligosaccharides (since oligosaccharides contain two to ten sugar molecules).

However, due to their comparatively simple chemical structure, disaccharides are classified as a different class of carbohydrates. Common disaccharides are sucrose, lactose, maltose, trehalose, and cellobiose.

Chemical Properties

A disaccharide is formed when two monosaccharides bond together (by glycosidic bond) by a condensation reaction and release one molecule of water. They are further classified into reducing and non-reducing disaccharides. In reducing disaccharides, the monosaccharide has a free hemiacetal unit. However, in non-reducing disaccharides, the components bond through an acetal linkage between their anomeric centers and do not have a free hemiacetal unit.

Physical Properties

Crystalline, Water-soluble, Sweet-tasting, Sticky.

Oligosaccharides

These are carbohydrates with more than two basic types of sugar molecules, usually between three and ten basic units. Their main role in the body is to store glucose. Raffinose and stachyose are the main types of oligosaccharides which consist of repetitive chains of fructose, galactose, and glucose.

Chemical Properties

Oligosaccharides are carbohydrate polymers with a low molecular weight. They are covalently bonded with glycosidic bonds due to condensation reaction or dehydration synthesis.Many oligosaccharides bond with proteins and lipids on the outer cell surface for cellular recognition of extracellular signal molecules.

Physical Properties

Crystalline, Water-soluble

Polysaccharides

Chemical Properties

Polysaccharides have a high molecular weight. They are further divided into homo-polysaccharides and hetero-polysaccharides. Homo-polysaccharides contain the same mono-saccharides, whereas hetero-polysaccharides contain more than one type of mono-saccharides. Common homo-polysaccharides include starch, cellulose, and glycogen.Pectin, hemicellulose, and gums are common hetero-polysaccharides.

Physical Properties

Not water-soluble, Not crystalline, Not sweet

Form colloidal suspensions instead of solutions

2.3 Effects of Cooking on Food

Carbohydrates are primarily found in foods with grains, sugars and fibre. Carbohydrates are comprised of sugar molecules, formed when oxygen, hydrogen and carbon fuse together. Each type of carbohydrate is made up of a certain number and pattern of sugar molecules. Simple carbohydrates are foods made with sugars, such as fruit sugar or table sugar. Examples include white bread, white pasta and baked goods. Complex carbohydrates are made when a food contains three or more linked sugars. Complex carbohydrates are healthier than simple carbohydrates, and include oatmeal, whole grains and beans.

There are two possible changes that occur when carbohydrates are cooked. Caramelization occurs when the sugars in the carbohydrates are browned. When bread turns golden brown on top, it is an example of the sugars becoming caramelized. Gelatinization occurs when the starches in carbohydrates absorb water and begin to swell. This chemical change is used to make cooked sauces, breads and other baked goods. When you add certain carbohydrates, such as flour, to liquids, the heat gelatinizes the carbohydrates. This is the process used to make gravy and other thick sauces.

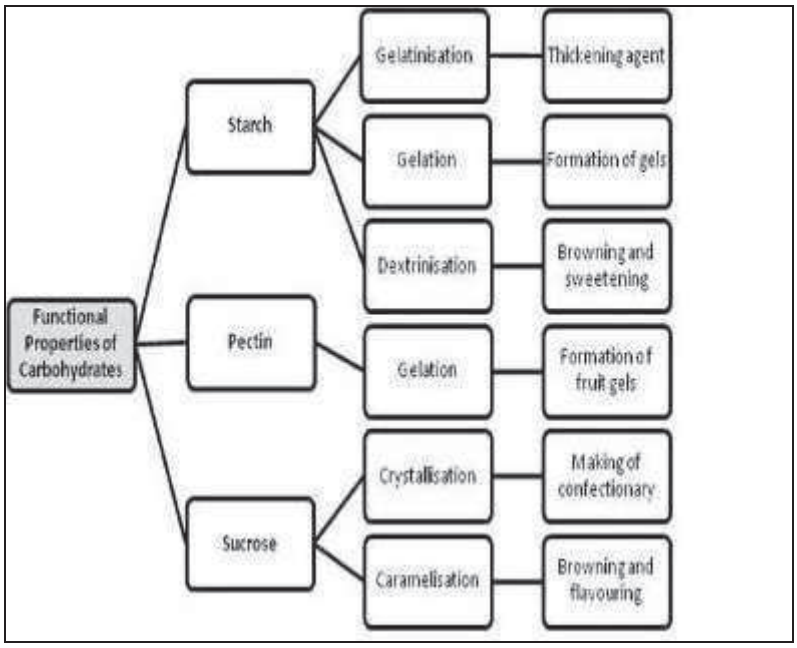
Carbohydrates include the common sugar, sucrose, a disaccharide, and such simple sugars as glucose and fructose (from fruit), and starches from sources such as cereal flour, rice, arrowroot, and potato. The interaction of heat and carbohydrate is complex.

Long-chain sugars such as starch tend to break down into simpler sugars when cooked, while simple sugars can form syrups. If sugars are heated so that all water of crystallisation is driven off, then caramelization starts, with the sugar undergoing thermal decomposition with the formation of carbon, and other breakdown products producing caramel. Similarly, the heating of sugars and proteins elicits the Mail lard reaction, a basic flavour-enhancing technique.

An emulsion of starch with fat or water can, when gently heated, provide thickening to the dish being cooked. In European cooking, a mixture of butter and flour called a roux is used to thicken liquids to make stews or sauces. In Asian cooking, a similar effect is obtained from a mixture of rice or corn starch and water. These techniques rely on the properties of starches to create simpler mucilaginous saccharides during cooking, which causes the familiar

thickening of sauces. This thickening will break down, however, under additional heat.

2.4 Factors Affecting Texture of Carbohydrates



Gelatinisation

Definition: The ability of starch to thicken mixtures in the presence of heat. This process takes place regardless of the type of starch. Common thickening agents: Plain wheat flour, corn flour and arrowroot. Two factors affect the qualities of the gel produced. These are the ratio of amylose to amylopectin and the method used to prepare the food. Wheat flour and Corn flour = More amylose, meaning a thick but cloudy gel.

Factors affecting the gelatinisation of starch

The functional properties of carbohydrates are affected by temperature, pH, agitation, and the presence of other ingredients.

Temperature: Gelatinisation requires warm moist conditions. Starch is not soluble in cold water and cannot thicken cool liquids. In order for the starch to absorb liquid, the outside of the starch granule needs to be softened by heating.

Agitation: Agitation is essential for the creation of a smooth, gelatinised sauce. If agitation is not used the starch granules that are not exposed to liquids burst

and trap the liquid around them, preventing it from reaching other starch granules resulting in a lumpy texture

Impact of other ingredients and pH: Sugar and acid have the greatest affect on gelatinisation. Sugar competes with starch for water therefore the starch does not absorb as much water. It also raises the temperature at which the granules start gelatinising, making the mixture more liquid and less likely to remain stable. Acids such as lemon juice should always be added to the mixture after it has thickened and boiled.

Example: White Sauce .
When you think of Gelatinisation think of making a white sauce. A mixture of fat and starch.

First you would make a roux, which is a mixture of melted butter and flour, the continued heat softens the outer shell of the starch granules allowing them to swell up with liquid. As you add the milk and continue to heat the mixture the starch granules burst and the amylose and amylopectin they contain are released, capturing the liquid causing it to thicken and form a gel. Agitation must be used whilst heating to prevent lumps.

The mixture is then further boiled for atleast a minute to ensure all of the starch has reached the desired temperature and all of the starch is gelatinised. A pasty taste will result from any ungelatinised starch. The sauce should look smooth and shiny if it is fully gelatinised.

Dextrinisation

Definition: The process in which starch breaks down into dextrins Example:When bread is toasted.Starch can undergo a partial chemical breakdown into shorter glucose chains called dextrins. The process is as follows: ⟶ ⟶ ⟶

Starch	**Dextrins**	**Maltose**	**Glucose**
(polysaccharide)		(disaccharide)	(monosaccharide)

Dextrins have a different chemical structure to starch, giving them different characteristics, these are: Dextrins dissolve in cold water but starch does not Dextrins taste sweet while starch tastes floury Dextrins are poor thickening agents while starch gelatinises Dextrinisation can be caused by many things, these are: Exposure of starch granules to dry heat. The action of acids The action of certain enzymes Dextrinisation is the reason for: Bread turning brown during toasting. Gravies being brown Brown crust forming on baked starchy vegetables, such as potatoes.

Crystallisation

Definition: The ability of sugar to dissolve and reform crystals. Crystallisation is used in the making of confectionary such as toffee, brittle, fudge and caramel.
Sugar is dissolved in a liquid and heated, the liquid evaporates, concentrating the sugar solution. As the solution cools, the sugar re-forms into crystals.

Factors affecting crystallisation .

Temperature: The hotter the water is the greater the amount of sucrose that can dissolve in it. Lower temperatures produce softer solutions such as fudge, extremely high temperatures produce harder solutions such as brittle.

Acid: Adding acids such as cream of tartar or vinegar inhibits the development of large crystals giving the confectionary a smoother texture.

Agitation: Stirring sugar solutions encourages crystals to develop. If a solution is stirred while hot, crystallisation starts to soon, giving the product a grainy texture. Sugar must be stirred and fully dissolved into a liquid before boiling starts. Stirring after boiling point is reached encourages crystals to develop. Different products require agitation at different points of the process.
.
Presence of other ingredients: Mono-saccharides i.e. honey, glucose, acidic ingredients, are included to ensure a smooth consistency. Fat i.e. butter or cream prevents large crystals forming ensuring a smooth texture.

Caramelisation

Definition: Sucrose melts at 186C. Above that temperature acids form and the molten sugar turns a light brown, or caramelises. The breakdown of sucrose occurs as follows:

sucrose + heat -> glucose + fructose + water -> acids + glucose

Caramelisation occurs without water, as it evaporates before caramelisation takes place
Caramelised sugar adds a distinctive flavour to foods and is often used in commercial products such as milks and cakes

2.5 Uses of Carbohydrate In Cooking

Many functional requirements are met by the use of simple and complex carbohydrates in food. Carbohydrates offer a wide range of rheological and other properties, including solubility, cry protection, sweetening effect,

hygroscopicity, crystallization inhibition, flavour encapsulation, and coating ability. These properties are based on chemical structure and interactions with other molecules through hydrogen bonding, ionic effect, and the formation of complexes with lipids and proteins. The ability to understand these properties directly affects the development of food products and processes. Thus, the functionality of carbohydrates in foods integrates precise knowledge of chemical structure and behavior with practical applications in the development and preparation of foods. Using a high-performance liquid chromatography (HPLC) method, researchers analyzed the sugar composition of chick-peas, kidney beans, and lentils at various points in the preparation and cooking process: after soaking, after “normal” cooking (ie, boiling), after pressure-cooking, and after cooked legumes had been held at 35°C for 5 hours. There was a considerable decrease in the amount of monosaccharides, disaccharides, and raffinose oligosaccharides in chick-peas and kidney beans after soaking and cooking. This change in carbohydrate composition was less pronounced when the cooking water was not drained before analysis, which was the method used when analyzing the lentils. Method of cooking (either boiling or pressure-cooking) did not have different effects on the sugar composition of chick-peas and lentils, but loss of oligosaccharides was slightly higher when kidney beans were boiled than when they were pressure-cooked. Loss of -galactosides occurred in chick-peas and kidney beans that had been boiled and then held at 35°C for 5 hours. The HPLC analysis showed that manninotriose was not one of the oligosaccharides present in these legumes.Carbohydrates are an essential part of a healthy diet and should make up 50% of our daily calorie intake. The majority should come from complex carbohydrates, preferably the wholemeal varieties, as well as a large intake of fruit and vegetables. Simple carbohydrates of the refined kind, including refined sugar (sucrose) should be limited. They have no nutritional value and are generally high in sugars and fats. To make it really simple:

"Good" carbohydrates are: Bran, wheat germ, wholemeal bread, brown rice, potatoes, all forms of pasta but especially wholemeal pasta, barley, oats, lentils, chickpeas, beans, peas, corn, sweet potatoes, wholegrain cereals such as Weetabix, muesli, All bran, brown breads, root vegetables such as carrots, turnips, leeks and radishes.

"Bad" carbohydrates are: Sweets, sugary breakfast cereals, cakes, pastries, syrup, table sugar (sucrose), fizzy drinks, biscuits, chocolate.

2.6 Carbohydrates and Nutrition

Bread, pasta, beans, potatoes, bran, rice and cereals are carbohydrate-rich foods. Most carbohydrate rich foods have a high starch content. Proteins and

fats require more water for digestion than carbohydrates. Carbohydrates are the most common source of energy for most organisms and animals, including humans. Carbohydrates are not classed as essential nutrients for humans. We could get all our energy from fats and proteins if we had to. However, our brain requires carbohydrates, specifically glucose. Neurons cannot burn fat.

- 1 gram of carbohydrate contains approximately 4 kilocalories (kcal)
- 1 gram of protein contains approximately 4 kcal
- 1 gram of fat contains approximately 9 kcal

However, proteins are used in both forms of metabolism - anabolism (building and maintaining tissue and cells) and catabolism (breaking molecules down and releasing/producing energy). So, the consumption of protein cannot be calculated in the same way as fats or carbohydrates when measuring our body's energy needs.

Not all carbohydrates are used as fuel (energy). A lot of dietary fiber is made of polysaccharides that our bodies do not digest. Most health authorities around the world say that humans should obtain 40 to 65% of their energy needs from carbohydrates - and only 10% from simple carbohydrates (glucose and simple sugars).There are three types of carbohydrates in foods. These are:

1.Polysaccharides
2.Disaccharides
3.Monosaccharides

Polysaccharides-starches ,pectins and dietary fibre Monosaccharides & Disaccharides =sugar

Polysaccharides have different reactions to Monosaccharides & Disaccharides during cookingStarch molecules are made up of two substances: Amylose and Amylopectin
The ratio of these two substances in a molecule determines the quality of the end product. For example, higher proportions of amylose produces semi-solid, opaque gels whereas higher proportions of amylopectin produce clearer, thicker gels

2.7 Summary

Carbohydrates, like fats, are an often misunderstood nutrient such that individuals may pursue a diet that restricts carbohydrates as a whole, rather than choosing foods that provide this valuable nutrient in recommended amounts. Understanding the role of carbohydrates in a healthy diet, including the value of dietary fiber, will help parents to make sound food choices for their children. As with protein and fat, a healthy diet includes a balance of

nutritious sources of carbohydrates. A diet that is low or deficient in this critical nutrient is truly not "balanced", and is in need of correction to best support overall health.

2.8 Review Questions

1. Why carbohydrate is important in our body?

2. What is the effect of heat on carbohydrate?

3. Discuss about the chemical properties of carbohydrate?

4. Discuss about the gelatinization ?

5. Write a note carbohydrate and nutrition?

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Unit - 3 : Fat & Oils

Structure of Unit:

3.0 Objective

After completing this unit you will be able to:

- Understand the basic structure of fats .
- Understand the types of fats .
- Know what the effect of heating on fats .
- Know about the factors affecting texture of fats .
- Know about the functional properties of fats .
- Know about uses of fats in cooking.
- Know about the smoke points.

3.1 Introduction

Fats consist of a wide group of compounds that are generally soluble in organic solvents and generally insoluble in water. Chemically, fats are triglycerides tri esters of glycerol and any of several fatty acids. Fats may be either solid or liquid at room temperature, depending on their structure and composition. Although the words "oils", "fats", and "lipids" are all used to refer to fats, in reality, fat is a subset of lipid. "Oils" is usually used to refer to fats that are liquids at normal room temperature, while "fats" is usually used to refer to fats that are solids at normal room temperature. "Lipids" is used to refer to both liquid and solid fats, along with other related substances, usually in a medical or biochemical context. The word "oil" is also used for any substance that does not mix with water and has a greasy feel, such as petroleum (or crude oil), heating oil, and essential oils, regardless of its chemical structure.

Fats form a category of lipid, distinguished from other lipids by their chemical structure and physical properties. This category of molecules is important for many forms of life, serving both structural and metabolic functions. They are an important part of the diet of most hetero trophs (including humans). Fats or lipids are broken down in the body by enzymes called lipases produced in the pancreas.

Examples of edible animal fats are larding, fish oil, butter/ghee and whale blubber. They are obtained from fats in the milk and meat, as well as

from under the skin, of an animal. Examples of edible plant fats include peanut, soya bean, sunflower, sesame, coconut and olive oils, and cocoa butter. Vegetable shortening, used mainly for baking, and margarine, used in baking and as a spread, can be derived from the above oils by hydrogenation.

These examples of fats can be categorized into saturated fats and unsaturated fats. Unsaturated fats can be further divided into fats, which are the most common in nature, and trans fats, which are rare in nature but present in partially hydrogenated vegetable oils.

3.2 Classification of Fats

A healthy diet for adults and children over 3 years old should consist of approximately 20 to 35 percent of calories from dietary fats. In order to maximize your nutritional intake and reduce your risk of chronic disease, it is best if these fat calories primarily come from healthy sources like mono- and poly-unsaturated fats as opposed to unhealthy saturated and trans fats.

Monounsaturated Fats

Monounsaturated fat is a type of dietary fat primarily found in plant-based foods, which has been associated with lower risks of cardiovascular disease and stroke. In addition, food sources of monounsaturated fats tend to be high in other nutrients and antioxidants, like vitamin E. Olive oil, avocados, natural peanut butter and seeds are all excellent sources of monounsaturated fat. Because of the health benefits associated with monounsaturated fats, up to 20 percent of your daily calories should come from this fat. This equates to up to 44 grams of monounsaturated fat each day for a 2,000-calorie diet.

Polyunsaturated Fats

Like monounsaturated fats, polyunsaturated fats are also considered heart-healthy. Omega-3 and omega-6 fatty acids, two types of polyunsaturated fats, are considered essential because they cannot be synthesized by the human body. As such, omega-3s and omega-6s must be consumed through your diet. Walnuts, flaxseeds, flaxseed oil and salmon are excellent sources of omega-3 fatty acids, and corn, soybean and cottonseed oils are excellent sources of omega-6 fatty acids. Most adults get plenty of omega-

6 fatty acids in their diets already, but to meet your recommendations for omega-3s, have fish at least two times per week.

Saturated Fats

Saturated fats are the primary types of fats found in animal-based products and foods fried in butter or certain oils. Butter, lard, milk, cheese, poultry skin and high-fat beef are the most common sources of saturated fat. Coconut, palm kernel and palm oils also have saturated fats, even though they are plant-based and do not contain cholesterol. High intakes of saturated fat have been associated with raising blood cholesterol levels, so the American Heart Association recommends limiting saturated fat to no more than 7 percent of your daily calorie intake. This equates to only 16 grams of saturated fat per day for a 2,000-calorie diet.

Trans Fats

Of all the dietary fats found in food products, trans fats have been associated with the most health consequences. A trans fat, or partially hydrogenated oil, is a healthy oil which has been chemically modified for stabilization and preservation purposes. Trans fats are often used to extend the shelf life or to improve the palatability of foods, and while very small amounts are present in some dairy and meat products, most trans fats are considered an additive or unnatural ingredient. Trans fats are most commonly found in baked goods like cakes, cookies and pies, but they can also be found in stick margarine, pizza dough and crackers. The American Heart Association recommends limiting trans fat to 1 percent of total calories.

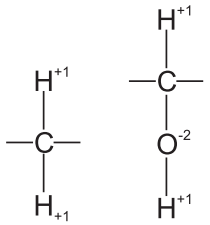
3.3 Auto Oxidation

Tri acyl glycerols (fats and oils) store the majority of the energy in most animals and plants. Fats such as beef tallow remain solid or semisolid at room temperature while oils such as olive oil or corn oil are liquid at that temperature. Oils solidify only at lower temperatures—in a refrigerator, for example. The different kinds of fatty acids found in the side chains of the triacylglycerol cause the different melting temperatures. The fatty acids of oils contain more double bonds than do those of fats.

These molecules make good energy-storing units because their oxidation releases more energy than the oxidation of carbohydrates or amino acids. The **caloric density** of triacylglyerols is about 9 kilocalories per gram, compared to 5 kilocalories per gram for the latter biomolecules.

Essential fatty acids are precursors to membrane lipids and to compounds that serve as intercellular signals in animals.

The caloric density of lipids is due to the side chain carbons of fats being more reduced (hydrogen-rich) than the side chain carbons of carbohydrates, for example:



Fat, oxidation state = − 2 →Carbohydrate, oxidation state = 0

Oxidation of the carbon found in fatty acids to carbon dioxide involves a change in oxidation number from − 2 to +4, while the oxidation of the carbon of carbohydrate involves a change from 0 to +4. The greater change in oxidation number means that the oxidation of fat releases more energy. (This is a general principle; for example, burning methane, CH_4, releases more heat than burning methanol, CH_2OH). On the other hand, while amino acids and carbohydrates can oxidize an aerobically (without added oxygen), fats can oxidize only aerobically. Many cultures have used this characteristic to preserve foods in animal fat. The fat prevents the growth of oxygen-requiring molds and bacteria.

3.4 Prevention of Auto Oxidation

Oxidation can be prevented or delayed by avoiding situations that would serve as catalysts for the reactions for eg. Fats and oils must be stored in a cool dark environment (offering temperature and light change controls) in a class container (to minimize oxygen availability) vacuum packaging of fat containing products controls oxygen exposure and colour glass or wraps control fluctuations in light intensity. Fats also must be stored away from metals that could catalyze the reaction and any cooking utensils used must be free of copper or iron. Lipoxygenases should be in activated.

3.5 Flavour Reversion

Flavour reversion caused by oxidation is the most prevalent in oils high in poly unsaturated. Reverted flavours are observed long before oxidized flavours are formed. At low levels of oxidations the changes generally known as flavour reversion is a characteristic of the source fats or oils .Flavour Reversion is defined as a change in edible fats that is characterized by the development, in the refined material, of an objectionable flavour prior to the onset of true rancidity. It may develop during the exposure of the fat to ultra violet or visible light or by heating. A small amount of oxygen seems to be necessary for the reaction that is catalysed by the presence of small amounts of metals such as iron and copper. Selective hydrogenation decreases the amount

of linolenic acid and aids in preventing flavour reversion. Soyab ean oil is most susceptible for flavour reversion.

3.6 Refining

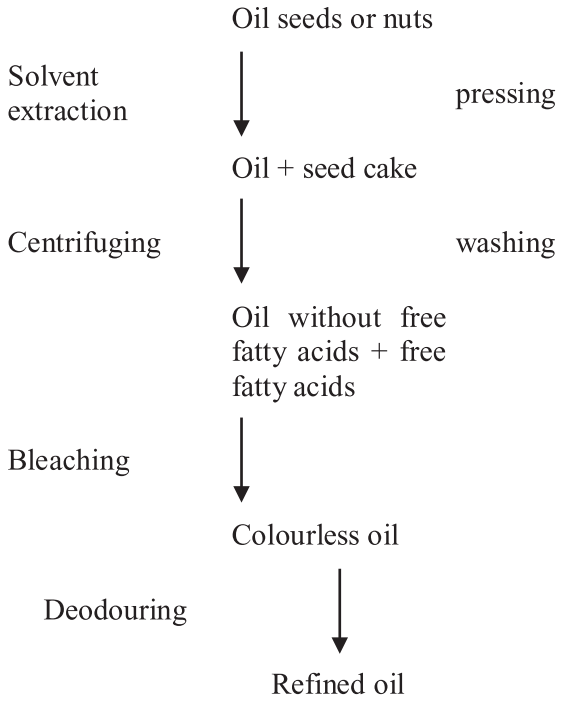
Vegetable oils are removed from oil containing seed fruits or nuts by various pressing processes, by solvent extraction and by combination of these. After extraction, the crude oils are refined. The nonglyceride components contribute practically all the colour and flavour to fats. In addition, such materials as the free fatty acids, waxes, colour bodies, mucilaginous materials, phospholipids, carotenoids, and gossypol (a yellow pigment found only in cottonseed oil) contribute other undesirable properties in fats used for edible and, to some extent, industrial purposes.

Alkali Refining

Many of these can be removed by treating fats at 40° to 85° C (104° to 185° F) with an aqueous solution of caustic soda (sodium hydroxide) or soda ash (sodium carbonate). The refining may be done in a tank (in which case it is called batch or tank refining) or in a continuous system. In batch refining, the aqueous emulsion of soaps formed from free fatty acids, along with other impurities (soapstock), settles to the bottom and is drawn off. In thecontinuous system the emulsion is separated with centrifuges. After the fat has been refined, it is usually washed with water to remove traces of alkali and soapstock. Oils that have been refined with soda ash or ammonia generally require a light re-refining with caustic soda to improve colour. After water washing, the oil may be dried by heating in a vacuum or by filtering through a dry filter-aid material. The refined oil may be used for industrial purposes or may be processed further to edible oils. Usually, the refined oils are neutral (*i.e.,* neither acidic nor alkaline), free of material that separates on heating (break material), lighter in colour, less viscous, and more susceptible to rancidity.

Water Refining

Water refining, usually called degumming, consists of treating the natural oil with a small amount of water, followed by centrifugal separation. The process is applied to many oils that contain phospholipids in significant amounts. Since the separated phospholipids are rather waxy or gummy solids, the term degumming was quite naturally applied to the separation. The separated phospholipid emulsion layer from oils such as corn (maize) and soybean oils may be dried (commercially, these products are called lecithin) and used as emulsifiers in such products as margarine, chocolate products, and emulsion paints. The degumming of crude soybean oil, which has an average phospholipid content of 1.8 percent, provides the primary source of commercial lecithin. To obtain products of lighter colour, hydrogen peroxide may be added as a bleaching agent during the drying of lecithin. The degummed oil may be used directly in industrial applications, such as in paints or alkyd resins, or refined with alkalies for ultimate edible consumption



3.7 Hydrogenation

The process or hydrogenation changes liquid oils into more solid plastic shortenings and to increase the stability of the oils to prevent spoilage from oxidation, which results in undesirable rancid flavor and odors. This chemical change makes the fatty acids more saturated. The melting point of the fat is thereby increased. With sufficient hydrogenation it becomes solid at room temperature. Hydrogenation to treat with hydrogen – is a chemical reaction between molecular hydrogen (H_2) and another compound or element, usually in the presence of a catalyst. The process is commonly employed to reduce or saturate organic compounds. Hydrogenation typically constitutes the addition of pairs of hydrogen atom to a molecule, generally an alkenes. Catalysts are required for the reaction to be usable; non-catalytic hydrogenation takes place only at very high temperatures. Hydrogenation reduces double and triple bonds in hydrocarbons

Because of the importance of hydrogen, many related reactions have been developed for its use. Most hydrogenations use gaseous hydrogen (H_2), but some involve the alternative sources of hydrogen, not H_2: these processes are called transfer hydrogenations. The reverse reaction, removal of hydrogen from a molecule, is called dehydrogenation. A reaction where bonds are broken while hydrogen is added is called hydrogenolysis, a reaction that may occur to carbon-carbon and carbon-heteroatom (oxygen, nitrogen or halogen) bonds. Hydrogenation differs from protonation or hydride addition: in hydrogenation, the products have the same charge as the reactants.

Hydrogenation of unsaturated fats produces saturated fats. In the case of partial hydrogenation, trans fats may be generated as well.

3.8 Winterisation

In this process, the temperature of the oil is lowered to a point at which the higher-melting triglycerides crystallise. Then the oil is filtered to remove these crystals. The remaining oil has a lower melting point and does not crystallise at refrigerator temperatures. It is referred to as salad oil. It is often desirable to remove the traces of waxes(*e.g.,* cuticle wax from seed coats) and the higher-melting glycerides from fats. Waxes can generally be removed by rapid chilling and filtering. Separation of high-melting glycerides, or stearine, usually requires very slow cooling in order to form crystals that are large enough to be removed by filtration or centrifuging. Thus linseed oil may be winterized to remove traces of waxes that otherwise interfere with its use in paints and varnishes. Stearine may be removed from fish oils in order to separate the solid glycerides that would detract from its use in paints and alkyd resins. At the same time, fish stearine is more suitable than whole oil for edible purposes. Cottonseed and peanut oils may be destearinated to produce salad oils that remain liquid at low temperatures. Tallows and other animal fats may be destearinated for simultaneous production of hard fats (high in stearic acid content for special uses such as in making candles) and of liquid oil called oleo oil.

3.9 Effect of Heating on Fats & Oils With Respect To Smoke Point

In cooking, the smoke point of an oil or fat is the temperature at which it begins to break down to glycerol and free fatty acids, and produce bluish smoke. The glycerol is then further broken down to acrolein which is a component of the smoke. It is the presence of the acrolein that causes the smoke to be extremely irritating to the eyes and throat. The smoke point also marks the beginning of both flavour and nutritional degradation. Therefore, it is a key consideration when selecting a fat for frying, with the smoke point of the specific oil dictating its maximum usable temperature and therefore its possible applications. For instance, since deep frying is a very high temperature process, it requires a fat with a high smoke point.

The smoke point for oil varies widely depending on origin and refinement. The smoke point of oil does tend to increase as free fatty acid content decreases and degree of refinement increases. Heating oil produces free fatty acid and as heating time increases, more free fatty acids are produced, thereby decreasing smoke point. It is one reason not to use the same oil to deep fry more than twice. Intermittent frying has a markedly greater effect on oil deterioration than continuous frying.

Considerably above the temperature of the smoke point is the flash point, the point at which the vapours from the oil can first ignite when mixed with air. Smoking Point

Smoke point of fat is the temperature at which smoke comes continuously from the surface of the fat. Development of free fatty acids by some hydrolysis of the fat during frying causes a decrease in the smoke point. Suspended matter such as flour or batter particles also lower the smoke point. And the greater the surface of the fat exposed, the lower is the smoke point.

Smoking temperatures of fats

Fat/Oil	**Smoking Temperature (^{o} C)**
Butter fat	208
Cotton seed oil	230
Coconut oil	138
Ground nut oil	149-162
Hydrogenated fat	221-232
Lard	194
Olive oil crude	176
Olive oil refined	234
Soyabean oil	230

3.10 Commercial Uses of Fats

Any refinery will have on hand a variety of properly refined, bleached and deodorized (RBD) oils as well as refined and bleached, partially hydrogenated base stocks for further blending and deodorization which they can sell in bulk to other processors who can use them as they are or process them into other fat containing foods for the consuming public.Salad and cooking oils, margarines, shortenings, salad dressings, wide variety of products based entirely on fats and oils or containing fats and oils as a major portion of their composition.The significance of any food product to our diet depends on its relationship to the total energy consumption. Hence, fat is popular in the diet not only for the sensory values of eating pleasure and satiety, but its prime nutritional advantage lies in its high caloric density: one gram of fat will supply about 9 Kcal whereas one gram of either protein or carbohydrate will supply about 4 Kcal each. Dietary fats have been categorized into "visible" and "invisible" sources of fat. The former category comprises the fats that have been isolated from animal tissues, oilseeds, or vegetable sources, such as salad oil, margarines and shortenings. The latter category are those that have not been isolated from the above mentioned sources but consumed as part of the animal tissues or the vegetables in our diet.

1. Salad and Cooking Oils.

Edible fats and oils intended for human consumption fall into one of the following two categories:

· Liquid oils, prepared from vegetable oils that are refined, bleached, and deodorized, such as corn, canola, soybean, sunflower and cottonseed. Sometimes they are lightly hydrogenated and winterized.

· Plastic fats, such as butter, lard, shortenings and margarines.The difference between salad and cooking oils is due the fact that the former will be substantially liquid and clear when kept in a refrigerator at 4° to 8° C. Also, they are generally suitable for all classes of cooking except those which require the production of a highly developed dough strength. They are also used by the packing industry for packing certain canned meats, sausages, fish, sardines, anchovies and tuna.On the other hand, cooking oils are in demand for deep frying of products such as french fried potatos or doughnuts, which are consumed reasonably fresh soon after production. It must be born in mind that in the Orient the common cooking oils such as peanut, rapeseed, sesame, soybean and sunflower are consumed in their crude form.

2. Plastic Shortenings.

The term plastic is applied to pure fats of such consistency that they are readily mixed, worked or spreadable. The term "shortening" refers to the ability of a fat to lubricate, weaken or short the structure of a baked product. Without shortening the gluten particles will adhere to each other and give the sensation of toughness when chewed. If shortening is present, the gluten particles slip by each other more readily and produce tenderness. For many years animal fats, particularly lard and marine oils, were the principle edible fats used in shortenings. For the record, compounded plastic shortening is an American invention, growing out of the cotton-raising industry. They were first prepared by the blending of hard and soft fats and called "lard compounds or simply "compounds". With the introduction of the catalytic hydrogenation process shortening manufacturers were able to produce plastic shortenings made entirely from vegetable oil. These shortenings have superior physical properties such as good mixing and creaming qualities, high stability and uniformity, as compared to lard.

3. Types of Shortening.

Shortenings fall into a number of categories, determined by the functional requirements of the product. They are formulated from one or more of the following ingredients: an oil, a base oil, a plasticizer and an emulsifier. The most common types are briefly discussed below.

This shortening may be prepared from a single base oil that has been partially hydrogenated to an iodine value of between 65 and 80, or a blend of oils that have been hydrogenated to a specific plasticity or consistency plus 8 to 10% of stearins or flakes (highly hydrogenated base stock, 5 IV maximum). In the case of an 100% vegetable all purpose soybean shortening, the hard stock must be a beta prime oil such as cottonseed or palm oil. Also, it must be born in mind that formulation of a product with good shelf life stability will require the use of non-selective hydrogenation of the base stock. With beta prime oils such as cottonseed it is possible to partially hydrogenate the base stock to

provide good body at high temperature without the addition of hard stock, . However, the blending method is generally preferred because it produces a more stable shortening and is easier to control.

Frying shortenings.

The major criteria for frying fat include a low level of unsaturation to assure superior flavor stability, a high smoke point, and a bland flavor. Frying fats are used at temperatures ranging from 180° to 190°C, so it is essential that they have as much heat stability as possible. The ability of frying fats to withstand oxidation is not a function of its overall degree of unsaturation, but rather is determined predominantly by its content of polyunsaturated fatty acids, or more accurately, by its concentration of the active methylene groups (linoleic and linolenic acids).Component oils vary in their ability to withstand the rigors of frying conditions, and a shortening which gives good results in baking will not necessarily be a satisfactory frying fat. Also, in producing frying fats the choice of the proper base stock is not the only important objective, as it is also important that they are properly refined and the trace quantities of iron and copper which are always found in the crude oil areneutralized by the use of the proper chelating agent. A frying fat with high oxidative stability does not have a long plastic working range. It will tend to be relatively brittle at temperatures below 36°C and soft at temperatures above 50°C.Because deep frying shortenings are present on the surface of foods, a high melting point can cause a greasy or waxy taste in the food. To avoid this, hydrogenation conditions of the oil must be carefully chosen in order to obtain maximum oxidative stability with the lowest possible melting point.

Cake and icing shortenings.

These shortenings are made by combining an appropriate amount of the selected emulsifier with a base similar to an all purpose shortening described above since the same consideration for crystal habit and form, texture, plastic range and mixing are important.Mono- and diglycerides possess marked surface activity due to their content of both oil loving (lipophilic) and water loving (hydrophilic) groups, and are extremely effective in promoting dispersion of the shortening in the doughs as well as giving it more strength, thus allowing the baker to use a higher ratio of sugar to flour and other ingredients (water and milk, etc.) in the recipe, while still obtaining adequate aeration of the batter during mixing. The result is a sweeter, more moist, lighter and finer textured cake. The choice of mono- and diglycerides will depend upon the ultimate purpose of the product. Generally speaking, a higher melting point one is preferred for cakes and a lower melting for icings. However, almost all cake and icing shortenings on the market contain an intermediate melting one. The traditional and most widely distributed cake and icing shortenings are formulated for dual purpose use, either cake or icing. Typically, these shortenings will contain a mono- and diglyceride emulsifier at a level of 2.5 to 3.0% as alpha monoglyceride.

Biscuit and cracker shortenings.

These are high stability type shortenings used in the manufacture of crackers and sweet biscuits which are sold in consumer packs nationally or regionally in supermarkets and grocery stores. They all require long shelf life stability since prolonged periods of time intervene between their time of manufacture and consumption. Shortenings are a major ingredient in the recipe of these products and may account for as much as one-third of the formula. Also, most of these products are manufactured in large factories which use complicated high speed production and packaging lines to produce a variety of items simultaneously. As a result, the shortening must be precisely tailored to meet the following objectives:

- It must provide the desired esthetic properties to the finished product.
- It must have the physical properties required for high speed mixing and processing equipment.
- It must have high oxidative stability for long shelf life storage.

Most manufacturers of shortenings make special products for biscuits and crackers in which the plastic range is sacrificed to some extent in favor of stability or to meet customer's specifications. One specification common to all is a high AOM stability, usually 100 hours.

Filler fat shortenings.

The manufacture of sandwich cookies and wafers requires the presence of a filler mixture between the cookies or the wafers. This mixture is composed of one-third shortening and two-thirds finely ground sugar with suitable flavors added. It is applied to the cookies or wafers when sufficiently fluid, but sets up due to the thixotropic properties of the base fat which allows its consistency to decrease while the mixture is being stirred, returning slowly to its original value when stirring stops and the material is allowed to rest. Wafer filler fat is quite firm since the filling must provide support for the fragile wafers.

Snack spray fats.

This is a very popular type of fat used by the snack industry for spraying snack crackers with as much as 25% of oil, in order to improve their eating quality and give them a glossy surface appearance. The oil must possess two important qualities: good oxidative stability because of the large food surface area covered; and a 20low melting point to avoid a waxy or greasy mouth feel and a dull surface appearance. These qualities were first found in coconut oil but partially hydrogenated soybean oil is on the market as a replacement.

Coating fats.

These are hard butter replacements or substitutes for cocoa butter in confectionary and immitation dairy products. Today such product is on the

market and is made from a combination of soybean and a small quantity of cottonseed oil through the utilization of special hydrogenation techniques. This product has excellent appearance and is sometimes preferred over coconut and palm kernel hard butters.

Fluid shortenings.

These cover the latest arrival on the market for frying and baking and are far removed from the traditional plastic or semi-solid products. They consist basically of either RBD or lightly hydrogenated soybean oil to which is added either hard fat (stearins) and/or hard emulsifiers. These are then processed in such a manner to incorporate these additives in finely divided crystals which will remain in suspension. A typical fluid shortening formula is formulated with 102 to 110 IV partially hydrogenated soybean oil with from 2 to 8% of soybean hard stock added, plus proper amounts of antioxidant and anti-foaming agent. These fluid shortenings have the distinct advantage of being pumpable or pourable at room temperature and can be used either for frying, or for bread baking in the continuous mixing process.

- **Lard**

To make lard, fatty tissues of the hog are chopped into small pieces and heated, with or without the addition of water, to remove fat from the cells, a so-called rendering process. The quality of the lard depends on the location of the fatty tissue in the animal and on the method of heating. An antioxidant is added to delay the onset of rancidity. To improve its quality it may be hydrogenated bleached or emulsifier is added.

- **Butter**

Butter is the fat of cream that is separated more or less completely from the other milk constituents by agitation or churning. Butter formation is an example of the breaking of an oil-in-water emulsion by agitation. The resulting emulsion that forms in butter itself is a water-in-oil emulsion with about 18% water being dispersed in about 80% fat and a small amount of protein acting as the emulsifier. Many volatile fatty acids and substances called diacetyl, formed from bacterial action is an important flavour component of butter. Butter is highly valued by many for its flavour.

- **Margarine**

Margarine is made from one or more optional fat ingredients churned with cultured pasteurised skim milk or whey. Other ingredients added to margarine are vitamins A and D for nutritive purposes; diacetyl as a flavour constituent, lecithin, monoglycerides and/or diglycerides of fat-forming fatty acids as emulsifying agents, artificial colours, salt, citric acid or certain citrates and sodium benzoate as preservative to the extent of 0.1%.

- **Hydrolysis**

Hydrolysis is brought about by enzymes that decompose fats into free fatty acids and glycerol. Heating thoroughly to destroy the lipase enzyme that catalyses the hydrolysis of triglycerides should prevent hydrolytic rancidity. Contaminating microorganisms may also produce lipase and these can similarly be destroyed with sufficient heating.

- **Oxidation**

Only unsaturated fats and foods which have lipoxygenase are susceptible to oxidative changes. Highly hydrogenated and saturated fatty acids are relatively resistant to oxidation.

- **Rancidity**
  Spoilage of fats may occur on storage, particularly if the fats are highly unsaturated and the conditions of storage are conducive to chemical change in the fats. Rancidity is of two types-hydrolytic and oxidative.

- **Prevention of rancidity**

1. Storage at refrigerator temperature prevents rancidity.
2. Rays of light catalyse the oxidation of fats by the use of coloured glass containers that absorb the active rays, fats can be protected against spoilage. Certain shades of green bottles and wrappers and yellow transparent cellophane wrappers are effective in preventing rancidity.
3. Vacuum packaging also helps to retard the development of rancidity by excluding oxygen.
4. Antioxidants naturally present in the food such as vitamin C, beta carotene and vitamin E protect against rancidity.

3.11 Summary

Fats have important roles in foods. As already indicated, vitamin E plays the role of a natural antioxidant. Fats also influence food structure. Fats separate out from an aqueous medium on standing. To create a system that will exist as one phase the fat has to be emulsified. The body employs a mixture of bile salts, fatty acids, mono glycerides and phospholipids to emulsify fats in the gut. In food processing also, mono glycerides, phospholipids and a wide range of synthetic compounds are used as emulsifiers.

3.12 Review Test

1. What is auto oxidation?

2. What is the effect of heat on fats ?

3. Discuss about the classification of fats ?

4. Discuss about the commercial use of fats?

5. Write a note on smoke point of fats?

3.13 Reference

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Unit - 4 : Proteins

Structure of Unit:

4.0 Objective

After completing this unit you will be able to**:**

- Understand the basic structure of proteins.
- Understand the types of protein.
- Know what is the affect of heating on protein.
- Know about the coagulation and denaturation.
- Know about the functional properties of protein.
- Know what is the commercial uses of protein .

4.1 Introduction

Protein, any of the group of highly complex organic compounds found in all living cells and comprising the most abundant class of all biological molecules. Protein comprises approximately 50% of cellular dry weight. Hundreds of protein molecules have been isolated in pure, homogeneous form; many have been crystallized. All contain carbon, hydrogen, and oxygen, and

nearly all contain sulphur as well. Some proteins also incorporate phosphorous, iron, zinc, and copper. Proteins are large molecules with high molecular weights (from about 10,000 for small ones [of 50–100 amino acids] to more than 1,000,000 for certain forms); they are composed of varying amounts of the same 20 amino acids, which in the intact protein are united through covalent chemical linkages called peptide bonds. The amino acids, linked together, form linear un branched polymeric structures called polypeptide chains; such chains may contain hundreds of amino-acid residues; these are arranged in specific order for a given species of protein. Protein is an essential nutrient to keep your body functioning well. Proteins are part of every cell in your body and are needed to build and repair muscle, tissue, skin, nails and hair. Protein also helps build hormones and enzymes.

4.2 Basic Structure of Proteins

Without proteins, living things would not exist. Proteins are involved in every aspect of every living thing. Many proteins provide structure to cells; others bind to and carry important molecules throughout the body. Some proteins are involved in reactions in the body when they serve as enzymes. Still others are involved in muscle contraction or immune responses. Amino acid chains. All proteins are made up of *amino acids*. Think of amino acids as train cars that make up an entire train called a protein. Proteins are formed by amino acids, which are produced based on the genetic information in a cell. Then, the amino acids that are created in the cell are linked together in a certain order. Each protein is made up of a unique number and order of amino acids. The protein that is created has a specific job to do or a specific tissue (such as muscle tissue) to create. The structure of amino acids is fairly simple. Each amino acid has an amino group at its core with a carboxyl group and a side chain attached. The side chain (a chemical compound) that is attached determines which amino acid it is. An *enzyme* is a protein used to speed up the rate of a chemical reaction. Because they regulate the rate of chemical reactions, they also are called *catalysts*. There are many, many, many different types of enzymes, because for each chemical reaction that occurs, an enzyme specific to that reaction must be made. Metabolic processes don't just automatically happen; they need enzymes. And, a reason that you must consume protein is so that you can make more enzymes so that your processes will occur. Chemical reactions control the metabolism and life of living things. Proteins are long chains of polypeptides, and thus, so are enzymes. However, some enzymes contain parts that are not made up of proteins but assist the enzyme in its function. These are called *coenzymes*. Vitamins often act as coenzymes. The name of an enzyme usually reflects the name of the chemical on which the enzyme acts (that is, the chemical substrate). For example, an enzyme that acts on a fat (fat being the substrate) is called a lipase (remember, *lip* = fat).To act on a substrate, an enzyme must contain an *active site*. The active site is the area on the enzyme that allows the

substrate and enzyme to fit together (like puzzle pieces). The way that enzymes and substrates fit together is often compared to the way a key fits a lock; the way enzymes kick-start reactions often is referred to as the *lock-and-key model*. Once the substrate and enzyme are connected, the enzyme can get to work. During an enzymatic reaction, the substrate is changed during the reaction, and new products are formed during the reaction, but the enzyme comes out of the whole thing unchanged. Then, the enzyme leaves the reaction to form a complex with a different substrate and catalyze another reaction. The products of the reaction continue on in their pathway. Enzymes are able to catalyze reaction after reaction millions of times before they start to wear out. Then, the body creates more enzymes by synthesizing the proper protein chains from the correct amino acids.

4.3 Structure of Proteins

Primary structure

The primary structure refers to amino acid linear sequence of the polypeptide chain. The primary structure is held together by covalent bonds such as peptide bonds, which are made during the process of protein biosynthesis or translation. The two ends of the polypeptide chain are referred to as the carboxyl terminus (C-terminus) and the amino terminus (N-terminus) based on the nature of the free group on each extremity. Counting of residues always starts at the N-terminal end (NH_2-group), which is the end where the amino group is not involved in a peptide bond. The primary structure of a protein is determined by the gene corresponding to the protein. A specific sequence of nucleotides in DNA is transcribed into mRNA, which is read by the ribosome in a process called translation. The sequence of amino acids was discovered by F.SANGER.The sequence of a protein is unique to that protein, and defines the structure and function of the protein. The sequence of a protein can be determined by methods such as Edman degradation or tandem mass spectrometry. Often however, it is read directly from the sequence of the gene using the genetic code. We know that there are over 10,000 proteins in our body which are composed of different arrangements of 20 types of amino acid residues (it is strictly recommended to use the word "amino acid residues" as when peptide bond is formed a water molecule is lost so, protein is made up of amino acid residues). Post-translational modifications such as disulfide formation, phosphorylations and glycosylations are usually also considered a part of the primary structure, and cannot be read from the gene. Example: Insulin is composed of 51 amino acids in 2 chains. One chain has 31 amino acids and the other has 20 amino acids.

Secondary structure

Secondary structure refers to highly regular local sub-structures. Two main types of secondary structure, the alpha helix and the beta strand or beta sheets,

were suggested in 1951 by Linus Pauling and coworkers. These secondary structures are defined by patterns of hydrogen bonds between the main-chain peptide groups. They have a regular geometry, being constrained to specific values of the dihedral angles and on the Ramachandran plot. Both the alpha helix and the beta-sheet represent a way of saturating all the hydrogen bond donors and acceptors in the peptide backbone. Some parts of the protein are ordered but do not form any regular structures. They should not be confused with random coil, an unfolded polypeptide chain lacking any fixed three-dimensional structure. Several sequential secondary structures may form a "supersecondary unit"

Tertiary structure

Tertiary structure refers to three-dimensional structure of a single protein molecule. The alpha-helices and beta-sheets are folded into a compact globule. The folding is driven by the *non-specific* hydrophobic interactions (the burial of hydrophobic residues from water), but the structure is stable only when the parts of a protein domain are locked into place by *specific* tertiary interactions, such as salt bridges, hydrogen bonds, and the tight packing of side chains and disulfide bonds. The disulfide bonds are extremely rare in cytosolic proteins, since the cytosol is generally a reducing environment.

Quaternary structure

Quaternary structure is the three-dimensional structure of a multi-subunit protein and how the subunits fit together. In this context, the quaternary structure is stabilized by the same non-covalent interactions and disulfide bonds as the tertiary structure. Complexes of two or more polypeptides (i.e. multiple subunits) are called multimers. Specifically it would be called a dimer if it contains two subunits, a trimer if it contains three subunits, and a tetramer if it contains four subunits. The subunits are frequently related to one another by symmetry operations, such as a 2-fold axis in a dimer. Multimers made up of identical subunits are referred to with a prefix of "homo-" (e.g. a homotetramer) and those made up of different subunits are referred to with a prefix of "hetero-" (e.g. a heterotetramer, such as the two alpha and two beta chains of hemoglobin).

4.4 Types & Sources of Proteins

Protein is vital for growth, repair and maintenance of the body. Protein can also be used to provide the body with energy, once it has been used for its main function of growth and repair. Our bodies are composed of millions of cells which are constantly being replaced and repaired. As the body grows, new cells are added. Each cell contains a substance called protoplasm, which mainly contains proteins. Meat, milk, cheese, egg white, egg yolk, wheat, maize, barley and fish are all healthy sources of protein..

4.4.1 Types of proteins

Proteins in foods can be placed into three categories: globular, fibrous and conjugated[1].

Globular Proteins

- Native protein that is rather spherical in the configuration of their tertiary structure.
- Examples: all enzymes, hormones, albumins (such as egg whites), globulins (found in meats and legumes) and others

Fibrous Proteins

- Insoluble, elongated protein molecules
- Examples: collagen and elastin (both are found in meats and poultry)

Conjugated Proteins

- Proteins combined with some other type of compound, such as carbohydrate or lipid
- Examples: *glycoprotein's* composed of carbohydrate & protein (ovomucoid protein in egg white, hem agglutinin in soy beans); *lipoproteins* composed of protein and lipid (cholesterol, triglycerides and phospholipids); *metalloprotein* is a protein-metal complex (ferritin, hemoglobin, and myoglobin in blood and meats); *phosphoprotein*s are inorganic phosphates linked with protein (casein in milk).

4.4.2 Sources Of Proteins:

Proteins are isolated from both plants and animals.

i. PLANT PROTEINS:
   a. Peanut, Coconut, Soya Beans
   b. Refined proteins such as Glutamic acid and Monosodium Glutamate
   c. Microbial Plants such as Algae and fungi
   d. Leaf proteins

ii. MILK PROTEINS:
   a. Caesin
   b. Milk Albumin
   c. Non fat dry solid milk
   d. Dried butter
   e. Milk powder

iii. EGG PROTEINS:
   a. Egg White: Globulins, Ovomucin, Ovimucoid, Ovalbumin Conalbumin, Avidin
   b. Egg Yolk: Lecithoprotein, Lipovitellin, Lipovitellenin

iv. ANIMAL PROTEINS:
   a. Gelatine

b. Fish Glue
c. Fish stock meal

i. PLANT PROTEINS

Proteins obtained from plants are discussed below:-

a. Peanut Protein

Among plants, soil seeds can be considered as the rich sources of proteins. Next to that is pulses and then cereals. Oilseeds contain 20-35% protein; Pulses contain 12-30% and Cereals 5-16%. After extracting oil from the peanuts the meal can be utilized for edible purposes. However two factors are to be considered carefully. These are the hygienic conditions and removal of inedible parts and the Denaturation of proteins.

The first factor can be looked after if sorting and cleaning is done properly. For this purpose the peanuts are shelled in a Peanut Sheller. The outer shell and the seed is separatedby means of the shaker. The final particles are further separated by means of a blower. The separated seeds are roasted fro about 3-5 mts. at about 300-400 C, till the skin separates out. The seeds are again passed through a shaker and decuticaled seeds are then sorted out by hand to remove the bad seeds. This seed is ready for oil extraction and for the manufactured edible protein. The meal left after extracting oil, is a concentrated protein material having 50% protein. This is mixed with roasted Bengal gram in the ratio of 3:1 i.e. three parts of peanut to one part of Bengal gram. This can be seasoned by adding spices. This type of powder is used for protein substitutes and is known as Multipurpose food or M.P.F. When M.P.F is mixed with wheat flour in the ratio of 20:80 it is known as peanut blended flour or Paustic Atta.

Peanut protein as liquid food can be made as Milk, curd, Butter milk, butter milk powder and baby foods. Peanut milk is nothing but peanut paste suspended in water to a milk consistency. The deficient nutrients such as calcium, vitamins are added to adjust it to a milk pH. The advantage of peanut milk is that many babies are allergic to cows milk but can consume peanut protein.

b. Coconut Protein

The products are processed are the same as peanut. The only difficulty is that coconut contains more crude fibre and therefore technically one has to face more problems in removing the crude fibre. Additional sieving is required for the above purpose.

c. Soya Bean Protein

Soyabean protein is about 45% in beans, which is maximum in pulses. Soya bean can be converted into Soya milk, Soya cheese and Soya Meal flour. The oil is extracted from soya beans by the Solvent extraction method. After removing oil the residue is made into fine powder. This is used as soya meal flour or for preparing soya milk or cheese by suspending in water and using culture for cheese making soya is then precipitated with Trichloresert acid to separate soya albumin. The residue left behind contains proteins such as Lecithoprotein.

d. Cereal Proteins

Cereal is considerably a poor source of protein. Only wheat , maize, rice germs are used to isolate proteins. The gluten of wheat is separated out from starch during starch manufacturing. This is known as Gluten. It is hydrolysed and then precipitated with alcohol to separate out Glutamic Acid. When it is treated with Sodium Hydroxide it forms into a salt of glutamic acid called Monosodium Glutamate. Both these are responsible fro meaty flavour

e. Microbial Protein

Many bacterial strains of algae and mould are rich sources of proteins. For example Bakers yeast, Red algae contain 60% proteins. These are dried and used as proteins.

f. Leaf Protein

The rich sources of protein are those leaves which are high in protein content.Lucerne, Methid and Bursene grass are rich sources of proteins ranging from 3.5-4.5 % protein. the method of preparation is simple so long as crude leaf protein is concerned The protein from the leaf is being continuously extracted in water by means of grinding. The water is collected which contains the leaf extract including the proteins. To this water Acetic acid is added so that the green colour is refluxed for 1-2 hours in absolute alcohol, which remove the green colouring pigments from the proteins. This protein can thus be used as a food substitute.

ii. MILK PROTEIN

The protein of milk is utilized in the form of casein, Milk albumin. Dried milk solids or Dried butter milk solids. Milk protein is considered first class protein having all the Eight essential amino acids.

a. Casein

It is insoluble in water which on hydrolysis is converted into soluble Casein known as Para Casein. Casein can also be precipitated by heating separated milk and adding 1% HCL. The precipitate becomes a rubber like structure which can easily be filtered off by cheese or a

canvas cloth . It is washed with water to make acid free and then it is dried. Acid precipitated Casein is generally used for non edible purposes while rennin precipitated Casein is used fro edible purposes.

b. Milk Albumin

It remains in after precipitating Casein. It is a little difficult to precipitate because the quantity is less. The Whey is concentrated to 6 to 7 times Lactose sugar of Lactic acid is separated out by crystallization

iii. EGG PROTEIN

Two constituents of egg protein are generally utilized commercially or the whole egg after beating is converted into Powder.

a. Egg Albumin

White of the egg is separated out from the yolk on screen and treated with enzyme Glucose. It is then dried in the spray dryer. it is also used as a foaming agent or as a stabalizer.

b. Egg Yolk

The solid yellow portion of egg is also rich in protein and Iecithin. This is used for thickening and emulsification. It is beaten and suspended in water to make a thin consistency and also spray dried.

c. Egg Powder

This is beaten to mix yolk and white. It is then dried either in vacuum shelf drier or in a spray drier, used in substitute for egg.

iv. ANIMAL PROTEIN:

a. Gelatine

It is a protein material obtained by hydrolysing the skin of calf and demineralized bones and cartilages. The extraction of the gelatine is performed by placing stock in large wooden cans covering with water and heating for several hours. The extract is drawn out and again more water is added fro second extraction. This is repeated 6 to 7 times. The broth is concentrated till the protein content comes to 25%. It is then made to flow on a rubber belt to form a film. This is powdered and used for non edible purposes as glue. In case, for edible purposes the powder is again dissolved in water, treated with active charcoal to remove odour and colour, reconcentrated and powdered.

b. Fish Glue

The outer shinning skin of scales of fish and bones are used for making glue. The method is the same as for gelatine.

c. Fish Stock Meal

Offals and bones residue are treated with water and boiled for a few hours. The broth is taken and concentrated. the residue of the bones and muscles is treated with an organic solvent to remove fatty substances which also remove the flavouring constituents of fish. This is then dried to make a meal. Meals can be prepared either from fish or any other animals such as beef, pork or goat.

4.5 Affect of Heating On Protein

When proteins are heated, their chemical structure is denatured. Remember, this is permanent alternation and cannot be reversed. As heating continues, proteins coagulate and generally become less soluble. If overheated, they become less digestible. The effect of heat on specific proteins is discussed below.

Meat: Molecules of connective protein start to coagulate at 60 degrees C, contracting as they do so, and causing the meat to shrink. Under 100 degrees C, coagulation is slow; over 100o C coagulation is rapid and the protein becomes hard and less digestible. In the presence of moisture, collagen is converted into the protein gelatin, which is soluble.
Milk: lactalbumin and lactoglobulin (proteins in milk) coagulate gradually as milk is heated and form a 'skin' on the surface

Wheat: gluten (protein in cereals) starts to coagulate at 80 degrees C and continues to do so until the heating ends. In this way, it helps to form the structure of cakes, bread and other baked wheat products.
Egg white: At 60 degrees C coagulation starts when ovalbumin denatures into a solid, and continues until the whole white is solid and opaque.
Egg yolk: Protein starts to denature at 70 degrees C, and continues to do so until the yolk becomes dry and hard.

4.6 Coagulation

When proteins are coagulated they clump into a semi-soft, solid-like substance. A chemical change has taken place because a new substance is produced. Blood coagulates (clots) to stop further bleeding. The first step in protein digestion is coagulation. Coagulation (thrombogenesis) is the process by which blood forms clots. It is an important part of haemostasis, the cessation of blood loss from a damaged vessel, wherein a damaged blood vessel wall is covered by a platelet and fibrin-containing clot to stop bleeding and begin repair of the damaged vessel. Disorders of coagulation can lead to an increased risk of bleeding (haemorrhage) or obstructive clotting (thrombosis)Coagulation is highly conserved throughout biology; in all mammals, coagulation involves both a cellular (platelet) and a protein (coagulation factor) component. The system in humans has been the most extensively researched and is the best understood. Coagulation begins almost instantly after an injury to the blood vessel has damaged the endothelium lining the vessel. Exposure of the blood to proteins such

as tissue factor initiates changes to blood platelets and the plasma protein fibrinogen, a clotting factor. Platelets immediately form a plug at the site of injury; this is called *primary haemostasis*. *Secondary haemostasis* occurs simultaneously: Proteins in the blood plasma, called *coagulation factors* or *clotting factors*, respond in a complex cascade to form fibrin strands, which strengthen the platelet plug.

4.7 De-naturation

Denaturation is a process in which proteins or nucleic acids lose the quaternary structure, tertiary structure and secondary structure which is present in their native state, by application of some external stress or compound such as a strong acid or base, a concentrated inorganic salt, an organic solvent (e.g., alcohol or chloroform), or heat. If proteins in a living cell are denatured, this results in disruption of cell activity and possibly cell death. Denatured proteins can exhibit a wide range of characteristics, from loss of solubility to communal aggregation. This concept is unrelated to denatured alcohol, which is alcohol that has been mixed with additives to make it unsuitable for human consumption. When food is cooked, some of its proteins become denatured. This is why boiled eggs become hard and cooked meat becomes firm. A classic example of denaturing in proteins comes from egg whites, which are largely egg albumins in water. Fresh from the eggs, egg whites are transparent and liquid. Cooking the thermally unstable whites turns them opaque, forming an interconnected solid mass. The same transformation can be effected with a denaturing chemical. Pouring egg whites into a beaker of acetone will also turn egg whites opaque and solid. The skin which forms on curdled milk is another common example of denatured protein. The cold appetizer known as ceviche is prepared by chemically "cooking" raw fish and shellfish in an acidic citrus marinade, without heat.

4.8 Functional Properties of Protein

Proteins are the principal structural and functional components of many food systems; e.g., meat, cheese, gelatine, egg white and many cereal products. In addition, proteins are being used increasingly to fabricate and facilitate the engineering of new foods such as protein beverages and extruded foods. These and other applications depend upon the physicochemical properties of protein ingredients, collectively referred to as the functional properties. Proteins per se as dry powders, have very limited appeal to potential users or consumers. To facilitate their use in foods and their conversion to desirable ingredients they must possess appropriate functional properties following interactions with other food components; e.g., water, carbohydrates or lipids, during processing. Functional properties of proteins are those physicochemical properties of proteins which affect their behaviour in food systems during preparation, processing, storage, and consumption, and contribute to the quality and organoleptic attributes of food systems . Chemical and Functional Properties

of Food Proteins presents the current state of knowledge on the content of proteins in food structures, the chemical, functional, and nutritive properties of food proteins, the chemical and biochemical modification of proteins in foods during storage and processing, and the mutagenicity and carcinogenicity of nitrogenous compounds. It emphasizes the structure-function relationship as well as the effects of practical conditions applied in food processing on the biochemical and chemical reactions in food proteins and food product quality.

4.9 Commercial Uses of Protein

Protein is one of the main food components, used for building structure and for helping certain reaction to take place. Wheat protein gives bread the ability to retain gas and rise. The commercial uses of proteins are many and varied.

Gelatine (or **gelatine**, from Latin: gelatus = stiff, frozen) is a translucent, colourless, brittle (when dry), flavourless solid substance, derived from collagen obtained from various animal by-products. It is commonly used as a gelling agent in food, pharmaceuticals, photography, and cosmetic manufacturing. Substances containing gelatine or functioning in a similar way are called *gelatinous*. Gelatine is an irreversibly hydrolysed form of collagen, and is classified as a foodstuff. It is found in most gummy candies as well as other products such as marshmallows, gelatine dessert, and some ice cream, dip and yogurt. Household gelatine comes in the form of sheets, granules, or powder. Instant types can be added to the food as they are; others need to be soaked in water beforehand.

Baking is a food cooking method that uses prolonged dry heat by convection, rather than by thermal radiation, normally in an oven, but also in hot ashes, or on hot stones. The most common baked item is bread but many other types of foods are baked. Heat is gradually transferred "from the surface of cakes, cookies and breads to their centre. As heat travels through it transforms batters and doughs into baked goods with a firm dry crust and a softer centre" Baking can be combined with grilling to produce a hybrid barbecue variant, by using both methods simultaneously or one before the other, cooking twice. Baking is related to barbecuing because the concept of the masonry oven is similar to that of a smoke pit.

Baking has been traditionally done at home by women for domestic consumption, by men in bakeries and restaurants for local consumption and when production was industrialised, by machines in large factories. The art and skill of baking remains a fundamental one and important for nutrition, as baked goods, especially breads, are a common food, economically and culturally important. A person who prepares baked goods as a profession is called a baker.

Egg Protein Coagulation
In un-shortened cakes, sugar molecules disperse among egg proteins and delay coagulation of the egg proteins during baking.As the temperature rises, egg proteins coagulate, or form bonds among each other. The sugar molecules raise the temperature at which bonds form between these egg proteins by surrounding the egg proteins and interfering with bond formations. Once the egg proteins coagulate, the cake "sets", forming the solid mesh-like structure of the cake.

Custards
Sugar delays coagulation of egg proteins in custards and similar cooked egg dishes. Just as most baked products are essentially flour protein structures, custards are egg protein structures. If the egg white solidifies too soon from the heat in the cooking process, the liquid ingredients in the custard will be squeezed out in droplets. This is known as syneresis or "weeping."Sugar in a custard mixture breaks up the clumps of protein molecules so that they are finely dispersed in the liquid mixture. The temperature at which the custard sets is thus raised, permitting the egg proteins to coagulate slowly and enmesh the other ingredients, resulting in a smooth, stable consistency.

Meringues
The amount of sugar added per egg white determines the nature of the meringue. For a meringue tart or pie shell that is to be filled with ice cream, fruit, or other soft mixtures, four tablespoons of sugar are used for each egg white. The stiff, shaped meringue is then baked in a very slow oven to ensure even setting and thorough drying throughout. The baked meringue will be very crisp and dry, and there will be little, if any, browning. For the meringue topping that is to be used on a pie or pudding, only two tablespoons of sugar is required per egg white, and the mixture may be baked in a hotter oven. This produces a softer meringue with a slightly crisp crust and a golden-brown colour due to the caramelization of the sugar. If no sugar is added to the beaten egg white topping, considerable air shrinkage occurs during baking, and the resulting product is flat, pale and gummy.

Creaming
Sugar crystals become interspersed among the shortening molecules when shortening and sugar are creamed together. In cakes and cookies, sugar helps promote lightness by incorporating air into the shortening. Air is trapped on the face of sugar's irregular crystals. When sugar is mixed with shortening, this air becomes incorporated as very small air cells. During baking, these air cells expand when filled with carbon dioxide and other gases from the leavening agents, resulting in a smooth, stable consistency.

Egg Foams
Sugar serves as a whipping aid to stabilize beaten egg foams. In foam-type cakes, sugar interacts with egg proteins to stabilize the whipped foam structure. In doing so, sugar makes the egg foam more elastic, so that air cells can expand and take up gases from the leavening agents.

4.10 Summary

Proteins play some functional roles in foods because they can form gel, sols and emulsion and can contribute color and flavor. Their most important role, however, is their nutritional value. The primary function of dietary protein s is to supply nitrogen and amino acid for the synthesis of body proteins and other nitrogen –containing substances. the value of protein as food depends upon its amino acids composition, especially that of essential amino acids. The nutritional value of protein also depends upon the presence of amino acids in proper proportion, the digestibility of the protein and its absorption.

4.11 Review Questions

1. What is structure of protein ?

2. What is the effect of heat on protein ?

3. Discuss about the classification of protein ?

4. Discuss about the commercial use of protein?

5. Write a note on functional properties of proteins?

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Unit - 5 : Food Processing

Structure of Unit:

5.0 Objective

Food processing can be defined as the science that deals with the process of prevention of decay or spoilage of food, thus allowing it to be stored in a fit condition for furthur use.

The process used varies with the length of storage intended. It may be as simple as boiling milk so that it may keep for 24 hours or pickling of mangoes or lemons where the storage period would as long as one year.

Food supply has to keep pace with the needs of the population. Increasing the food production to meet the shortage results in wastage due to inadequate facilities available for storage and preservation.

5.1 Introduction

Food processing is the technique and a set of methods used to transform raw ingredients into food for consumptions by human or animals. Food processing

often takes clean, harvested or slaughtered components converting them to marketable food products.

The concern for developing these methods for conversion of food forms where to:

a) Produce attractive

b) Marketable

c) Often long shelf-life food products with variation in tastes.

d) Quick, nutritious easy meal option for busy family.

For example, potato may be liked boiled but the conversion in the form of chips make it available easily, can be carried along any time anywhere and tastes good. There are various examples of food processing techniques that are discussed below:

5.2 Methods Food Processing

Food processing is an important development in Food Technology and food processing dates back to history where we find one of the major contributions from Napoleon Bonaparte. In order to keep his army well fed, who would rather feed on villagers food, unlikely to suit a diets soldier, he declared reward for anybody who would suggest on way s for how to feed the soldiers, who due to lack of food where becoming casualties.

5.2 .1 Food Processing – Canning

Nicholas Appert ,in 1810,in the rein of Napoleon Bonaparte, invented a process and named after himself "Appertisation" to day known as canning. He placed potted beef in a bottle and heated it. The meat's shelf life was found to increase and Appert was rewarded.
Today canning is considered to be the "father" of all food processing with greatly perfected techniques. Canning is defined as the preservation of food in sealed container and usually implies heat treatment as the principle factor in the prevention of spoilage.

Canning is done in glass, plastic or aluminium with sufficient heating to destroy food borne illness microbes. Cans are sealed with inert materials, material that will not react with canning material or food ingredients. Care must be taken while selecting material for metals otherwise it could prove fatal. Appert used lead to seal the tin can. The lead reacted with the wine in which the meat was soaked leading to food poisoning of troop of soldiers. Most modern cans are made of steel plate coated with tin.

Canning usually employs temps. above 100 C to kill spoilage organisms and to activate the enzyme action. The food is sealed in sterilized tight containers and then subjected to temps. of above 100 C. Low acid foods have to be processed at temps. higher than 100 C. This can be obtained by using Auto claves or pressure cookers. The time and temperature necessary varies with the type of food, vegetables.

5.2.2 Irradiation

It is a technique of food preservation by bombarding food with high powered x ray or electron beams as they are able to destroy many more diseases causing pathogens.

This method is applicable as many insects, parasites and food borne bacteria, such as e. coli, salmonella, staphylococcus and listeria ,resist traditional food preservation technique like drying or refrigeration. Also known as ***cold pasteurization.***

It is a myth that eating irradiated food causes cancer. The research reveals that only change that occurs in the food is the similar chemical change that would occur due to cooking. Irradiation only disrupts the protein in parasites and bacteria as well .Since no heat involved, less changes occur in food. This means that irradiated foods can taste and look fresher than traditionally preserved food. Irradiated food are quite popular. Developing countries have been using irradiation for years to ensure adequate supply of food for their citizens.

5.2.3 Food Processing – Addition of Heat

Application of heat helps preserve food by inactivating the enzymes, destroying the microorganisms of both spoilage and public health concern. Pasteurization processes only deal with mild heat, aiming at providing short term extension of shelf life. In combination with refrigeration, whereas the commercial sterilisation process (canning) produces shelf stable products.

The heat treatment achieved during the cooking of foods also helps to render the food more safe and palatable.

A. Blanching & Steaming

Blanching represents perhaps the least severe heat: nutrient loss during blanching can occur due to reasons other than heat, such as leaching.

Steam and hot water are two blanching techniques.

These conventional processes are simple and inexpensive but are also energy intensive, resulting in considerable leaching of soluble components (which

occur both during heating and cooling.) and produce large quantities of affluent.

With steam blanching, it is possible to significantly reduce the effluent volume, as well as leaching losses. The individual quick blanching is based on two stages heat hold principle and has been shown to significantly improve nutrient retention. The vegetables are heated to a single layer to a temperature high enough to inactivate the enzyme, in second stage they are held in a deep bed long enough to cause enzyme in activation.

Depending on the method of blanching, commodity and nutrient concern, the loss due to blanching can be up to 40% for minerals and vitamins (especially vitamin c and thiamine,35% for sugar, and 20% for protein and amino acids.

Blanching can result in some undesirable colour changes resulting from the thermal degradation of blue/green chlorophyll pigments to yellow/greenpheophytins.

Chlorophylls are sensititive to pH and presence of metal ions. Alkaline agents and chelating agents favour better retention of the green colour, whereas texture degradation is characteristics of most heat treatments low temperature blanching has been shown to improve the texture of some products (carrots beans, potatoes, tomatoes, cauliflower due to activation of the pectin methyl esterase enzyme.

B. Pasteurisation

Pasteurisation is a heat treatment applied to foods which is sufficient to inactivate particular disease producing organisms of importance in a specific foodstuff and shelf life is improved. Therefore the process in which heat is given to food below boiling point of water for a definite time is pasteurization.

- Pasteurisation activates most viable vegetative form of microorganisms but not heat resistant spores.
- Number of viable organisms is reduced by ratios of the orderof10 (15):1.
- Enzymes present in the food that could be activated by heat.
- A combinations of temperature and time must be used that is sufficient to inactivate the particular species of bacteria or enzyme under consideration.
- The most common application is pasteurisation of liquid milk (62.8degreeC) for 30 minutes, whole egg (64.4 degree C for 2 -5 min) by this salmonella is controlled.
- The nutritional and sensory characteristics of most food are affected by the pasteurisation process because of its mild heat treatment.

However, because it is only temporary method of shelf life extension, the product quality continues to change (deteriorate) during storage.

- The shelf life depends on the post pasteurisation packaging conditions and storage environment.
- No loss of fat soluble A,D,E,K.
- .The extent of loss in thiamine, vitamin B6,vitamin B12,and folic acid due to pasteurisation has no pronounced effect in color.
- Small losses of volatile aroma compounds occur during the mild heat treatment of pasteurisation. Colour changes in fruits and vegetables are caused by enzymesactivity(polyphenoloxidase) and the presence of oxygen and the heat treatment inactivates the enzyme to minimise color deterioratetion of fruits n vegetables.
- There are 3 methods of pasteurisation.:
    a. **Low temperature Holding(LTH):62 DEGREE FOR 32 minutes**
    b. **High Temperature for short time or flash time(HTSC):72 degree for 15 min.**
    c. **Ultra high temperature sterilisation(UHTS)above 120 degree for 2 sec.**

C. Sterilisation:

Sterilisation processes are more severe with respect to the heat treatment given generally to achieve commercial sterility.The following nutrients are more sensitive to destruction by heat. Vitamin A,B1,B6,B12,C,D,E,Folic Acid, inositol, and pantothenic acid and aminoacid such as lysine and threonine. Because of the possibility of using numerous(time temperature combinations for achieving thermal sterilisation, the influence of the process cannot be easily quantified.

The severity of the heat treatment is determined by the following factors;

- Ph of the food (low acid foods require more severe heat treatment to ensure the destruction of C.botulimum) resistance of microorganisms.
- The heating behaviour of the food (conduction .convection)
- The nature, size of the container as well as the nature and mode of application of the heating medium.

Thermal Death Time

- It has been found that microorganisms including C.botulinum are destroyed by the heat at the rate which depends on the temperature .Higher the temperature, the spores are killed faster.

- Temperature is given accordingly to the microbial growth in the food .More the number of microbes, higher the temperature will be given to kill the bacteria.

- At any given temperature, the spores are killed at any time durations. Some spores being apparently more resistant to heat than other spores.

- An enzyme present in milk, phosphatase, is destroyed under somewhat the same time temperature conditions as the tuberculosis and since chemical test for the enzyme can be carried out simply. Its presence is used as an indicator of inadequate heat treatment.

- The temperature and time required are determined and then heat transfer equipment is designed using the equations developed for heat transfer operations.

5.2.4 Food Processing – Removal of Heat. (Cooling Or Refrigeration)

Since most of the biological, biochemical, physiological and microbial activities increase or decrease with temperature, control at temperature (refrigeration) remains the most widely used method to keep food fresh. Because the spoilage activities are not completely stopped, refrigeration only provides temporary shelf life extension.

Freezing terminates most of these microbiological and physiological activities (except chemical and some enzymatic changes) the freezing process can provide a long storage life, especially when the product is frozen and stored at a temperature below -18 degree C.

Methods of Removal of Heat

A. **Chilling** :Can be used adjacent to other preservation methods.Temperature required for this (-) 1 degree C and (-)4 degree C. Up to 2 years (-) 28 degree C & (-) 18 degree C for 1 year. e.g. Meat, eggs, chicken and all sea foods can be kept for limited time.

Factors to be kept under control are relative humidity:

i. Low condition: moisture loss, wilting and shrinking of skin of fruits and vegetables.

ii. High conditions: provide favourable conditions for microbial growth.

Refrigerate- no change in texture, flavour and nutritive value. Freon or liquid ammonia gas is used for this.

B. **Cook Chill:**

- Precooked food is used and chilled very quickly
- Temperature stored at 0-3 degree
- Food is reheated before use.

Precautions:

- Cook food properly.
- Blast chillers unit should be used within 30 min.of cooking at the temperature 0-3 degree C.
- Food should be used immediately but not after 2 hrs.
- Internal temperature should be 70 degree for two minutes.
- Can be kept for two days only.

Process of cook chill:

High grade ingredients should be stored properly. (dry ,refrigerate or freeze).

For preparation of dishes the internal temperature should not be less than 70 degree C. (Meat, fish, vegetable, dessert) labelled container should undergo blast chilling where kept food should not have temperature 10 degree C. Reheating should be done very quickly and 70 degree C for immediate use.

Freezing should be done very slowly as it can cause the formation if ice crystal that may cause harm to the cells of the food and result in distorted result and texture.

5.2.4 Food Processing – Removal of Moisture (or Drying or Dehydration)

All life sustaining activities require the use of water, available as free moisture in the foods. By removing or reducing the moisture content, the food can be rendered stable, because most of the spoilage activities are stopped or retarded. This is the principal used in such processing applications s drying, concentration and evaporation.

It is not just the presence of the moisture in foods that renders them unstable. It is the availability of moisture for their activities. Water activity is a measure of the available moisture. A water activity level of 0.75 is considered the minimum required for most activities. Water can be bound to salt sugar, or other larger molecules, which makes it unavailable. Such conditions can exist in dried product, concentrates,etc.

Humidity and Relative Humidity: The amount of air that can be easily held at specific temperature. If air can't be held then condensation (change from gaseous phase into liquid phase) will occur generally known as dew. Relative humidity depends on the temperature of the air, as warm air can hold more moisture than cold air

Food Drying & Dehydration

1. Drying or dehydration is one of the oldest methods of preserving food.

2. Dried foods can be stored for long periods without deterioration occurring.

3. The principal reasons for this are that the microorganisms which cause food spoilage and decay are unable to grow and multiply in the absence of sufficient water and many the enzymes which promote undesired changes in the chemical composition of the food cannot function without water.

4. The low water content attend by drying extends the shelf life of dried foods without the need for refrigerated storage or transportation. As well, available surplus can be converted to stable forms. For Example, liquid milk is highly perishable, whereas milk power is more stable and easy to preserve and handle.

5. Usually, a significant reduction in weight in weight a savings in the bulk volume occurs during drying, which can lead to savings in the cost of transportation and storage.

6. The reconstitution characteristics and relatively good organolyptic qualities of many modern dehydrated products make them acceptable as convenience foods.

7. Examples of such foods include instant coffee, tea, milk, chocolate, instant drinks, soup mixes and instant meals containing dried vegetables. Breakfast cereals and instant meals containing dried vegetables, breakfast cereals, and cereals products such as rice ,baby foods containing dried cereals, pasta ,dried vegetable(such as potato flakes or granules)peas ,beans, carrots, dried meat and fish ingredients , dried fruits for use as snacks or in desserts or backed products etc.

Drying Processes Fall Into Three Categories

1 .Air and contact drying under atmospheric pressure:
In air and contact drying, heat is transferred through the food stuff either from heated air or from heated surfaces. The water vapour is removed from the air.

2. Vacuum drying:

In vacuum drying, advantage is taken of the fact that evaporation of the water occurs more readily at lower pressure than at higher ones. Heat transfer in vacuum drying is generally by conduction, sometimes by radiation.

3. Freeze Drying: In freeze drying, the water vapour is sublimed (convert a substance directly from a solid to gas or from a gas to solid without an intermediate phase, or undergo this process)off frozen food. The food structure is better maintained under these conditions.

Suitable temperature and pressures must be established in the dryer to ensure that sublimation occurs.

✓ **Heat requirement for vaporisation:**

The energy, which must be supplied to vaporise the water at any temperature, depends upon this temperature. The quantity of energy required per kg of water is called the **latent heat of vaporisation, if** it is from a liquid, or latent heat or sublimation if it is from a solid. The heat energy required to vaporize water under any given conditions can be calculated from the latent heats given in the steam table.

✓ **Heat transfer in drying:**

The rate of drying are generally determined by the rates at which the heat energy can be transferred to the water or to the ice in order to provide the latent heats, though under some circumstances the rate of mass transfer (removal of water)can be limiting. All three of the mechanisms by which the heat is transferred- conduction, convection, and radiation may enter into drying. The relative importance of the mechanisms varies from one drying. The relative importance of the mechanisms varies from drying process to another and very often one mode of heat transfer predominates to such extent that it governs the overall process. For freeze drying, energy must be transferred to the surface at which sublimation occurs. However, it must be supplied at such a rate as not to increase the temperature at the drying surface above freezing point.

As drying proceeds, the character of the heat transfer situation changes. Dry material begins to occupy the surface layers which are poor heat conductors so that heat is transferred to the drying region progressively more slowly.

✓ **Drying and water activity:**

Dehydration accomplishes preservation in two major ways.

First, it removes the water necessary for the growth of micro organism and for the enzymatic activity.

Second, by removing the water, it increases the osmotic pressure by concentrating salts, sugar, and the acids, creating a chemical environment unfavourable for the growth of many organisms. The microbial stability of dehydrated foods results from the interruption of vital processes essential to microbial growth or spore germination. The number and types of microorganisms that can be associated with foods are extremely large.

Moreover , they differ depending on the types of foods. And might not remain constant during the life of a food. This can originate from the raw material or from the raw material from contaminations (by people , animals, insects, water, air contact surface, etc.)

The water activity of fresh fruits, vegetables, meats and milk falls in the range of 0.97 to 0.99. Most dehydrated foods exhibit a maximum water activity below 0.70, which is below the minimum value for food pathogens. Fungi tends to grow more slowly than bacteria unless bacterial growth is limited, they are also more resistant to harsh environmental conditions and can cause spoilage under these conditions.

Some molds can produce mycotoxins that can result in a variety of acute and chronic toxicities.

As well, drying does not necessarily destroy food toxins (from c.botulinum, s.aureusor b.cereus) occurring as contaminant prior to during drying. Other microorganisms such as viruses,protozoaN,algae,and prior are not known to grow on foods. Along with water activities, many other factors will influence the microbial growth such a temperature, pH, nutrients, preservatives, other food components and oxygen content. It is important to remember to remember that for the same food water content several water activities are possible. This will influence significantly the shelf life of the food. A dehydrated product remains stable only when it is protected from the subsequent exposure to the surrounding environment (e.g. water, air, sunlight and contaminants) Hence, appropriate packaging of a dried product is an important consideration.

The dehydrated producted remains stable only when it is when it is protected from the subsequent exposure to the surrounding environment (e.g water, air, sunlight and contaminants). Hence, appropriate packaging of a dried product is an important consideration.

5.3 Food Additives –Additions of Chemical Agents

Any item that intentionally or unintentionally becomes the part of food product are called additives.

They are of two types A) Natural and B) Artificial

There are almost 4000 substances used as intentional food products and at least 10,000 unintentionally becomes the part of food product. To be listed as Intentional additives, the substance must fit any of the below mentioned categories.

These have specific roles in different products. Preservatives can specifically control the activities of micro organisms and enzymes. Sugar and salt can

control the water activity. Some acids (acetic acid-vinegar) have anti microbial properties. Products such as jam jellies preserves, pickles ,bottled beverages, etc ,make use of such concept.

Chemical Agents

These chemical may be produced in the food by itself by the activity of MO or they may be added to the food. The preservatives produced in food by microbial action are acids like lactic acid and alcohol. Fermented milk keeps for a long time than fresh milk because of the formation of lactic acid from lactose of the milk by the activity of MO. In some countries meat is preserved in butter milk and dried.

Salt and Sugar Preservation

These substances use a mechanism that can be employed by other means. Drying up moisture by the addition of solutes such as salt or sugar also prevents growth of MO and helps to preserve the food. Dry salting is used in the preservation of Tamarind, raw mango, amla, fish and meat. In different kinds of pickles common salt is the most common type of preservative.
Cane sugar in an concentration of 60-70%usually prevents the growth of all types of MO. Common salt and sugar seem to act mainly by osmosis or the withdrawal of water from the protoplasm. Vinegar is also used in chutneys, sauces and ketchups as an extra preservative. Acid conditions inhibit the growth of MO

Drying :- When a microbe is in a non saline environment, available water can pass through the membrane of the microbe easily. In the non saline environment, water inside and outside of the cell comes into equilibrium because of diffusion. **Diffusion is the process by which water moves from area of low concentration of solute to areas of high concentration of solute**.(A solute is any substance which dissolves in water) This means that the amount of water moving out of the cell is the same as water moving into the cell. This must happen for the organism to survive.

However, if we add salt to the water to make a saline environment, this creates isotonic conditions for the cell. It means that more water moving out of the cell. This results in the slower growth for the microbes or even death. Because of the drying effect of the salt, it has been used for thousands of year .It usually takes about 20% salt to inhibit microbes. Sugar has the same mechanism as salt, but it takes much more sugar than salt to produce the same effect.

Use of Oil And Spices
A layer of oil on top of nay food product prevents the growth of any types of yeast and molds. Spices like turmeric, pepper and asafoetida have little bacteriostatic effect. Certain pickles can be preserved by this method.

Inorganic Compounds
Boric Acid and Borates are used sometimes for butter
Nitric Acid and Nitrates are used for pickling of meats
Sulphurous Acid and Sulphites are usually added to alcoholic liquids like wines.

Organic Compounds
The most common compounds used are:

Benzoic Acid for vegetables
Salic Cyclic Acid for fruits and vegetables
Acetic Acid or Vinegar is used in Pickles

Antibiotics
The use of them in the preservation of food is a very modern method. They are tested on raw foods, chiefly like protein foods like meats, fish and poultry in an attempt to lengthen the storage time at chilling temperature.

Other techniques: Other techniques, such as irradiation, exposure to ultra violet light, high intensity pulsed light, pulsed electric field, high pressure etc .have different mechanisms for controlling the spoilage activities in foods and have been used for shelf life extension.

There are secondary objectives of food processing as well. They include diversification of products to provide variety, taste, nutrition ,etc ,to provide end use convenience facilitate marketing, prepare food ingredients through isolation or synthesis and to produce nonconventional food.

5.4 Food Processing –Freezing

The different methods of freezing are grouped as:

1) Air freezing
2) Plate Freezing
3) Liquid immersion freezing
4) Cryogenic Freezing

5.4.1 Air Freezing

The material, packaged or unpackaged is frozen by exposure to air at temperature ranging from -18 to -40 degree C. Slow or sharp freezing refers to freezing in a room under very slow air circulations. This process is undesirable as the process is very slow and tends to produce large ice crystals that damage the product quality. The slow cooling of product may also allow some of the undesirable activity of enzymes and micro organisms prior to the completion of freezing again damaging the product quality .Air blast freezing refers to freezing the product in a powerful blast of circulating cold air at temperatures ranging from -18 to -14 degree C under forced circulation. Various systems are available including cabinet, tunnel, belt, fludised bed, etc. The product can be placed on trays or one conveyor or tunnel freezer the product is conveyed through insulated tunnel through which cold air is forced to flow at high velocity.

A counter current flow is employed. The conveyor length is designed such that by appropriately varying the conveyor speed ,a variety of products are frozen as they emerge out of the tunnel .Fluidised bed energy is another form air blast freezing .Here, particulate food, such as peas ,kernel corn, cut beans, brussels ,sprouts, straw berries ,cherries etc, are fluidised by a powerful blast of cold air. Typically , the product is placed on a perforated mesh or belt to a layer of 1-to 10cm thick. Then the cold air is passed from below, under such pressure and velocity that the product will actually float in the air current. Due to thorough contact with the medium and agitation, the freezing is accomplished at a very fast rate

A similar set up is sometimes used for non fluidizable products like fish fillets. This is similar to tunnel freezing, except that the cold air is passing from bottom to top. This type of freezing is referred to as through flow freezing because the air flow from the product.

5.4.2 Plate freezing

Regular size of food packages is frozen by contact with a metal plate, which is cooled either by circulating cold brine (salt water) or refrigerant.

Double contact plates are employed between which the packaged product are sandwiched under a slight pneumatic (filled with air) pressure which provides a good contact between the package and the contact surface.

Heat transfer occurs from both the side of the package, minimising moisture loss from the product during freezing.

5.4.3 Liquid immersion freezing

This technique involves the immersion of the product.Packeged or non packaged, in the cooling medium. The process is relatively fast, because heat transfer from direct contact liquid medium is much more efficient than from air.Aquous solution of propylene gycol,glycerol,soduim chloride, calcium chloride and sugar have been tried(for example, in the freezing of orange juice concentrates)

5.4.4 Cryogenic freezing or spray freezing

Cryogenic freezing provides for a very rapid freezing by good quality of the low temperatures of the cooling medium. Liquid nitrogen and liquid and solid carbon dioxides are common cryogenic freezing agents. Liquid nitrogen boils at -196 degree C. whereas solid Co2 sublimes at -79degreeC.In this procedure the product is conveyed through the freezing chamber by way of a tunnel. As the product enters it will meet the emerging vapour of the nitrogen gas at about -30to -40Cwhich pre cools the product.

The product is frozen in the freezing chamber at the centre of the tunnel, with a brief exposure to a spray of liquid N2. The conveyor speed determines the contact time. Following this the product will flow out along with the vapour of N2 where it gets equilibrated to the desired finishing temperatures. Application with Co2 involves tumbling of the product with powdered Co2 which might not be desirable for delicate product. Liquid Co2 acts somewhat differently in a freezer than liquid nitrogen. Co2 is piped to the tunnel as a high pressure liquid (300psi) but once is exits the injection orifice, it instanenously into a mixture of gas and tiny dry ice solid particle. The dry ice solid, commonly referred to as dry ice snow, is driven into the surface of the food product where the food from the heat product rapidly causes the dry ice to sublimate or Ph phase directly from a solid into a gas.

5.5 Summary

Food Processing helps to increase the shelf life of the food items, it also helps in increasing the availability of food items through out the year. Processing of food also helps in adding variety to the diet. With the changing life style of today it helps in reducing the preparation time and energy. The processing of food also assists in providing more balanced and nutritive diet food to people at large.

The development in technology has now made it possible to have preserved food of practically the same nutritive value and palatability standards as fresh foods. Preservation availability of foods thus improves the nutrition of the people.

5.6 Review Questions

1 Describe the importance of food processing and the significance of food processing in today's life style.

2. Discuss various methods of food processing involving removal of heat.

3. What are the various chemical agents used in food processing?

4. How does addition of salt and sugar helps in food preservation?

5 . Differentiate between cryogenic and plate freezing.

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Unit - 6 : Food Assessment

Structure of the Unit

6.0 Objectives of Food Evaluation

- Is to produce quality food product and to satisfy the need and requirement of the consumers.
- Is to sustain working within the Community to enhance food quality and educate young People.
- To Understand the food assessment approaches
- To Increase the knowledge and skills in relation to food evaluation.
- Able to assess and judge the food attributes.

6.1 Introduction

Food assessment is the process by which the quality of food is judged and the degree of acceptability is evaluated of any meal of food product. The reaction of food which is evaluated is clearly seen on the consumer who use it. .Foods are evaluated different according to their structure ,functions, composition,

characteristics etc. Cooking methods affects the taste of food and also changes the structure . when the quality of food product is assessed by human being by their sensory organs it is called sensory evauation, done by different senses of perception.

A person's sense of taste, smell, touch, sound and sight form his perception of food. In a taste panel, these senses can be measured scientifically to obtain information about particular aspects of a food.

6.2 History and Development

Historically, all human beings satisfy their need of food by hefting, procuring and preserving foods. The paleothic man could not make fine quality distinctions between foods and therefore rejected certain foods

The idea to improve the quality of food only came accidently when man discovered the art of roasting food neolithic man developed the flavors distinction and food preferences and thereafter variety of food grew on the plate, after the inventory of pottery history of nutrition includes over 100 years but the earliest guideline which included food pyramid, recommended dietary allowance were published in 1894. Consumer were made aware what to eat and how much to eat each day through printed guideline and to assess the food quality. In 1995 Stone and Sidel gave the scientific method to measure the responses of food perception through the senses of sight, smell, touch, taste and hearing. its field of sensory evaluation has grown rapidly in the second half of the 20 the century with the expansion of the processed food and products industry sensory analysis appeared in the mid 19^{th} century with the 'Taste tests' and at the end of the 1960 started to acquire greater importance with psychophysics. Therefore food assessment is important to make further improvement in food quality.

6.3 Meaning and Definition

The word quality is a latin word 'Qualis' meaning of what kind quality is not scientific but it is a technical word to understand the meaning of quality one should know the existing food chain "from producer to consumer, how the food is measured for quality.

The consumer who is (human) finally makes an assessment of food quality therefore the present market should satisfy the needs and requirement of the consumers.

There are many definitions which are applied on food staffs to understand the quality of food. The institute of food science and technology describes that the

good quality of food us measured by the standards of excellence fit for purpose and with the total features of the characteristics of any food product.

- Crosby in 1979 defined quality as a conformance to regiments of specification
- J.W. Baick, 1950 defined quality as a degree of excellence that the consumer accepts.
- ISO 9000 : Quality is a desirable chanters of that product or same must have.
- ISO 8402 Quality is the totality of features and characteristic of a product of service that bear on its ability to satisfy of implied needs.
- Sensory Evaluation is defined in 1975 as a scientific discipline used to evolve ,measure, analyze, and interpret reaction of people to those characteristics of food and materials of foods and material s as they are perceived by the senses of sight,smell,taste,touch and hearing.

6.4 Importance Of Food Assessment

It is an important issue for food to be assessed for its quality by the consumer Basically food is influenced by external factors which affect the quality of food. Food is judged by psychological and physiological reactions on any human being. Nowadays many modern and sophisticated measuring instruments are introduced to analyze the quality of food.

6.5 Concept of Food Quality

There are three types of quality.

- Traditional
- Modern
- Consumer

The traditional concepts of quality were very simple and depend mainly on visual and flavor perception to judge the acceptability of foods. As food were purchased, cooked, and served the same day.

With the life style changes relaxed early gave way to hurried meals and there fore convenience foods was the need for fast cooking and serving.

Nowdays food are sent out of the states and to different countries, so the need of high quality control measure more required in the market for the safe availability of food products.

A consumer appreciation of quality food is very important. The food preference of consumer are usually influenced by a number of genetic, physiological and psychological factors the importance of the consumer in the growth and development of food industry is essential to be focused to increase food market.

Consumer perception is influenced by three major factors.

- Includes aroma and taste compound, texture, colour appearance, temperature.
- Concerns with for process of eating with all aspect of physio, anatomy,& physic chemistry.
- Psyhco-social & cognate factor such as culture, education, mood condition.

6.6 Food Quality Attributes

Food quality is evaluated on the following attributes- Flavor, texture, aroma, appearance, color etc when the food is eaten .In human body there are three receptors for the sensory attributes of the food.

- Olfactory receptors
- Taste receptors
- Visual receptors

It can be evaluated by two types -quantitative and qualitative .Of which the quantitative is dependent of shelf life, Serving size, price availability, variety, convenience etc. For most people price is important because the quality they expect is perceived to be relative to its cost.

6.7 Sensory Evaluation

Sensory evaluation is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses (sight, smell,taste, touch and hearing) for the purposes of evaluating consumer products. The discipline requires panels of human

assessors, on whom the products are tested, and recording the responses made by them.

By applying statistical techniques to the results it is possible to make inferences and insights about the products under test. Most large consumer goods companies have departments dedicated to sensory analysis.

Sensory analysis can mainly be broken down into three sub-sections:

- Effective testing (dealing with objective facts about products)
- Affective testing (dealing with subjective facts such as preferences)
- Perception (the biochemical and psychological aspects of sensation)

Effective testing: This type of testing is concerned with obtaining objective facts about products. This could range from basic discrimination testing (e.g. Do two or more products differ from each other?) to descriptive profiling (e.g. What are the characteristics of two or more products?). The type of panel required for this type of testing would normally be a trained panel.

Affective testing:Also known as consumer testing, this type of testing is concerned with obtaining subjective data, or how well products are likely to be accepted. Usually large (50 or more) panels of untrained personnel are recruited for this type of testing, although smaller focus groups can be utilised to gain insights into products. The range of testing can vary from simple comparative testing (e.g. Which do you prefer, A or B?) to structured questioning regarding the magnitude of acceptance of individual characteristics (e.g. Please rate the "fruity aroma": dislike|neither|like).

Perception: Perception involvesthe biochemical and psychological theories relating to human sensations. By understanding the mechanisms involved it may be possible to explain why certain characteristics are preferred over others.

Descriptive analysis As a major branch of the sensory science, descriptive analysis is widely used for collecting people's sensory opinions on an object being food, cosmetics, apparel items, etc. A typical procedure of descriptive analysis starts from the recruitment of a number of evaluation panelists being either trained experts or naive consumers according to the objective of the research. Normally, for descriptive analysis, a minimum of 5 experts is required, while with respect to naive panelists, this number should be much bigger. The sensory experiment should be carried out according to standardized techniques and procedures designed before the evaluation. After

experiments, statistical analysis is often applied to the interpretation of the sensory results obtained.

Consumer testing also called 'hedonic testing' involves having potential consumers of a product evaluate various products and a small number of items on a ballot.

Organoleptic properties are the aspects of food or other substances as experienced by the senses, including taste, sight, smell, and touch, in cases where dryness, moisture, and stale-fresh factors are to be considered. Sensory evaluation is a tool used for product development, and improvement and quality control.

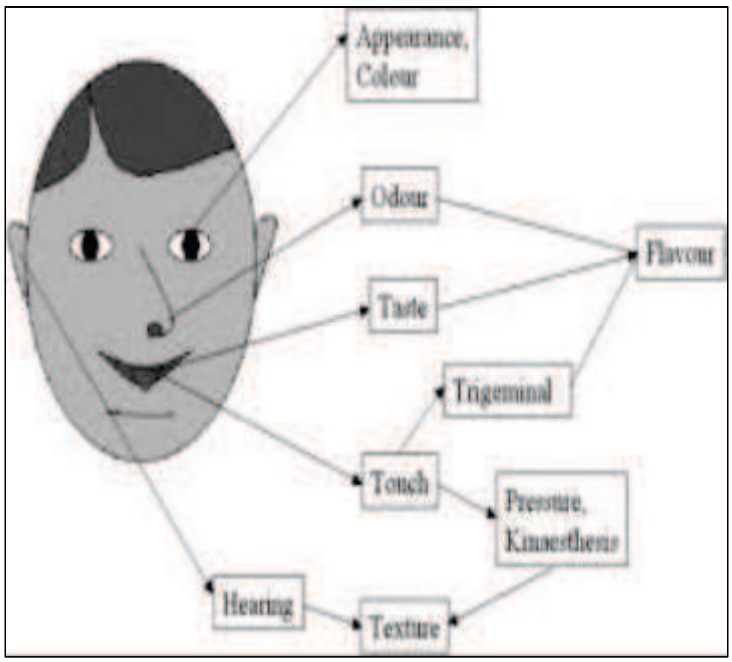

Fig 6.1 Sensory Evaluation

6.8 Method of Food Assessment

To produce foods that meet consumer needs food manufactures need to know the relative contribution of the various sensory qualities of food such as taste, odour and texture by measuring them. It is difficult if not impossible to understand the consumers responses to the product.

Measurement made with rating scales are always relative they do not quality an absolute quantity unlike for example, measuring the concentration of a chemical compound.

These skills are developed and trained panelists aim to have an analytical approach to respond likes and dislikes toward the product as of they were instrument. Basically there are four basic methods of sensory evaluation

- Analytical Test
- Descriptive Test
- Acceptance Test
- Sensitivity Test.

An analytical test the trained panelist is able to decide any difference exists between samples these test are done in laboratory there are several method to identify the difference between the product which are to be evaluated.The judge indicates that the sample given for test is identical or different or the judge chooses the sample within each pair that has the greats amount of a specified characteristics

1. Duo-trio test in which three sample two identical and one different is taken one sample is taken as standard and the after two coded samples of which one 15 identical to standard is tested.

2. Triangle test in which three coded sample two political and one different is coded none of the sample is made standard the judge has to deferent which of the three sample differ from the other.

3. Ranking Tests : The sample are given numerical scores for the intensity of any quality attribute such as taste or rancidity or aroma as follows :

0 - nil, 1-weak, 2 Medium, 3-strong, 4 very strong.

4.Sensivity Test –These are of two types

- Threshold
- Dilution Test

Threshold test are usually used for the concentration of the substance sample for threshold are prepared with a series of concentration then judged by the intensity scale for different primary taste:

0 - none, 1 - very weak, 2- medium, 3- strong, 4- very strong, 5- extremely strong

5.Dilution test are used to detect difference in order due to added materials, e.g. synthetic fruit flavors, dried milk powder in fresh milk.

6.Acceptance Test :- These are measured by the preference determined by the panelist eg. pleasure - displeasure, like dislike, there are three types of acceptance test

-Paired reference

-Ranking

-Rating

When two Samples are taken for test and the panelists expresses a preference based on any specific attribute. There or more sample are taken and the subject is asked to assign an order to the sample according to his or her preference.

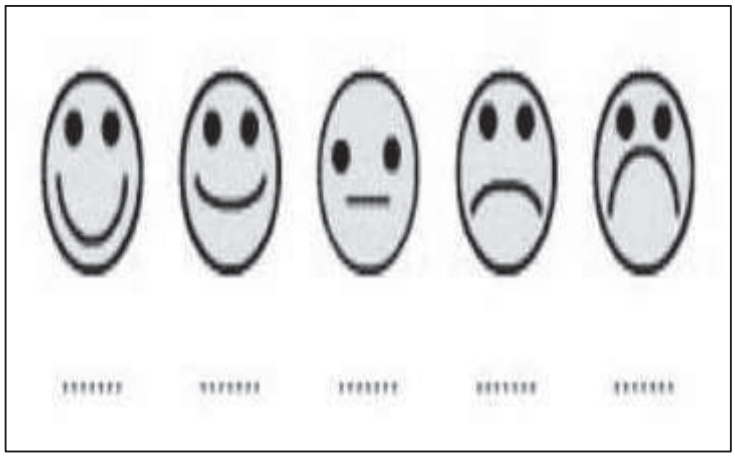

Fig 6.2 Hedonic Scale

The Hedonic scale is a rating system used for little kids to get a better understanding of what their opinion is. it is usually a selection of different 'happy faces' or a system of stars out of five.

6.9 Introduction of Approximate Analysis of Food Constituents

Water is the essence of life. We can live longer without food than without water. Water is the carrier of other food materials.

Nutrition is essential for the maintenance of good health. Nutrition of the body means the supply of essential nutrients in proper quantity and proportions to the body. Diet is a combination of different kinds of food. No

single food can give each and every nutrient required for the growth and the preservation of the health.

Materials present in the food can be classified into six groups of compounds.

These groups are known as constituents of food. They are:

A) Proteins
B) Carbohydrates
C) Fats
D) Vitamins
E) Minerals
F) Water

Proteins are essential for the growth and repair if tissues of the body. They are also called as body building foods. Foods rich in vitamins are absolutely essential for children. Milk, cheese, meat, fish, eggs, pulses, oil –seeds and nuts are sources of proteins. Carbohydrates give energy on which all the activities of the life are dependent. They are also known as energy yielding foods. Foods rich in carbohydrates are essential for the persons who are engaged in manual work. Rice, wheat, maize, potatoes, barley, sugar and syrups are rich in carbohydrates.

Fats are also heat and energy giving foods. The uses of fats add taste to the food and make the food palatable. A person who does a lot of physical work daily needs more fats. The sources of fats are vegetable oil, butter, ghee, olive oil ad groundnut oil.

Foods rich in vitamins and minerals are termed as protective foods. Vitamins help in keeping our eyes, bones, teeth and gums healthy. Minerals help in the formation of blood, bones and teeth. Fruits, vegetables, milk meat, eggs, fish, liver, oil and hand polished rice are sources of vitamins and minerals. They protect us against diseases.

Proximate analysis of foods

Originally the most extensive information about the composition of foods was based on a system of analysis described as the proximate analysis of foods, which was devised over 100 years ago by two German scientists, Henneberg and Stohmann. Recently, new analytical techniques have been introduced and the information about food composition is rapidly expanding.

This system of analysis divides the food into six fractions: moisture, ash, crude protein, ether extract, crude fibre and nitrogen-free extractives. The moisture content is determined as the loss in weight that results from drying a known weight of food to constant weight at 100 oC. This method is satisfactory for

most foods, but with a few, such as silage, significant losses of volatile material may take place.

The ash content is determined by ignition of a known weight of the food at 550 oC until all carbon has been removed. The residue is the ash and is taken to represent the inorganic constituents of the food. The ash may, however, contain material of organic origin such as sulphur and phosphorus from proteins, and some loss of volatile material in the form of sodium, chloride, potassium, phosphorus and sulphur will take place during ignition. The ash content is thus not truly representative of the inorganic material in the food either qualitatively or quantitatively.

The crude protein (CP) content is calculated from the nitrogen content of the food. In this method the food is digested with sulphuric acid, which converts to ammonia all nitrogen present except that in the form of nitrate and nitrite. This ammonia is liberated by adding sodium hydroxide to the digest, distilled off and collected in standard acid, the quantity so collected being determined by titration or by an automated colorimetric method. It is assumed that the nitrogen is derived from protein containing 16 per cent nitrogen, and by multiplying the nitrogen figure by 6.25 (i.e. 100/16) an approximate protein value is obtained. This is not 'true protein' since the method determines nitrogen from sources other than protein, such as free amino acids, amines and nucleic acids, and the fraction is therefore designated crude protein.

The ether extract (EE) fraction is determined by subjecting the food to a continuous extraction with petroleum ether for a defined period. The residue, after evaporation of the solvent, is the ether extract. As well as lipids it contains organic acids, alcohol and pigments. In the current official method, the extraction with ether is preceded by hydrolysis of the sample with sulphuric acid and the resultant residue is the acid ether extract.

The carbohydrate of the food is contained in two fractions, the crude fibre (CF) and the nitrogen-free extractives (NFE). The former is determined by subjecting the residual food from ether extraction to successive treatments with boiling acid and alkali of defined concentration; the organic residue is the crude fibre.

The crude fibre fraction contains cellulose, lignin and hemicelluloses, but not necessarily the whole amounts of these that are present in the food: a variable proportion, depending upon the species and stage of growth of the plant material, is contained in the nitrogen-free extractives. The nitrogen-free extractives fraction is a heterogeneous mixture of all those components not determined in the other fractions. It includes sugars, fructans, starch, pectins, organic acids and pigments, in addition to those components

6.10 Rheological Aspect of Food

Rheology is the study of the flow of matter, primarily in the liquid state, but also as 'soft solids' or solids under conditions in which they respond with plastic flow rather than deforming elastically in response to an applied force.

It applies to substances which have a complex microstructure, such as muds, sludges, suspensions, polymers and other glass formers as well as many foods and other biological materials or other materials which belong to the class of soft matter. Although this viscosity will change with temperature, Only a small group of fluids exhibit such constant viscosity, and they are known as Newtonian fluids

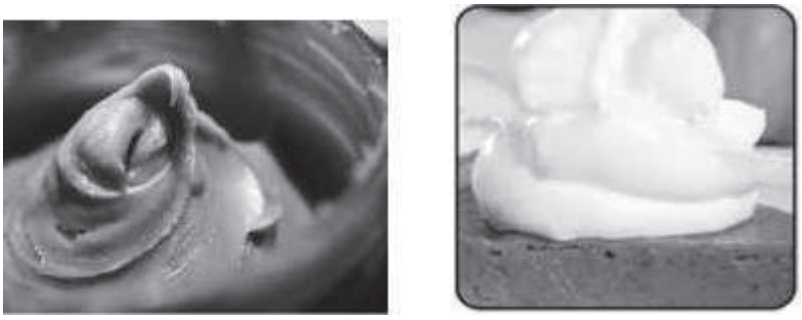

Fig 6.3

Rheology generally accounts for the behaviour of non-Newtonian fluids, by characterizing the minimum number of functions that are needed to relate stresses with rate of change of strains or strain rates. For example, ketchup can have its viscosity reduced by shaking (or other forms of mechanical agitation, where the relative movement of different layers in the material actually causes the reduction in viscosity) but water cannot. Ketchup is a shear thinning material, as an increase in relative velocity caused a reduction in viscosity, while some other non-Newtonian materials show the opposite behaviour: viscosity going up with relative deformation, which are called shear thickening.

Theoretical aspects of rheology are the relation of the flow/deformation behaviour of material and its internal structure , and the flow/deformation behaviour of materials that cannot be described by classical fluid mechanics or elasticity.

Food rheology is important in the manufacture and processing of food products, e.g. cheese. Food rheology is the study of the rheological properties of food, that is, the consistency and flow of food under tightly specified conditions. The consistency, degree of fluidity, and other mechanical properties are important in understanding how long food can be stored, how

stable it will remain, and in determining food texture. The acceptability of food products to the consumer is often determined by food texture, such as how spreadable and creamy a food product is. Food rheology is important in quality control during food manufacture and processing.

Thickening agents, or thickeners, are substances which, when added to an aqueous mixture, increase its viscosity without substantially modifying its other properties, such as taste. They provide body, increase stability, and improve suspension of added ingredients. Thickening agents are often used as food additives and in cosmetics and personal hygiene products. Some thickening agents are **gelling agents**, forming a gel. The agents are materials used to thicken and stabilize liquid solutions, emulsions, and suspensions. They dissolve in the liquid phase as a colloid mixture that forms a weakly cohesive internal structure. Food thickeners frequently are based on either polysaccharides (starches, vegetable gums, and pectin), or proteins.

6.11 Summary

Food assessment is the process by which the quality of food is judged and the degree of acceptability is evaluated of any meal of food product. The reaction of food which is evaluated is clearly seen on the consumer who use it. .Foods are evaluated different according to their structure ,functions, composition, characteristics etc. Cooking methods affects the taste of food and also changes the structure . when the quality of food product is assessed by human being by their sensory organs it is called sensory evauation, done by different senses of perception. In the unit we have studied the various method of evaluating the food and use of senses in evaluating the food.

6.12 Review Questions

1 Give the importance of food assessment?

2 What is sensory evaluation?

3 Explain the importance of sensory evaluation?

4 Give the Difference between duo test and triangle test?

5 What do you understand by rheology ?

6 Give the names of food constituents?

7 How is sensory evaluation done by Hedonic scale?

8 Give the methods of sensory evaluation?

6.13 Reference Books

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2. Food quality Evaluation—Eram S Rao
3. Principles of food Science –IGNOU
4. Food Science- B. Srilaxami
5. Food Science-experiments and applications-2nd edition,Mohini Sethi ,Eram Rao

Unit – 7 : Emulsion Colloids And Flavours

Structure of the Unit

7.0 Objective

Upon completion of this exercise, you should be able to:

- Define and/or identify emulsions and emulsifying agents.
- Identify two factors that determine emulsion type (o/w vs. w/o).
- Describe the levels of instability to which emulsions are subject.
- Describe 3 mechanisms by which emulsions are stabilized.
- Classify emulsifying agents by type and describe their uses, advantages, limitations.
- Define and calculate HLB for any nonionic surfactant system.
- Describe and/or demonstrate 3 methods of emulsion preparation.
- Identify pharmaceutical uses of emulsions.

7.1 Introduction

An **emulsion** is a mixture of two or more liquids that are normally immiscible (nonmixable or unblendable). Emulsions are part of a more general class of two-phase systems of matter called colloids. Although the terms *colloid* and *emulsion* are sometimes used interchangeably, *emulsion* should be used when both the dispersed and the continuous phase are liquids. In an emulsion, one liquid (the dispersed phase) is dispersed in the other (the continuous phase). Examples of emulsions include vinaigrettes, milk, mayonnaise, and some cutting fluids for metal

working. The photo-sensitive side of photographic film is an example of a colloid.

The word "emulsion" comes from the Latin word for "to milk", as milk is an emulsion of milk fat and water, among other components.

Two liquids can form different types of emulsions. As an example, oil and water can form, firstly, an oil-in-water emulsion, where the oil is the dispersed phase, and water is the dispersion medium. Secondly, they can form a water-in-oil emulsion, where water is the dispersed phase and oil is the external phase. Multiple emulsions are also possible, including a "water-in-oil-in-water" emulsion and an "oil-in-water-in-oil" emulsion.

Emulsions, being liquids, do not exhibit a static internal structure. The droplets dispersed in the liquid matrix (called the “dispersion medium”) are usually assumed to be statistically distributed. An emulsion is a thermodynamically unstable two-phase system consisting of at least two immiscible liquids, one of which is dispersed in the form of small droplets throughout the other, and an emulsifying agent. The dispersed liquid is known as the **internal or discontinuous phase**, whereas the dispersion medium is known as the **external or continuous phase**. Where oils, petroleum hydrocarbons, and/or waxes are the dispersed phase, and water or an aqueous solution is the continuous phase, the system is called an oil-in-water (o/w) emulsion. An o/w emulsion is generally formed if the aqueous phase constitutes > 45% of the total weight, and a hydrophilic emulsifier is used. Conversely, where water or aqueous solutions are dispersed in an oleaginous medium, the system is known as a water-in-oil (w/o) emulsion. W/O emulsions are generally formed if the aqueous phase constitutes < 45% of the total weight and an lipophilic emulsifier is used.

Emulsions are also used a ointment bases and intravenously administered as part of parenteral nutrition therapy.

The consistency of emulsions varies from easily pourable liquids to semisolid creams. Their consistency will depend upon:

1. The internal phase volume to external phase volume ratio
2. In which phase ingredients solidify
3. What ingredients are solidifying

Stearic acid creams (sometimes called vanishing creams) are emulsions and have a semisolid consistency but are only 15% internal phase volume. Many emulsions have internal phases that account for 40% - 50% of the total volume of the formulation. Any semisolid character with w/o emulsions generally is attributable to a semisolid external phase.

Emulsions tend to be immiscible in water, not water washable, will not absorb water, are occlusive, and may be "greasy." This is primarily because oil is the external phase, and oil will repel any of the actions of water. The occlusiveness is because the oil will not allow water to evaporate from the

surface of the skin. Conversely, o/w emulsions are miscible with water, are water washable, will absorb water, are nonocclusive, and are nongreasy. Here water is the external phase and will readily associate with any of the actions of water.

Emulsions are, by nature, physically unstable; that is, they tend to separate into two distinct phases or layers over time. Several levels of instability are described in the literature. **Creaming** occurs when dispersed oil droplets merge and rise to the top of an o/w emulsion or settle to the bottom in w/o emulsions. In both cases, the emulsion can be easily redispersed by shaking. **Coalescence (breaking or cracking)** is the complete and irreversible separation and fusion of the dispersed phase. Finally, a phenomenon known as **phase inversion** or a change from w/o to o/w (or vice versa) may occur. This is considered a type of instability by some.

7.2 Theory of Emulsion

Bancroft states that the necessary conditions for forming a stableemulsionare that the drops of the dispersed phase shall be so small that they will stay suspended and that there shall be a sufficiently viscous film around each drop to keep the drops of the dispersed phase from coalescing.

Many theories have been advanced to account for the way or means by which theemulsionis stabilized by theemulsifier. At the present time no theory has been postulated that seemsto applyuniversally to all emulsions. As Fischer suggests, probably a number of factors play a role, and the relative importance of each varies not only in different emulsions but in one and the sameemulsionunder different circumstances. Clayton in his latest book on emulsions gives a summary of the various theories for emulsions. Only a few will be mentioned here.

The electrical double layer. Theoilglobules in a pure oil and pure wateremulsioncarry a negative charge. The water ionizes so that bothhydrogenand hydroxyl ions are present. The negative charge on the oil may come from adsorption of the OH ions. These adsorbed hydroxyl ions form a layer around the oil globules. A second layer of oppositely charged ions forms a layer in the liquid outside the layer ofnegative ions. These two layers of oppositely charged ions are known as the Helmholtz double layer. They are not confined to emulsions but accompany allboundary phenomena. The electric charge is a factor in all emulsions, even those stabilized with emulsifying agents.

The phase-volume theory. If spheres of the same diameter are packed as closely as possible, one sphere will touch 12 others and the volume the spheres occupy is about 74per centof the total volume. Thus if the spheres or drops of the dispersed phase remain rigid it is possible to disperse 74 parts of the dispersed phase in the continuous phase; but if the dispersed phase is increased to more than 74 parts of the total volume, a reversal of theemulsionwill occur. However, the dispersed phase does not remain rigid in shape but the drops flatten out where they come in contact with each other, nor are all the

dispersed particles the same size (see Figs. 27 to 30), so that it is possible for the dispersed phase to consist of from 1 to 99 per cent of theemulsion.

Hydration theory of emulsions. Fischer and Hooker state thathydratedcolloids make the best emulsifiers. Fischer states the emulsifying agent, by which a permanentemulsionis obtained, invariably "proves to be a hydrophilic colloid whenwater and oilemulsions are concerned (a lyophilic colloid of some sort when other than aqueous mixtures are under consideration). Put another way, oil cannot permanently be beaten into water, but only into a colloid hydrate."

Fischer and Hooker have found albumin, casein, andgelatinto be good emulsifying agents. Casein when nothydrated, i.e., at its isoelectric point, is a poor emulsifying agent, buthydratedcasein, i.e., acid or alkali casein is a good emulsifying agent.

Fischer states that all permanent emulsions can be explained on the basis ofhydratedor lyated colloids. He says that when water changes to a colloid hydrate, its physical constants change; and these include, among others, surface tension,viscosity, and adsorption. The treatment of the colloid, such as freezing or heating, or the addition of substances which alter the water-holding capacity of the colloid may crack the emulsion or lessen its emulsifying ability.

Interfacial films. Clayton in discussing "Foods as Colloid Systems" describes interfacial films as follows: "As early as 1840, As chers on observed 'that coagulation in form of a membrane occurs inevitably and instantaneously when albumin comes into contact with a liquid fat.' - Any solute which lowers the interfacial tension between oil and water will necessarily accumulate at that interface, and in the case of certain proteins, notably albumen, the act of adsorption leads to a change in the physical character of the emulsifying agent, this being 'precipitated' as a fibrous or membrane-fibrous solid, no longer soluble in its original solvent. The existence of such interfacial membranes was verified by Rams den and other investigators."

In reading the various theories of emulsion one is impressed with the similarity of many factors.

Oriented wedge theory. This theory for the manner in which emulsions are stabilized has been developed from the work of Langmuir and of Harkins. It is based upon the concept that the molecules of the emulsifier orient themselves in the interface between the dispersed and continuous phases, forming a wedge, the curvature of which determines the size of the dispersed phase. Fuller accounts may be found in Clayton's book and in the articles of the authorities mentioned above.

Adsorbed film and interfacial tension theory. This theory has been developed or rather extended from earlier theories. At the present time it is probably the most universally accepted theory for the formation of emulsions. Bancroft stated the underlying principles, basing them upon Don-nan's early work of interfacial tension; but many others have extended the interpretations. Clayton

states that with this theory "emphasis is laid upon the fact that emulsification is influenced by (1) the mass of the emulsifying agent present, (2) the ease with which this agent is adsorbed at the interfacial separating surface, and (3) the nature of the ions adsorbed by the resultant film."

The emulsifier may be absorbed by the water or by the oil, but it is usually adsorbed more in one liquid than in the other and thus lowers the interfacial tension of one liquid to a greater extent than that of the other. If the tension of the water is lowered more than that of the oil, the water has fewer tendencies to form drops, flows to form a film more readily, and becomes the continuous phase.

7.3 Types of Emulsion

Depending upon the nature of the dispersed phase, the emulsions are classified as;

(i) **Oil-in-water emulsions** (O/W) **:** The emulsion in which oil is present as the dispersed phase and water as the dispersion medium **(**continuous phase**)** is called an oil-in-water emulsion. Milk is an example of the oil-in-water type of emulsion. In milk liquid fat globules are dispersed in water. Other examples are vanishing cream etc.

(ii) **Water-in-oil emulsion** (W/O) **:** The emulsion in which water forms the dispersed phase, and the oil acts as the dispersion medium is called a water-in-oil emulsion. These emulsions are also termed oil emulsions. Butter and cold cream are typical examples of these types of emulsions. Other examples are cod liver oil etc.

7.4 Emulsifying Agents

Emulsions are stabilized by adding an emulsifier or emulsifying agents. These agents have both a hydrophilic and a lipophilic part in their chemical structure. All emulsifying agents concentrate at and are adsorbed onto the oil:water interface to provide a protective barrier around the dispersed droplets. In addition to this protective barrier, emulsifiers stabilize the emulsion by reducing the interfacial tension of the system. Some agents enhance stability by imparting a charge on the droplet surface thus reducing the physical contact between the droplets and decreasing the potential for coalescence. Some commonly used emulsifying agents include tragacanth, sodium lauryl sulfate, sodium dioctyl sulfosuccinate, and polymers known as the Spans and Tweens.

Emulsifying agents can be classified according to: 1) chemical structure; or 2) mechanism of action. Classes according to chemical structure are synthetic, natural, finely dispersed solids, and auxiliary agents. Classes according to mechanism of action are monomolecular, multimolecular, and solid particle films. Regardless of their classification, all emulsifying agents must be chemically stable in the system, inert and chemically non-reactive with other emulsion components, and nontoxic and nonirritant. They should also be reasonably odorless and not cost prohibitive.

7.5 Role of Emulsifying Agents In Foods

Emulsifying agents are substances that are added to liquid ingredients in order to stabilize the mixture. For example, when oil and water are combined, they will eventually separate into two layers if left to their own devices. An emulsifying agent has stabilizing properties that distribute oil and water molecules evenly throughout the mixture to prevent separation. Emulsification is used to make food more visually appealing and to improve taste and texture. Oil-in-water emulsions are common in food:

- Crema (foam) in espresso – coffee oil in water (brewed coffee), unstable emulsion
- Mayonnaise and Hollandaise sauce – these are oil-in-water emulsions that are stabilized with egg yolk lecithin, or with other types of food additives, such as sodium stearoyl lactylate
- Homogenized milk – an emulsion of milk fat in water and milk proteins
- Water-in-oil emulsions are less common in food but still exist:
- Butter – an emulsion of water in butterfat
- Vinaigrette – an emulsion of vegetable oil in vinegar. If this is prepared using only oil and vinegar (i.e. without an emulsifier), an unstable emulsion results

Properties of emulsion

(i) Emulsions show all the characteristic properties of colloidal solution such as Brownian movement, Tyndall effect, electrophoresis etc.

(ii) These are coagulated by the addition of electrolytes containing polyvalent metal ions indicating the negative charge on the globules.

(iii) The size of the dispersed particles in emulsions in larger than those in the sols. It ranges from 1000 Å to 10,000 Å. However, the size is smaller than the particles in suspensioins.

(iv) Emulsions can be converted into two separate liquids by heating, centrifuging, freezing etc. This process is also known as de emulsification.

Applications of emulsions

(i) Concentration of ores in metallurgy

(ii) In medicine (Emulsion water-in-oil type)

(iii) Cleansing action of soaps.

(iv) Milk, which is an important constituent of our diet an emulsion of fat in water.

(v) Digestion of fats in intestine is through emulsification

7.6 Colloids Definition

A mixture in which very small particles of one substance are distributed evenly throughout another substance. The particles are generally larger than those in a solution, and smaller than those in a suspension. Paints, milk, and fog are colloids. A **colloid** is a substance microscopically dispersed throughout another substance.

The dispersed-phase particles have a diameter of between approximately 2 and 500 nanometres. Such particles are normally invisible in an optical microscope, though their presence can be confirmed with the use of an ultra microscope or an microscope. Homogeneous mixtures with a dispersed phase in this size range may be called *colloidal aerosols*, *colloidal emulsions*, *colloidal foams*, *colloidal dispersions*, or *hydrosols*. The dispersed-phase particles or droplets are affected largely by the surface chemistry present in the colloid.

Some colloids are translucent because of the Tyndall effect, which is the scattering of light by particles in the colloid. Other colloids may be opaque or have a slight color.

Colloidal solutions (also called colloidal suspensions) are the subject of interface and colloid science. This field of study was introduced in 1861 by Scottish scientist Thomas Graham.

Many common food items (jelly) and other products (paper) are colloids. They appear to be singular components but actually are comprised of two separate things. These molecule clumps are often murky or opaque in appearance, such as fog and milk. And they do not separate while standing, such as oil and water do when they are combined.

7.7 Application of Colloids Systems In Foods Preparation

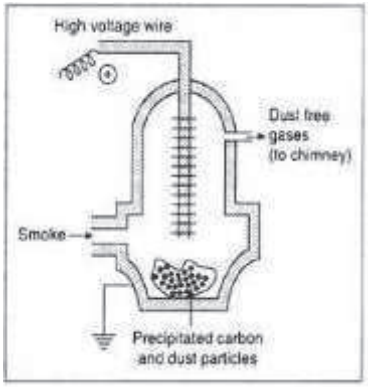
Colloids play a very important role in nature, in our daily life and in industry. Some of the important applications of colloids are discussed below.

1. Food stuffs and medicines: Many of our food stuffs are colloidal in nature. Milk, butter, whipped cream, fruit jellies, ice cream, bread etc. are all colloidal in nature. For example, milk is an emulsion of butter fat in water, stabilized by milk protein (casein). Ice cream is a dispersion of colloidal ice particles in cream. Similarly, bread consists of air dispersed in baked dough.

Colloidal medicines are more effective and are easily absorbed by the body system. Therefore a large number of pharmaceutical preparations are emulsions. Halibut-liver oil, cod-liver oil, skin ointments etc. are emulsions. Antibiotics such as penicillin, streptomycin etc. are usually injected in the body in colloidal form. Several metal sols are also used as medicines.

2. Purification of water: In water works, water is usually purified by the addition of certain electrolytes such as potash alum, aluminium sulphate etc. This involves the phenomenon of coagulation. The impure water usually contains dispersed colloidal particles which cannot be removed by filtration. When potash alum is added to impure water, the negatively charged colloidal particles of impurities get coagulated by the action of Al^{3+} ions furnished by the alum and can be removed by filtration or decantation.

3. Sewage disposal: Sewage water contains particles of dirt, mud etc. which are colloidal in nature and carry some electrical charge. These particles may be removed by using the phenomenon of electrophoresis. The sewage water is passed through a tunnel fitted with metallic electrodes and maintained at a high potential difference. The colloidal particles present in the sewage water migrate to the oppositely charged electrodes and get coagulated. This solves the problem of sewage disposal. Moreover, the rubbish matter obtained on account of the coagulation of colloidal dirt particles may be used as manure.



Cottrel smoke precipitator

4. Smoke precipitation: Smoke is colloidal system and consists of electrically charged colloidal particles of carbon dispersed in air. As smoke is a big source of pollution. It is always desirable to precipitate it, i.e., to remove colloidal carbon particles present in it. The removal of colloidal carbon particles from smoke can be effected by using the phenomenon of electrophoresis. This is achieved in an apparatus called Cottrell precipitator as shown in figure. Smoke is allowed to pass through a chamber having a number of metal plates attached to a metal wire connected to a source of high potential (20,000 to 70,000V). The electrically charged colloidal particles of carbon and dust get discharged when come in contact with the oppositely charged plates and fall down to the bottom. The clean hot air leaves the precipitator from an exit near the top.

5. Artificial rain: Clouds are colloidal systems and consist of water vapour mixed with dust particles. The water molecules present in a cloud develop some electrical charge. Therefore, clouds can be made to rain by neutralizing the charge present on colloidal particles (water molecules). This type of rain is called artificial rain and may be carried out by spraying oppositely charged colloidal dust or sand particles over a cloud. This neutralizes the charge on water molecules and compels them to get coagulated, i.e. to rain.

7.8 Flavours Definition

Flavor or **flavour** is the sensory impression of a food or other substance, and is determined mainly by the chemical senses of taste and smell. The "trigeminal senses", which detect chemical irritants in the mouth and throat as well as temperature and texture, are also very important to the overall Gestalt of flavor perception. The flavor of the food, as such, can be altered with natural or artificial flavorants, which affect these senses.

Flavorant is defined as a substance that gives another substance flavor, altering the characteristics of the solute, causing it to become sweet, sour, tangy, etc.

Of the three chemical senses, smell is the main determinant of a food item's flavor. While the taste of food is limited to sweet, sour, bitter, salty, umami (savory) pungent or piquant, and metallic – the seven basic tastes – the smells of a food are potentially limitless. A food's flavor, therefore, can be easily altered by changing its smell while keeping its taste similar. Nowhere is this better exemplified than in artificially flavored jellies, soft drinks and candies, which, while made of bases with a similar taste, have dramatically different flavors due to the use of different scents or fragrances. The flavorings of commercially produced food products are typically created by flavorists.

Although the terms "*flavoring*" or "*flavorant*" in common language denote the combined chemical sensations of taste and smell, the same terms are usually used in the fragrance and flavors industry to refer to edible chemicals and extracts that alter the flavor of food and food products through the sense of smell. Due to the high cost or unavailability of natural flavor extracts, most commercial flavorants are *nature-identical*, which means that they are the chemical equivalent of natural flavors but chemically synthesized rather than being extracted from the source materials. Identification of nature-identical flavorants are done using technology such as headspace techniques.

7.9 Description of Food Flavour

By definition, **Herbs** are the aromatic leaves of plants without woody stems that grow in temperate zones. **Spices** are seasonings obtained from the bark, buds, fruit or flower parts, roots, seeds or stems of various aromatic plants and trees. We will use the word spices to indicate any substance, herb, spice, or vegetable used to flavor foods. There are a myriad of spices and a host of varieties. It is typically cost prohibitive to stock every conceivable type and variety of spice.

Allspice

- **Description/Taste and Aroma:** Dried Berries often used in ground form. It is not a mixture made up of all spices. People often think it smells and tastes like a mixture of cloves, cinnamon, and nutmeg. This spice tends to enhance the flavors of other herbs and spices used with it, especially when used with cinnamon and nutmeg.
- **Geographic Information:** Bermuda, Honduras, Jamaica, and Mexico are major suppliers.

- **Uses:** A versatile spice used with meats, veggies, and in sweet items. Allspice is often an ingredient in Jamaican jerk seasoning, in pickling spices, in spiced tea mixes, cakes, cookies, and pies. It is used to enhance soups, stews, and curries. It works well with apples, beets, cabbage, caramel, cardamom, cinnamon, cloves, coriander, game meats, ginger, juniper, mace, mustard, nuts, nutmeg, onions, pears, poultry, pork, pumpkin, root vegetables, seafood and yams.

Anise and Star Anise

- **Description/Taste and Aroma:** Two different spices both with licorice overtones. Anise comes in seed and ground forms while star anise is a cluster of tiny spokes that are most often used in ground form.
- **Geographic Information:** Spain and Mexico, China, Vietnam.

- **Uses:** Gives the distinctive taste to licorice candy**.** Often used in cakes, cookies, and breads, soups, and stews, syrups, cordials, and fruit preserves. . Pairs well with apples, beets, beef, caramel, carrots, chocolate, citrus, cinnamon, coconut, coriander, cranberry, fennel, figs, fish, game meats, garlic, peaches, pomegranates, pork, poultry, pumpkin, root vegetables, seafood, and is often used in tea.

Basil

- **Description/Taste and Aroma:** Many varieties are available. Sweet Basil is most often used. Leaves that are used whole, chopped, or ground. Imparts a sweet taste with a refreshing bouquet.
- **Geographic Information:** Grown primarily in the United States, France, and the Mediterranean region but is cultivated throughout the world and it is easy to grow your own.

- **Uses:** A must for any tomato based sauce or dish. Basil is a staple in Italian and Greek ethnic cuisine. It enhances the flavor of beef, chicken, eggs, fish and seafood. Basil blends well with capers, chives, cilantro, garlic, marjoram, oregano, mint, onion, parsley, rosemary, thyme, and savory. It can be used alone or along with other spices to enhance the taste of pasta. Serve basil with artichokes, eggplant, green vegetables, mushrooms, olives, pizza, grains and some fruits. **Sweet Basil** is the best basil for pesto and tomato salads.

Bay leaf

- **Description/Taste and Aroma:** Bay leaves are often used whole in Bouquet Garni or chopped or ground for use in other cooking. It is pungent and sharp at the same time and also both bitter /sweet. Flavor is at its peak when dried and best when used with other herbs and spices.
- **Geographic Information:** Originally from the Mediterranean and now grown in Europe and the Americas. It prefers temperate climates that are not too cold or too hot.

- **Uses:** A staple in American kitchens, slow to release its flavor it is best used in soups, stews, sauces, marinades and foods that need to take time to settle for a while. The leaves also flavor classic French dishes such as bouillabaisse and bouillon. This herb is essential to French, Italian, and

Greek cooking. A classic bouquet garni includes bay, thyme, parsley and rosemary. Most recipes will use a dried leaf crumbled or ground. It blends well with allspice, artichokes, beans, beef, game meats, garlic, grains, juniper, lentils, marjoram, mushrooms, nuts, oregano, parsley, potatoes, poultry, sage, savory, seafood, thyme and tomatoes. It is sometimes used as a compliment to add a note of spice to fruit compotes and puddings. It is always used with milk to prepare a béchamel sauce.

Caraway

- **Description/Taste and Aroma:** Generally used in seed form or as a ground spice. It imparts its unique taste to Rye Bread. Often thought of as tangy yet sweet.
- **Geographic Information:** Holland is the world's largest Caraway producer. It is also grown in Germany, Russia, Morocco, parts of Scandinavia, Canada, and the USA.

- **Uses:** It is favored by German cooks and often found in rye bread, sauerkraut, sausage, cheese, cabbage, and soups. It adds a unique tang to broccoli, apples, beets, cured meats, mushrooms, nuts, pork, poultry, root vegetables, potatoes, seafood and yeast breads. Blends well with coriander, dill, fennel, garlic, onions, oregano, parsley, and thyme.

Cardamom

- **Description/Taste and Aroma:** Ground seed of the ginger family. The seeds are between 1/4 and 1-inch long. Comes in regular (greenish white) and black varieties. Greenish White is preferred with a smoother taste. Has an intense, sweet flavor and a pungent aroma.
- **Geographic Information:** India, Guatemala, Vietnam, Papua New Guinea, and Ceylon

- **Uses:** Curry blends and breads, but the majority is used in Arabic countries as a flavoring for coffee. Most often used in sweet or savory dishes. Combines well with apples, bananas, beans, caramel, cinnamon, citrus, coconut, coriander, curry, dates, ginger, grains, nuts, paprika, pears, pepper (true), pumpkin, rice, saffron, sugar, squash, tea, turmeric, yams, and yeast breads.

Celery

- **Description/Taste and Aroma:** Both seeds and dried stalks are used It has a salty and slightly bitter flavor with an aroma a bit like parsley.
- **Geographic Information:** Most of the cultivated seed is grown in France and India

- **Uses:** In bread stuffing, casseroles, soups, stews, appetizers and as a garnish. Combines well with cabbage, cilantro, cucumber, cumin, fish, garlic, ginger, mustard, onion, parsley, pepper (capsicum and true) potatoes, poultry, rice, rosemary, sage, tomatoes, and thyme.

Chives

- **Description/Taste and Aroma:** A member of the lily family it has a mild onion flavor with faint taste of garlic.

- **Geographic Information:** Most of North America. Easy to grow and often grown as a window plant. California produces much of the commercial crop. Grown in many parts of the world.

- **Uses:** Fines herbs, a traditional French herb blend, as a garnish, in mashed potatoes, soups, scrambled eggs, stews. Works well with asparagus, basil, cheese, cilantro, dill, fennel, green vegetables, horseradish, mushrooms, olives, paprika, pasta, parsley, seafood, and tarragon. Often served with butter and sour cream.

Cilantro

- **Description/Taste and Aroma:** It is the leaf of the coriander plant. Some think it is similar to a mixture of citrus and parsley with a bite. People either love it or hate it. Some find it soap like others find it refreshing.
- **Geographic Information:** Most of North America. California produces much of the commercial crop. Staple in many Mexican dishes and grown in Mexico. Also grown in Mediterranean area.

- **Uses:** Most Mexican cooking. One of the first herbs to be used by humans it is used in a variety of Ethnic cuisines including Indian, Mediterranean, European, and Mexican. Great with avocados, beef, chilies, citrus foods, coconut, coriander, corn, cumin, curry, dates, fennel, figs, garlic, mint, onion, oregano, pepper (capsicum and true), poultry, sausage, seafood, and tomatoes. Better to add leaves at end of cooking as heat diminishes them.

Cinnamon

- **Description/Taste and Aroma:** Dried bark of various laurel trees. One of the more common trees from which Cinnamon is derived is the cassia and Chinese cassia is very robust in flavor. Americans grew up with the cassia version of cinnamon. Cinnamon sticks are made from long pieces of bark that are rolled, pressed, and dried. It is slightly bitter and sweet at the same time. It has an appealing smell and is often used as an air freshener or to disguise odors. The higher the level of volatile oils the more intense the flavor and smell. True Cinnamon has no volatile oils. Cassia varieties from 1 to around 5 percent volatile oils. Vietnamese cinnamons have around 5 to 7 percent volatile oils.
- **Geographic Information:** True Cinnamon is native to Sri Lanka. The Cassia Cinnamon used in North America is from the cassia tree which is grown in Vietnam, China, Indonesia, and Central America

- **Uses:** One of the most common baking spices. Mixes well with Nutmeg, Ginger, and Allspice. Used in cakes, cookies, and desserts throughout the world. Often used in savory chicken and lamb dishes, used to enhance fruit and to flavor cereal dishes. Stick Cinnamon is used in pickling and for flavoring hot beverages and as aromatic decoration at holiday celebrations. Combines well with apples, bananas, beans, caramel, cardamom, chilies, chocolate, cloves, coffee, coriander, cranberry, cumin, curry, dates, game meats, figs, grains, lamb, mace, peaches, pears, poultry, pumpkin, rice, sugar, squash, tangerines, tea, turmeric, vanilla, yams and yeast breads. One of the ingredients in 5-spice powder.

Cloves

- **Description/Taste and Aroma:** Brown dried flower buds of an evergreen tree in the myrtle family it is strongly pungent and bittersweet.
- **Geographic Information:** Madagascar, Indonesia, Brazil, and Ceylon

- **Uses:** Spice cookies and cakes. Much of the world crop is used in Indonesia for Clove cigarettes. Combines well with allspice, apples, bay leaf, beets, cardamom, carrots, chocolate, cinnamon, citrus, coriander, curry, fennel, game meats, ginger, mace, nuts, nutmeg, peaches, pineapple, pork, pumpkin, root vegetables, sausages, vanilla and yams.

Coriander

- **Description/Taste and Aroma:** Both seed and ground forms are used. It is has a strong lemon scent and can impart a lemony or orange tang.
- **Geographic Information:** Morocco and Romania, Europe, India, and the USA

- **Uses:** Indian curries, gin, American cigarettes, and sausages. It is used in a specific type of bread, some stews, and new uses for this old world spice are being found in modern times. It should be crushed or ground prior to use. Combines well with allspice, apples, bananas, beans, chili, cilantro, cinnamon, citrus, cloves, cumin, cured meats, curry, game meats, fennel, fish, garlic, ginger, mace, mint, mushrooms, nutmeg, onion, parsley, pork, potatoes, poultry, and seafood.

Cumin

- **Description/Taste and Aroma:** Pale green oval seed from the parsley family. It has a distinctive, slightly bitter taste with tinge of heat or warmth left on the tongue. Also there is black cumin which is milder and sweeter.
- **Geographic Information:** Iran, India, Sicily and Malta but is easy to grow and adapts well to multiple climates. Does not produce seeds until the second year and is not a pretty garden plant.

- **Uses:** Mexican dishes such as chili. Robust stews and piquant sauces. Combines well with allspice, anise, avocados, bay leaf, beans, beef, cabbage, cardamom, cheese (hard), cilantro, cinnamon, citrus, coconut, coriander, cucumber, curry, fennel, fenugreek, garlic, ginger, grains, lamb, lentils, mace, onion, nutmeg, parsley, potatoes, poultry, rice, sausages, seafood, and tomatoes.

Dill

- **Description/Taste and Aroma:** Both seed and weed are used and both come from the same annual plant. The weed is best used prior to flowering. The seeds come from the flower head and are pungent imparting a scent that is a bit like caraway, but lighter. Can have hints of anise or lemon depending upon the variety used. Has a bit of warmth to it.
- **Geographic Information:** Native to southern Russia. United States and India for commercial uses but it is easy to grow and can be found in many countries.

- **Uses:** A common pickling spice. Often sprinkled on tomatoes, blended into tuna salad, enhances dips with rye bread. Often used in German, Russian, and Scandinavian dishes. Combines well with anise, basil, cabbage, capers, caraway, carrots, chives, coriander, cucumbers, cumin, eggs, fennel, garlic, ginger, horseradish, mint, mustard, oregano, onion, paprika, parsley, potatoes, seafood, tarragon, tomatoes, turmeric, veal, vinegar, and yeast bread. When cooking, add at end of the cooking as it looses flavor if over heated.

Fennel

- **Description/Taste and Aroma:** Several varieties and all have oval, green-yellowish brown dried fruit and are a member of the parsley family. It is reminiscent of anise but sweeter and less pungent.
  - **Common Fennel** *(Meim fanindum)* often cultivated in kitchen gardens.
  - **Sweet Fennel** *(Famuulum dulcc)* native of Italy and Portugal, smaller plant than the common fennel but the fruit is 5 times the size of the common fennel.
- **Geographic Information:** India and Egypt
- **Uses:** Fish seasoning, blackened seasonings, Italian sausages, Middle Eastern cooking, curry powder mixes. Combines well with anise, artichokes, basil, beans, cabbage, cheese, cilantro, cinnamon, cucumber, cumin, dill, eggplant, fenugreek, figs, fish, garlic, lemon balm, lentils, mint, olives, onion, oregano, parsley, pork, potatoes, rice, sausage, seafood, thyme, tomatoes and veal. One of the spices in 5-spice powder and garam masala.

Garlic

- **Description/Taste and Aroma:** The dried root is a member of the lily family. The root bulb is used and comprised of sections called cloves that are protected by a layer of skin and held together by additional layers of skin. There are several varieties each having its own flavor. Not all are used in cooking. Distinctive, pungent, warm, aromatic, sweet and spicy at the same time. Whole cloves, minced, granulated and powdered forms are commonly used.
- **Geographic Information:** Native to central Asia, grown throughout the world.
- **Uses:** A staple in almost every cuisine throughout the world. It is a key ingredient in Italian, Mexican, and Chinese cooking. Used with every food group except desserts and sweets. It is also rarely used in beverages. Compliments almost everything but sweet spices and fruit.

Ginger

- **Description/Taste and Aroma:** Often dried and ground or "crystallized" with sugar. It is slightly hot and biting while also sweet, warm, and somewhat woody.
- **Geographic Information:** India, China and Jamaica.

- **Uses:** Gingerbread, ginger ale, gingersnaps, fruit pies, savory dishes and Asian dishes. Combines well with allspice, anise, asparagus, bananas, basil, beef, carrots, chilies, chives, chocolate, cilantro, cinnamon, citrus, cloves, coconut, coriander, cranberry, cumin, curry, dates, fennel, figs, fish, garlic, nuts, nutmeg, onion, peaches, pears, pepper (capsicum and true) poultry, pumpkin, raisins, root vegetables, seafood, sugar, tea, turmeric, vanilla, veal, and yams. Enhances flavor in salt-free seasonings.

Mace

- **Description/Taste and Aroma:** The nutmeg tree produces two spices, nutmeg and mace. Mace is the ground outer covering of the nutmeg seed. Its flavor and aroma are similar to nutmeg but mace has higher degree of pungency.
- **Geographic Information:** Warm climates throughout the world. Indonesia, Grenada, New Guinea, West Indies and like climates. Most comes from Banda Islands processed through Java and Sumatra.

- **Uses:** Primarily used in baking, it is the dominant flavor in doughnuts. It is often used in cakes, cookies, and in savory dishes like European soups and stews. Combines well with allspice, asparagus, beans, cabbage, carrots, cheese, cinnamon, cloves, coffee, cranberries, cumin, eggs, ginger, nutmeg, peaches, pumpkin, potatoes, sausage, sugar, vanilla, veal, and yams.

Marjoram

- **Description/Taste and Aroma:** Grayish-green leaf. Can be mistaken for oregano. There are at least 8 species, besides numerous varieties. The species most frequently cultivated are the common or pot marjorum (O. *vulgare),* sweet or summer marjoram (O. *majorana),* and winter marjoram (O. *herachoticum.)* sweet with an undertone of bitterness.
- **Geographic Information:** United States, France, Mediterranean

- **Uses:** A seasoning used in pasta blends, tomato dishes, vegetables, meat sauces, poultry seasonings, soups, and stews. Combines well with artichokes, basil, beans, beef, cheese, cinnamon, cumin, eggplant, fennel, garlic, mushrooms, onion, oregano, parsley, seafood, squash, thyme, and veal.

Mustard

- **Description/Taste and Aroma:** There are three types of mustards, all having yellow flowers and small round seeds. Hot and spicy, powdered mustard has no aroma when dry, but when mixed with water it releases a hot aroma.
  - **Brown Mustard,** Brassica juncea, more pungent and brighter flavor

  - **White Mustard,** Brassica hirta, less pungent and more mellow in flavor. This is the mustard that is commonly called Yellow Mustard as the seeds are more yellow than white.

  - **Black Mustard,** Brassica nigra, very strong and distinctive flavor used often in Southeast Asian and Indian cooking,

- **Geographic Information:** India, Asia

- **Uses:** Indian dishes and a world of condiments. There are a myriad of prepared types to purchase including stone ground, salad, gourmet, Dijon, and wine varieties. Enhances meats, fish, fowl, sauces, and salad dressings. Often used in pickling or in boiling vegetables such as cabbage or sauerkraut. Combines well with beef, cabbage, capers, cheese, chilies, cured meats, fennel, game meats, garlic, honey, onion, poultry, root vegetables, sausage, seafood, vinegar /wine, and yeast breads.

Nutmeg

- **Description/Taste and Aroma:** The nutmeg tree produces two spices, nutmeg and mace. Nutmeg is the brown seed of the evergreen tree native to the Molucca Islands. It is piquant yet sweet, similar to cinnamon but has more of a bite. Less intense than its sibling, mace.
- **Geographic Information:** Warm climates throughout the world. Indonesia, Grenada, New Guinea, West Indies and like climates. Most comes from Banda Islands processed through Java and Sumatra.

- **Uses:** Primarily used in baking, it is often found in cakes, cookies, and in savory dishes like European soups and stews, sausages, meats, soups, and preserves. Nutmeg is commonly added to eggnog. Combines well with allspice, asparagus, beans, cabbage, cardamom, carrots, cheese, cinnamon, cloves, coffee, coriander, cranberries, cumin, eggs, fish, ginger, lamb, mace, onion, peaches, pepper (true), pumpkin, potatoes, pumpkin, sausage, seafood chowders, , sugar, thyme, vanilla, veal, and yams.

Onion

- **Description/Taste and Aroma:** The ever popular onion is a bulb of Allium cepa, of either the lily or the amaryllis family. A number of varieties exist each with a unique flavor and various colors. Intensely pungent with a sharp bite. Some varieties are almost sweet.
- **Geographic Information:** Worldwide

- **Uses:** Meats, vegetables, sauces, soups, stews, appetizers, eggs, sauces, relishes, breads. Compliments everything but sweet spices and fruit.

Oregano

- **Description/Taste and Aroma:** Multiple varieties exist. Greek Oregano is a dried leaf that is uniquely pungent, highly aromatic and a mixture of sweet and savory. The Mexican variety is more intense and has a wilder flavor.
- **Geographic Information:** United States, France, Mediterranean, Mexico, Turkey

- **Uses:** Pasta seasoning blends, tomato dishes, vegetables, meat sauces, poultry seasonings, soups, and stews. A key ingredient in chili powders. Combines well with artichokes, basil, beans, beef, cheese, cinnamon, cumin, eggplant, fennel, garlic, marjoram, mushrooms, onion, parsley, pasta, poultry, seafood, squash, thyme, tomatoes, and veal.

Paprika

- **Description/Taste and Aroma:** Comes from a mild red pepper in the Capsicum annum family. There are several varieties and some are hotter o r sweeter than others but all have a slight heat to them and a strong red color.
- **Geographic Information:** Hungary, Spain, South America, and California.

- **Uses:** Main flavor in Hungarian cooking, including dishes such as Goulash and Chicken Paprikash. Often used with eggs, fish /shellfish, cheese, sausages, tomato dishes and in vegetable casseroles. Combines well with all meats, all vegetables, and can be used to spice fruit. Often used with allspice, beans, beef, caraway, cardamom, cheese (white preferred), garlic, ginger, legumes, oregano, parsley, pepper (other capsicum varieties and true pepper), pork, poultry, rosemary, saffron, thyme, turmeric and vegetables..

Parsley
- **Description/Taste and Aroma:** Several varieties exist with various tastes. Light, fresh, slightly sweet and slightly bitter taste.
- **Geographic Information:** USA, European Countries. Often found in windowsill gardens and in home gardens as it is easy to grow.

- **Uses:** Curly parsley is often used as a garnish. Flat parsley, also called French or Italian parsley, is favored by chefs for cooking in soups and sauces, tuna salad, and eggs. It is often combined with other herbs and spices in prepared blends. Works well with artichokes, asparagus, basil, bay leaf, beans, beef, chives, dill, game meats, garlic, marjoram, mushrooms, grains, onion, oregano, pasta, potatoes, poultry, seafood, thyme, tomatoes, and yeast bread.

Pepper, Capsicum Chili and Bell versions
- **Description/Taste and Aroma:** Multiple varieties all from the nightshade family. Commonly called chili pepper, red pepper, or sweet pepper. Some are very hot while bell peppe have no heat to them at all. Chemicals in the fruit can produce a strong burning sensation in the mouth. Most have mild aromas but a few are very intensely pungent. Rated for hotness based on a scale devised by American chemist Wilbur Scoville in 1912 which measures the hotness or piquancy of a chili pepper, calculated on the amount of capsaicin it contains. The number of Scoville heat units (SHU) indicates the amount of capsaicin present and how hot the pepper is. Naga Jolokia is the hottest chili in the world with a rating of 1,040,000 SHU. Each year's crop can vary so heat units shown on the scale are approximate for each type of pepper listed. Crushed Red versions can vary in hotness but most range in the 20,000 to 40,000 unit level.
- **Geographic Information:** Grown throughout the world. Major crops are produced in Central and South America and the West Indies. A majority are found in the Americas.

- **Uses:** Often combined with other herbs and spices in prepared blends. Each has a distinctive taste. Used with eggs, meats, cheese, vegetables, soups, sauces, pastas, breads. A main ingredient in Mexican, Hungarian, Italian and United States cuisine. Compliments all meats, all vegetables, and can be used to spice fruit.

7.10 Summary

Many foods consist either partly or wholly as food emulsions, or have been in an emulsified state sometime during their manufacture, including milk, cream, salad cream, mayonnaise, salad dressings, soups, sauces, butter, margarine, low-fat spreads, beverages, ice cream and coffee whitener. The bulk physicochemical properties of these foods (appearance, flavour, rheology and stability) depend on colloidal properties, such as droplet concentration, size and physical state, colloidal interactions and interfacial properties. Our laboratory is involved in a number of research projects aimed at improving the understanding of the molecular-colloidal basis of the bulk physicochemical properties of food emulsions. The influence of pH, ionic strength, droplet crystallinity, temperature, and ingredient interactions on the rheology, stability and appearance of oil-in-water emulsions is being investigated using a variety of experimental methods, including laser diffraction, particle electrophoresis, dynamic shear rheometry, ultrasonic spectroscopy, ultrasonic imaging and optical microscopy. Standardized methods are being developed to categorize the functional properties of food emulsifiers, which will enable food manufacturers to select ingredients in a more systematic and informed manner. Novel interfacial engineering technologies are being developed based on multiple-layer formation to improve the properties and stability of food emulsions.

7.11 Review Questions

1 Write Short Note On Theory Of Emulsion?

2 What Is Emulsifying Agents. Explain In Detail?

3. What Is Role Of Emulsifying Agents In Food ?

4 Explain Application Of Colloids Systems In Food Preparation?

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13.18 Functions and significance of Calcium

Calcium is essential for bone growth and strength, as well as muscle, heart and digestive system health. Sources of the mineral include dairy products, green leafy vegetables, sardines eaten with bones, nuts and seeds. The recommended daily amount (RDA) is 1000 mg.

Calcium (Ca)	Calcium is important for the formation of teeth and bone. About 99% of the calcium in our bodies is in our bones anbnnnnnnnnnnd teeth. Calcium is also needed for muscles to contract properly, heart function and for blood to clot normally. It also helps control blood pressure and is important in controlling high blood pressure.	Rich sources of calcium are dairy products (milk and milk products, cheese and yoghurt). Other good sources are green vegetables, fortified cereals, juice and flour, tofu and brazil nuts. It is also present in small-boned fish (e.g. sardines where where we eat the bones).

Iron

Iron is essential for the production of hemoglobin, the protein which transports oxygen in red blood cells. The mineral is necessary to prevent anemia. Foods with iron include red meat, leafy green vegetables, fish such as tuna or salmon, eggs, dried fruits, beans, whole grains, and enriched grains. The FDA for iron is 8 mg.

Iron (Fe)	Iron is needed for the transfer of oxygen between tissues in our body. The majority of the iron in our body is within the haemoglobin or myoglobin- two proteins that carry oxygen. Haemoglobin carries oxygen in our blood and transfers it to our cells and myoglobin transports oxygen in muscle tissues. Red blood cells are red because of the iron content (haemoglobin). Iron is also essential for a healthy immune system and is part of some enzymes in our body.	Iron in the diet can be found in two forms known as haem and non-haem. The type of iron found in meat and meat products are haem iron. Good sources include red meats, liver, kidney and heart. This form of iron is more easily absorbed. Non-haem iron is the main form of iron found in foods. Good sources include green leafy vegetables, seaweed, beans, eggs and oily fish (e.g. salmon). This form of iron is more difficult to be absorbed, if taken with vitamin C, it could improve its absorption.

Sodium

Sodium is necessary for regulating body fluid, nerve function, and heart health. Foods with sodium are table salt, sea vegetables, milk, and spinach. The RDA for sodium is 1500 mg.

Sodium (Na)	Sodium is essential for maintaining blood pressure and our nervous system. It helps ensure proper function of nerves (involved in nerve	A rich source of sodium is salt, which has the chemical name sodium chloride. Sodium chloride is the major source of sodium in foods. Other sources include

	impulse transmissions) and proper muscle function (muscle contraction). It also helps in digestion, bone formation and keeps our body from becoming too acidic or too alkaline.	butter, olives, bacon, ham and processed foods (salt is widely used as additives, where it is added into a food).

Iodine

Iodine is required for maintaining the production of thyroid hormones, regulating metabolism, and may also work as an antioxidant. Foods that have iodine are iodized salt, seafood, or some processed foods with iodized salt. The RDA for iodine is 150 mg.

Iodine (I)	Essential for the formation of thyroid hormones which regulate your metabolism, as well as growth and synthesis (to maintain healthy skin, hair and nails).	Rich sources of iodine are shellfish and sea salt. Other sources include milk (because iodine is used to sterilise milking machines on the farm and cow food), seafood (e.g. lobsters), seaweed and iodised salt

Fluoride (F)	Helps to maintain our teeth, make them stronger and prevent tooth decay. Also helps with new bone formation and maintaining healthy bones.	Good sources of fluoride are drinking water although it can contain varying amounts of fluoride depending on if it is naturally or chemically fluoridated (where fluoride is added to drinking water), tea and seafood.

13.19 Summery

Our body needs a fresh supply of vitamins and minerals everyday to function properly and for normal growth and development. Vitamins and minerals obtained from a healthy diet work together and separately to maintain the health of tissue, organs, muscles, nerves, bones and blood. In addition, certain **vitamins** are necessary to absorb certain minerals. For example Vitamin C helps in the absorption of iron needed to prevent anemia, and **Vitamin D** is needed to absorb calcium, essential for strong bones and teeth. Minerals help in forming bones, making hormones and regulating heartbeat. Some **minerals** like calcium, phosphorus and magnesium are needed in large amounts and they are termed as **macro minerals.** On the contrary, **trace elements** like chromium, copper, selenium, iron and zinc are very essential, but needed only in small quantity every day.

13.20 Questions

1 Why we need minerals?

2 Explain the role of vitamin in the body?

3 Explain the Classification of Vitamin?

4 Explain the Classification of Minerals ?

5 Define the role of minerals in the body?

13.21Reference

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Unit -14 : Menu Planning

Structure of Unit:

14.0 Objective

- To understand the concept and aim of meal planning
- To enumerate the different factors which influence meal planning
- To evaluate the nutritional adequacy of meals served to indivi duals
- To understand the special requirements for nutrients at various stages in life
- To enumerate the types of modification of normal diet

14.1 Introduction

Planning a balanced diet within the income level needs precise knowledge about the source of nutrients, their requirements for various groups, seasonal availability of various foodstuffs and dietary habits of the group.

Blending this theoretical knowledge into a day's menu needs skill which has to be acquired through practice. There are certain basic principles which has top be observed while planning a balanced diet. A diet is called balanced when all the nutrients required by the body are present in correct proportion. A judicious selection from the food groups will supply adequate nutrients for maintenance, repair and growth. Other factors to be considered are composition of the family and the physiological phases of family members, dietary habits of the family, food budget of the family, variety in meals patterns, appearance, texture and taste of meals, selection of food for seasons(cold and hot climate condition) and nutritional balance.

Today, the scenario is different. Eating out has become a way of life. Education and employment has taken many of us away from home, and the mother's role now has an added responsibility of contributing to the family income. Modern day compulsions have made eating out a necessity. No longer does one find time for the traditional fare of yesterdays and depends on the caterer for the following;

1. Food for festivals and celebration
2. Meals at the work place
3. Ready-to-eat meals picked up on the way home from work
4. Snacks and sweeteners for daily consumption
5. Preserves, pickles, papads, etc.
6. All meals served in institutions such as hospitals, school/college cafeteria, mess or dinning hall, and boarding school

Thus, menu planning can be defined as a simple process which involves application of the knowledge of food, nutrients, food habits, and likes and dislikes to plan wholesome and attractive meals.

14.2 Menu Planning

Menu is a French word which means a list of articles offered for sale which may also be called programme of a meal or silent salesman. Its objective is to present a list of dishes or courses, eatable and beverages. One of the most important object of organization and planning is food service industry is menu planning compiling of menu is an art and it needs careful selection of dishes

for different courses best results are obtained if the person incharge of the food product plan the menu in consultation with the chef.

Menu planning is the time consuming but very important finished product must fulfil the need of the test and give the people what they want, when they want.

14.2.1 Factors that influence menu planning

1. Location of the establishment:

If the establishment is situated in a business area the menu should be planned in a

certain way so the service would be quick and should be moderately priced.

Situated on highway/motels or road sides menu will after a ltd. Choice, quick service and moderately priced. Residential area- menu should be moderately priced it should appeal to families.

2. Type of establishment:

If it is Chinese restaurant- majority of selection will be Chinese. Snack bar – Majority of dishes will be snacks. Menu pattern will vary from hotels, restaurants, hostel, hospitals and industrial canteens. In a hostel or hospital and industrial canteen more or less fixed menu is offered and important is given to nutritive value.

3. Type of customer:

Type of people there age group, sex, religion, occupation spending power should be taken into consideration a seating habits vary with group. People doing physical and laborious jobs require more substantial meal then people who do clerical work.

4. Seasonal availability:

Although in these days of cold storage ingredients of all are available yet food in season should be included in the menu.

5. Availability of equipments in the kitchen:
Menu should be in accordance to the equipments in the kitchen to plan a menu for roast items with only oven, in the kitchen would make it difficult for service.

6. Capability of kitchen and services staff:

Do not plan an elaborate menu if it is the beyond the ability of the cooks pre pack the dishes also consider the staff is capable of serving certain dishes with special presentation.

7. **Leftovers in hand:**

It is better to use leftovers and recover some money or cost rather than spoiling the food. Chefs skill is in converting leftover to a new dish so that customer does not know about it (Specialty of the day)

8. **Cost of the menu:**

The selling price of the menu should be kept in mind so that the food cost is well controlled.

9. **Policy of the establishment**:

Certain establishments may not serve exception foods because of their policy eg, pork , beef.

10. **Service hours:**

Also determines the type of menu.

11. **Nutritional factor:** Menu should be nutritionally balanced.

12. **Occasion:** What kind of Occasion it is??? For eg. Festivals, Marriages Etc.

14.3 Meal planning

Meal is regarded both as a science as well as an art. It is regarded as an art because it involves the skillful blending of colour, texture and flavour and it is considered to be a science because it involves a careful selection of food for optimum nutrition and digestion. A well planned meal is always appealing to the eyes. Therefore, it is very important that we should obtain adequate nutrition by including the foods from all the food groups in sufficient quantity as well as proportion. Meal planning means planning for adequate nutrition. Meal planning is an art which develops through inspiration and thought. It may appear to be difficult at first but it is a skill which grows with patience and practice.

The wisely planned meal not only has to be palatable but also it should be nutritious. Appetite depends not only on hunger but also on the taste, texture, appearance and attractiveness of the foods.

14.3.1 Importance of meal Planning

1. Planning of meals in a family is very important in order to fulfill the nutritional requirements of the family members. This is very important to keep them strong and healthy and also free from any nutritional deficiency disease symptoms of any kind.
2. The food or the meal that is planned has to be palatable and appealing to the eye as well as nutritious. It has been observed that a majority of the people do not prefer to eat the foods that they do not like, even if those foods are of high nutritional value.
3. Meal planning is of utmost importance because it involves economizing on time, labour and fuel. While planning of meals the cooking method should be such that there is maximum retention of nutrients and at the same time there is minimum loss of nutrients.
4. This is also very important to keep in mind that the meals should be planned according to the budget of the family. There can be the maximum utilization of the money spent on foods if it is spent in the best possible way. It is possible to have a diet rich in quality and nutritive value without purchasing expensive foods like milk, eggs, butter, meat and a recognition of this will remove misconceptions that only expensive foods are nutritious. Meal planning, therefore, helps one to plan within the family's means and resources.
5. There are so many varieties of foods that it becomes difficult to decide and 8elect the food to be cooked. A knowledge of the nutritive value of the foods is, therefore, very important because it enables one to make a better choice and at the same time to avoid any monotony in the diet.
6. It is always advisable to plan the meals in advance before cooking. This will be very much economical as the left-overs from the previous meal can be made use of, instead of being wasted. For instance, the boiled rice can be used in khichri or in some rice pudding. The nutritive value of some foods can also be enhanced by sprouting or fermenting the foods required in advance.
7. Meal planning also helps to determine the adequacy of the diet, the kind of the food purchased, its quality and its cost, the way it is stored, prepared and served. It is very much advisable for the housewife to record and find out how the meals she serves can be improved, their cost reduced and their nutritive value be enhanced.

14.3.2 Factors Affecting Meal Planning

In a family, it has been observed that no two individuals have exactly the same nutritional requirements. Therefore, their dietary pattern also differs in order to meet their physical, social and psychological requirements. There are a number of factors which play an important role in the meal planning.

1. Adequacy of the foods

A good meal planning or menu is the one which will not only provide the adequate amounts of nutrients, such is, fats, calories and proteins, but also minerals and vitamins essential for the physical well-being of each family members. Hence, it is very important that the age, sex, occupation, physiological condition and number of family members must be kept in mind while meal planning.

Pattern of meal planning may vary widely but an attempt must be made to provide a diet that will not lead to protein deficiency accompanied by a deficiency of iron. Sometimes deficiency of milk leads to a diet which is low in calcium. It is advisable to include one or more foods from each of the different food groups. This will help to prevent most imbalances in the diets.

2. Meal patterns must fulfill the family needs

While planning meals, it is advisable that the person should consider the requirements of each individual member of the family. In a family, there may be a child, a sedentary working lady, a hard-working man, an adolescent boy and a hard working housewife. The housewife who plans the meals has to see to their different nutritional requirements. The texture and method of cooking food for a young person will be different from that of an old person because an old person is unable to digest hard foods and requires soft cooked foods. Young and adolescent girls have to be given more iron in their diets as compared to boys because of blood loss during menstruation. A heavy worker requires more calories than a moderate worker.

3. Time and energy saving

Meal planning should be done in such a manner that it should be easy to cook and save time and energy. This is especially important for the families of low income groups or where the housewives are also working. If the meal consists of too many dishes and each takes a lot of time to prepare, then the housewife will spend too much time in the kitchen and she may get frustrated because the other household works will remain incomplete. Therefore, the meal planning of the diet should be such that it involves the minimum amount of time, energy, and expenditure.

4. Individual likes and dislikes

Although it is important that the recommended daily allowances for each of the food group must be followed, there is a room for individual preferences amongst the foods in each class. In many families, some people make personal likes and dislikes to be the only basis for the inclusion or exclusion of certain foods in their meals, the failure to include milk is a common practice. It is

always advisable to change the form of the food rather than to completely avoid it. For instance, milk can be given in the form of curd, cheese, custard or another sweet dish soyabeans in the form of soya flour chapttis mixed with wheat flour.

5. Making suitable food combination

By mixing or combining the foods in suitable ways, variety in meals can be obtained, it means acceptability, thus thereby ensuring better nutrition. This can be Introduced by changes in the colour, shape, texture, flavour and methods of preparation. Attractive colour combinations are always appealing to the eyes. Variation in the texture is also essential.

All the soft or hard foods will not be liked by an individual. Flavour plays an important role and different flavours introduce variety and meal appeal. Also it is very important that all the meals should not have too sharp flavour. Various methods of cooking can also introduce variety, for instance a meal consisting of tandoori roti, dal (urad or masoor), and a seasonal green vegetable along with a salad and fruit is well planned.

Cereals and pulses when cooked in combination also enhance their nutritive value of the food stuffs, for instance, khichri, roti, dosa, idli. If they are cooked in combination with green leafy vegetables, nuts, oilseeds and milk etc., the nutritive value is further enhanced. For instance, it has been suggested that maize (corn) taken with lime is of superior nutritional value than the plain maize alone.

6. Satiety value

It is important to know that the foods rich in proteins and fats have a higher satiety value compared to carbohydrates. Planning the interval between the two meals should be considered, and accordingly the foods from different food groups must be included. If the interval between the two meals is longer, the foods should be rich in protein and fat. If the interval between the too meals is short, then the food should be rich in carbohydrate.

7. Availability of foods

In the earlier times, the dietary habits were much depending upon the foods produced in a particular area or the community, but today with improved methods of food preservation and distribution, even the most perishable foods are available over large areas. The wide variation in the dietary patterns throughout the world depends largely upon the local availability of the food supply.

8. Economic considerations

The financial conditions of a family of moderate means cannot afford to provide luxury foods or expensive foods, but it can definitely offer variety and choice. Food budgets of low income groups restrict the choices still further and it may be possible that it becomes necessary to depend largely on the cereal based foods. Then the problem faced would be to provide supplementation of these cereal foods with the foods essential for a balanced diet. Although, it becomes quite difficult to plan, but at the same time it is not impossible. When the cost of food per day is low, it is realised that it is very important to have a good knowledge of less expensive foods, which provide high nutritional value. However, such recipes and foods should be included in the meal planning, for instance, seasonal vegetables, butter -milk, pickle or chutney and preparation of paushtik roti (that is the mixture of cereals and pulses).

9. Seasonal foods

At the present time it is seen that the seasons play a less important role in meal planning than in the olden times because the fresh frozen toads are available throughout the year. It is advisable that the foods included in the diet plans should be seasonal foods because they are cheap and locally available in good quality and are also within the reach of all the people.

10. Customs, traditions and religions

This is a very important factor to be kept in mind while meal preparation. This is an important factor and food habits must be kept in mind while planning meals because they belong to different religions. Muslims cannot eat pork, whereas Hindus will not eat beef. Rice is considered to be an auspicious dish at festivals and marriages. Widows are generally not served fish in West Bengal. Customs and traditions differ from community to community and hence should be kept in view while planning meals for a family.

14.3.3 Essentials of Meal Planning

Successful meal planning not only depends upon the nutritional requirements of the body but also it depends upon many other factors. Some important factors are explained here.

1. Good breakfast

A good breakfast should provide one fourth of the daily caloric and protein allowances. Breakfast may include some protein food such as egg or milk, cereal or bread or both and a beverage. It is advisable that diet of children and

teenagers should include milk in the breakfast. A breakfast may be light or heavy depending upon the individual's work, activity and food preferences.

2. Lunch should not be neglected

It has been observed that many workers eat lunches that are limited to the choices of food. It has been observed that the lunch eaten by the pre-school children and the women contains leftovers because the women do not take time for adequate planning or preparation. Therefore, it is essential that the lunch should contain a balance of all the foods from different food groups.

3. Dinner patterns

The dinner is a meal over which most housewives has control. For many families, dinner is the only time when all the members are present together. This meal must make up for any deficiencies that might have taken place earlier in other meals of the day. Meat, fish, fowl, cheese, eggs or legumes should comprise the main dish at dinner. Potatoes or a starchy food and a green or yellow vegetable is generally included. If no salad has been provided in the lunch, it should be served here. Desserts should also be provided as a part of the dinner. Dessert may consist of fruits, pudding, cake or pastry. Milk should also be provided to the children.

4. Snacks

Most people consume snacks and beverages between meals and in the evening. When they are selected as part of the total food pattern for the day and consist primarily of nutrient rich foods and they can enhance the nutritional quality of the diet. Most often, snacks consist of high-caloric foods that are low in nutritive value. This indicates that some people will exceed their caloric requirements and that others, especially the children, may not consume sufficient amount of essential nutrients.

14.3.4 Levels of Meal Planning

A well planned meal may be defined as one which contains the various groups of foods such as energy giving foods, body building foods and protective foods in the correct proportions and amounts so that an individual is assured of obtaining the minimum requirement of all the nutrients. The components of the meal will vary according to the age, sex, physical activity, economic status, physiological conditions, time of the day i.e. morning break-fast, lunch and dinner.

1. Meal planning at high cost

Such meals will include liberal amounts of protective and protein rich foods such as milk, eggs, meat, fish and fruits and moderate quantities of cereals, pulses, nuts and fats.

2. Meal planning at moderate cost

These diets will include minimal amounts of protective and protein-rich foods such as milk, eggs, meat, fish, fruits and fats but will contain liberal amounts of cereals, pulses, nuts and green leafy vegetables.

3. Meal planning at low cost

These diets will include minimal amounts of protective and protein-rich foods, such as milk, eggs, meats, fish and fats and liberal, amounts of cereals, pulses, nuts and green leafy vegetables.

4. Meal which is not well planned

An ill-balanced diet or meal planning is deficient in calories, proteins, essential vitamins and minerals because it is lacking in protein-rich and protective foods as mentioned earlier.

Many factors influence the menu planning or food habits. Customers select what appeals most to them from a menu card based on individuals likes and dislikes, in budget, popularity of items, and so on. Therefore for planning menu the above discussed factors need to be kept in mind.

14.4 Planning Balanced Meals

Meal planning involves proper selection of food to ensure balanced meals. Food can be classified on the basis of its source, the nutrients present in it, or on the basis of its functions into 3-11 food groups. These food groups help us in the three basic food groups which help us in planning balanced meals and supply all essential nutrients.

A healthy diet consists of a wide variety of foods to help your body and stay in good condition and to give you energy. It must include enough of these nutrients: proteins; fats; carbohydrates; vitamins; minerals; and fiber; as well as water, to fuel and maintain your body's vital functions. Ideally, you should eat three to four meals a day. The three main functions performed by food are:

1. Providing energy
2. Body building and maintenance
3. Regulation of body processes and protection against infection.

On the basis of functions performed, food is classified into the following three groups.

1. Protective / regulatory foods
2. Body- building foods
3. Energy- giving foods

Protective / regulatory foods

All fruits and vegetables including green leafy and other vegetables and all fruits, are protective or regulatory foods. This group includes green leafy vegetables, orange, yellow, red fruits and vegetables are rich in carotene, citrus fruits and also citrus fruits. All these are rich in ascorbic acid and they also contain minerals, fiber, and carbohydrates.

Body- building foods

Foods rich in protein are included in this group. Nuts and oilseeds also provide fats. All animals proteins and pulses, nuts, and oilseeds are rich in protein, vitamins, and minerals and nuts and oilseeds are also rich in fibre, and oils.

Energy – giving foods

This group provides mainly carbohydrates and fats, along with proteins, some vitamins and minerals, and essential fatty acids. Foods included in this group are cereals and millets which are rich in complex carbohydrates with other nutrients; sugars and jaggery which provides carbohydrates and minerals; and also fats and oils which mainly rich in fats and oils.

While planning meals one should ensure that foods from all three groups are included in the each meal. This classification is simple and easy to use for menu planning.

Steps in planning balanced meals:

1. Collect information regarding the customer with respect to
    a. age
    b. gender
    c. activity level
    d. religion
    e. socio-economic background
    f. Food habit.
2. Check the RDA's for energy and proteins
3. Prepare a food plan, i.e., list number of servings from each food group to meet the RDA.
4. Decide on number of meals
5. Distribute servings for each meal

6. Select foods within each group and state their amount
7. Plan a menu
8. Cross- check to ensure that all food groups are included in requisite amounts.

Balanced meal for adults-sedentary/moderate/heavy activity (number of portions)

Food Groups	Portion g	Type of work					
		Sedentary		Moderate		Heavy	
		Man	Woman	Man	Woman	Man	Woman
Cereals and millets	30	14	10	16	12	23	16
Pulses	30	2	2	3	2.5	3	3
Milk	100 ml	3	3	3	3	3	3
Roots & tubers	100	2	1	2	1	2	2
Green leafy vegetables	100	1	1	1	1	1	1
Other vegetables	100	1	1	1	1	1	1
Fruits	100	1	1	1	1	1	1
Sugar	5	5	4	8	5	11	9
Fats and Oils (visible)	5	4	4	7	6	11	8

For non-vegetarians substitute one pulse portion with one portion of egg/meat/chicken/fish.
For infants introduce egg/meat/chicken/fish around 9 months.
Specific recommendations as compared to a sedentary woman:

Children

1–6 years	: ½ to ¾ the amount of cereals, pulses and vegetables and extra cup of milk.
7–12 years	: Extra cup of milk
Adolescent girls	: Extra cup of milk
Adolescent boys	: Diet of sedentary man with extra cup of milk.

Source: Dietary Guidelines for Indians—A manual, 1999, National Institute of Nutrition, ICMR, Hyderabad.

Balanced meal for infants, children and adolescents (number of portions)

Food groups	Porgtion g	Infants 6–12 months	Years						
			1–3	4–6	7–9	10–12		13–18	
						Girls	Boys	Girls	Boys
Cereals and millets	30	1.5	4	7	9	9	11	10	14
Pulses	30	0.5	1	1.5	2	2	2	2	2
Milk (ml)	100	5*	5	5	5	5	5	5	5
Roots & tubers	100	0.5	0.5	1	1	1	1	1	2
Green leafy vegetables	100	0.25	0.5	0.5	1	1	1	1	1
Other vegetables	100	0.25	0.5	0.5	1	1	1	1	1
Fruits	100	1	1	1	1	1	1	1	1
Sugar	5	5	5	6	6	6	7	6	7
Fats/Oils (visible)	5	2	4	5	5	5	5	5	5

*Quantity indicates top milk. For breastfed infants, 200 ml top milk is required.
One portion of pulse may be exchanged with one portion (50 g) of egg/meat/chicken/fish.

100 kcal exchange list, capacity of 1 standard calorie is 150 ml

Cereal exchange – 1.5–3.5 g protein	
Idli (big)	1
(medium)	1 1/3
Dosa (small)	1
(big)	1/2
Phulka	2
Chapathi	1
Puri	1 1/2
Rava idli	1
Veg. sandwich	3/4
Bread toast (medium)	1 1/2
Bread pakoda	3
Plain rice	3/4 kg
Upma	1/2 kg
Veg. noodles	1 kg
Coconut Rice	1/2 kg
Pongal	1/2 kg
Boiled Wheat Rava	1 kg
Sweet Pongal	2 Tb Sp
Paniyaram	1¼ pieces
Vermicelli payasam	2 Tb Sp
Kesari	1 1/2 Tb Sp
Rice flakes upma	1/2 kg
Naan	2/3
Cheese Sandwich	1/3
Ragi puttu	3/4 kg
Ragi adai	3/4
Pulao	1/2 kg
Bise bela bath	1/2 kg
Tamarind rice	1/2 kg
Curd rice	1/2 kg
Idiappam	1
Pulse Exchange – 3–6 g protein	
Sambar	1 1/3 kg
Rasam	2 1/2 kg
Thick dal	1/2 kg
Thin dal	1 kg
Channa masala	1/2 kg
Dry peas sundal	3/4 kg
Roasted bengal gram chutney (without coconut)	1/2 kg
Sprouted moong salad	1 heaped katori
Pesarattu	3/4
Baked Masala Vada (with negligible amount of fat)	2 nos
Adai	1
Vada	1
Keerai vada	3/4
Bajji	2
Bonda	1
Meat exchange – 5 g of protein	
Egg omelette	1
Scrambled egg	One egg
Fish Kolambu	2/3 kg
Fish fry	1 small piece
Boiled egg with gravy	1/3 to 1/2 serving
Meat curry	1 serving
Egg Custard	1/2 kg
Milk exchange – 4.5 g protein	
Milk	150 ml–1 tea cup
Curd	150 ml–1 full katori
Cheese	1 1/3 cube 30 g
Paneer	40 g
Butter milk	1 glass–(350 ml)
Badam Milk Shake	1/4 glass
Banana Milk Shake	1/3 glass
Milk kheer	1/2 kg
Carrot Kheer	3/4 kg

Vegetable A exchange		
	Curry without coconut and gravy (with simple seasoning) Amaranth curry	1 heaped katori
	Plain tomato soup	2 kg (1 soup bowl)
	Soup with white sauce	1 kg (1/2 soup bowl)
	Mint Chutney	1/2 kg
	Onion Chutney	1/2 kg
Vegetable B exchange		
	Roots and tubers curry	1/2 kg
	Cutlet	1/2
Fruit exchange		
	Apple	1 medium
	Banana	1
	Custard apple	1
	Pine apple	3 slices
	Orange	2½
	Sapota	2 (small)
	Fruit salad (no sugar or dressing)	3/4 kg
	Guava	1 (Big)

Exchange list (100 kcal each)

Food exchange	*Total no. of exchanges/ day*	*Distribution*		
		Breakfast+ Mid morning	*Lunch+ Evening tea*	*Dinner+ after dinner*
Cereal exchange	11	3	4	4
Pulse exchange	3	1	1	1
Milk exchange	4	1	2	1
Fruit+Vegetable exchange	5	1	2	2
Meat exchange	1	—	1	—

Energy value of fat and oil are included in the above exchanges. Sugar 1 g = 4 kcal. Fat 1 g = 9 kcal.

14.5 Finding nutritive value of meals

The main focus of this section is on learning the salient features and the use of the food composition tables for the purpose of finding the nutritive value of foodstuffs. The use of food composition tables involves simple mathematical calculations.

What are food composition tables.

You can find your way through the food composition tables by carefully looking at them. Observe the food composition tables given in figure and look for some of its salient features.

1. The first thing which you will notice is that the tables provide information regarding the energy, protein, fat, carbohydrate, fibre, mineral(calcium, phosphorus, iron) and vitamin(vitamin A, vitamin C, thiamine, riboflavin, niacin, and folic acid) content of commonly used food stuffs in Indian households.
2. Another important point which you can note by carefully looking at tables is the classification of foodstuffs into food groups. You are

familiar with these food groups. These are energy- giving foods, body-building food groups and protective / regulatory foods. The various categories of foodstuffs included in each food group are listed below:

a. Energy giving foods
    i. Cereals
    ii. Roots and tubers
    iii. Sugars
    iv. Fats and oils

b. Body- building foods
    i. Milk and milk products
    ii. Pulses
    iii. Flesh foods

c. Protective / regulatory foods
    i. Leafy vegetables
    ii. Other vegetables
    iii. Fruits

d. Miscellaneous
    i. Nuts and oilseeds
    ii. Condiments and spices

3. You should also become familiar with the various columns of the food composition tables. Here is a small extract of the table (food composition tables).

Nutritive value of some common foods

S.NO.	Name of foodstuff	Protein (g)	Energy (Cal.)	Iron (mg.)	Carotene/Vit. A (µg.)
1	2	3	4	5	6
	Cereals & Millets				
1.	Bajra	11.6	361	5.0	132
2.	Barley	11.5	336	3.0	10
3.	Jowar	10.4	349	5.8	47
4.	Maize dry	11.1	342	2.0	90
5.	Ragi	7.3	328	6.4	42
6.	Rice, raw milled	6.8	345	3.1	0
7.	Wheat (whole)	11.8	346	4.9	64
	Pulses and legumes				
8.	Bengal gram (whole)	17.1	360	10.2	189
9.	Green gram (whole)	24.0	334	7.3	94
10.	Lentil	25.1	343	4.8	270
11.	Redgram dal	22.3	335	5.8	132
12.	Soyabean	43.2	432	11.5	426
	Leafy vegetables				
13.	Bathua leaves	3.7	30	4.2	1740
14.	Cabbage	1.8	27	0.8	120
15.	Coriander leaves	3.3	44	18.5	6918
16	Spinach	2.0	26	10.9	5580
17	Amaranth leave	4.0	45	3.5	4620
18.	Fenugreek leaves	4.4	49	1.9	2340
19.	Radish leaves	3.9	38	18.0	5742
	Roots and tubers				
20.	Carrot	0.9	48	2.2	1890
21.	Onion, big	1.2	50	0.7	0
22.	Potato	1.6	97	0.7	24
23.	Sweet Potato	1.2	120	0.8	6
	Other vegetables				
24.	Cauliflower	2.6	30	1.5	30
25.	Pumpkin	1.4	25	0.7	50
	Fats & edible oils				
26.	Hydrogenated oil (fortified)	0	900	0	750*
27.	Cooking oil (groundnut, gingerly, mustard, coconut, etc.)	0	900	0	0
	MILK & MILKPRODUCTS				
28.	Milk (buffalos)	4.3	117	0.2	46*
29.	Milk (cow's)	3.2	67	0.2	53*
30.	Curds (cow milk)	3.1	60	0.2	31*
31.	Butter milk	0.8	15	0.1	-
32.	Skimmed milk liquid	2.5	29	0.2	-
33.	Channa(cow milk)	18.3	265	-	110*
34.	Skimmed milk powder	36.0	357	1.4	-
35.	Channa (Baffalo milk)	13.4	292	-	-
	MISCELLENIUS				
36.	Bread	7.8	245	1.1	-
37.	Sugar	0.1	398	0.155	-
38.	Jaggery	0.4	383	2.64	-

*Vitamin A : Retinol µg
Source : Nutritive value of Indian Food, National Institution of Nutrition, ICMR Hydrabad - 2004.

Table tells you the amount of various nutrients in 100g edible portion of raw foodstuffs. The edible portion means when we buy foodstuffs like vegetables, fruits or nuts from the market, we usually do not consume them as such. We throw away the skin or seeds/ stalks and consume only the rest. Similarly, when we buy peas from the market, we actually consume seeds/ peas and throw away the pods/ shells. We throw the stalks from the spinach and consume only the leaves. While in the case of other foodstuffs like milk, sugar, atta, maida and suji, we consume all of what

we buy. The portions of the foodstuffs which are really consumed /eaten are known as edible portion. Inedible portions are not consumed or eaten and are thrown away.

It means that foodstuffs like milk, atta, maida, suji, rice, pulses, sugars, jaggery, etc., are 100 percent edible While others like vegetables, fruits, nuts and oilseeds are not 100 percent edible. Remember that the nutrient content of foodstuffs given in the food composition tables is based on the 100 g edible portion of the raw foodstuffs.

Finding the nutritive value of foodstuffs using food composition tables

You can make use of food composition tables in any one of the following ways:

1. Comparison of the nutrient content of 100g edible portion of raw foodstuffs
2. Calculation of the nutrient content of edible portions of foodstuffs for amounts other than 100g.
3. Calculation of the nutrient content of a meal/ dish.

1. Comparison of the nutrient content of 100g edible portion of raw foodstuffs

This aspect is explained here by means of the following examples:

Compare the energy, protein and carotene values of 100g edible portion of wheat and spinach.

For answering the question opens the food composition tables and look for the following:

- Identify the food group to which they belong: Wheat is energy – giving food and placed in the category of cereals. Spinach is a protective / regulatory food placed in the category of leafy vegetables.
- Refer to the appropriate columns: Column 8(energy), column 4(protein), and column 12 (carotene).

2. Calculation of nutrient content of foodstuffs for amounts other than 100g edible portion of foodstuffs. If you want to calculate energy and protein content of 75g spinach and 150g wheat, how will you do it. Here you will have to apply simple mathematical calculations. Let us see below:

Wheat	Spinach
a) 100g wheat has = 346Kcal	a) 100g spinach has 26 Kcal
150g wheat has 346 X 1.50	75g spinach has 26 X 0.75
= 529	= 19.50Kcal

b) 100g wheat = 4.8g protein
150g wheat = 4.8X1.50
=7.2 g protein

b) 100g spinach has = 2 g protein
75g spinach has = 2X 0.75
=1.5g protein

Similarly, you can use the information given in the table for calculating the nutrient content of any foodstuff in any amount. While doing these calculations, you should also know how to express the values for various nutrients and how to record the results. Let us

see the following

i) How to express values for various nutrients: While calculating the nutritive value of foodstuffs, you would notice that you may not get results / numerical values. For example, energy content of 75g of spinach came to 19.5 Kcal. However energy values are expressed in round figures and you will write energy content as 20 Kcal instead of 19.5 Kcal.

ii) How to record your results: In practice all related calculations can be done on a rough page and result can be presented in tabular form as shown here

S.No.	Foodstuff	Amount (g)	Energy (Kcal) (g)	Protein
1.	Wheat	150	529	7.2
2.	Spinach	75	20	1.5

C) Calculation of the nutrient content of a dish: So far you have learnt calculation of nutrient content of food stuffs. However, the meals you consume do not consist of individual foodstuffs like, egg, jaggery, wheat or spinach. Instead, these foodstuffs are a part of various dishes / snacks included in meal.

1. If you want to calculate the nutritive value of a meal / dish, you will be required to note down the each ingredient of a dish and then calculate the nutritive value.
2. Prepare a table with the blank columns, and fill up the ingredients and quantity column from the recipe. Given below is the Performa which you can use for recording which you can use for recording your results.
3. Refer to the food composition tables for the nutrients present in 100g of edible portion of each ingredients
4. Calculate the nutrients present for the quantities used in the recipe.
5. Weigh the finished product to know the total yield.
6. Divide these values by the number of portions to know the nutritive value per portion.
7. For general calculations, do not include salt, baking powder, stock, or ingredients which are used in very small quantities (less than 10g) except sugar and fat. Baking powder and salt are calculated for their sodium content, and not for their proximate principles, for sodium- restricted diets only.

Nutritive value of besan spinach cheela

Ingredients	**Amount(gm)**
Besan	40
Spinach	50
Onion	30
Oil	10

100g Besan has 60 Kcal

40g Besan has 60 X40/100 = 24 Kcal

40g Besan has 24 Kcal

100g Besan has 20g protein

40g Besan has 20 X40/100 = 8g

40g Besan has 8g protein

100g Spinach has 26 Kcal

50g Spinach has 26 X50/100 = 13 Kcal

50g Spinach has 13Kcal

100g Spinach has 2g protein

50g Spinach has 2 X50/100 = 1g

50g Spinach has 1g protein

100g Onion has 50 Kcal

30g Onion has 50X30/100 = 15 Kcal

30g Onion has 15 Kcal

100g Onion has 1.2g protein

30g Onion has 1.2X30/100 = 0.36g

30g Onion has 0.36g protein

100g Oil has 900 Kcal

10g Oil has 900X10/100 = 90 Kcal

10g Oil has 90Kcal

100g Oil has negligible amount of protein

Name of the dish besan spinach cheela

Ingredients	Amount(g)	Energy Others(Kcal)	Protein(g)
1. Besan	40	24	8
2. Spinach	50	13	1
3. Onion	30	15	0.36
4. Oil	10	90	-
Total	**130**	**142**	**9.36**

Besan spinach cheela contains-

Energy- 142 kcal

Protein- 9.36 gm

14.6 Summary

It is very important to realize that an adequate nutrition in terms of well planned meal is vital for every one of all ages, sex, socio-economic conditions

and physiological conditions. For instance young children and adolescent boys and girls, pregnant and nursing mothers have increased demands for nutrients. This is so because young children and adolescent boys arid girls are in a period of rapid growth. Hence, it is essential to consume adequate amounts of a variety of foods in the form of a well planned meal so as to provide all the nutrients required.

The nutritional needs of individuals are not often understood while planning meals and consuming food in a family. Often, it has been observed that in spite of rich foods such as milk, eggs, fruits being available in sufficient amounts in a family, deficiencies may develop in some persons because of wrong beliefs or due to customs and traditions.

Hence, in view of all these considerations, an attempt has been made to create an awareness of the meal planning in a family especially in view of the special nutritional requirements of particular age groups and the way the diets can be planned for them for the whole day.

14.7 Glossary

- **Balanced Diet:** A diet containing all essential (macro and micro) nutrients in optimum quantities and in appropriate proportions that meet the requirements.
- **Food Exchange**: Foods are classified into different groups for exchange. Each "exchange list" includes a number of measured foods of similar nutritive value that can be ubstituted Inter-changeably in meal plans.
- **RDA:** The amounts of dietary energy and nutrients considered sufficient for maintaining good health by the people of a country.
- **Satiety:** Feeling of satisfaction after food intake.
- **Food Plan:** A list of exchanges to be included in a day's diet with their number and contribution to total energy and protein content of the diet.
- **Edible portion:** The portions of foodstuff which are really consumed or eaten like leaves of spinach (inedible stalks are thrown away) or seeds of peapods (inedible pods are thrown away).
- **Diet:** Dishes consumed during an entire day.
- **Meal:** Referring to breakfast/lunch/tea/dinner etc.
- **Menu:** List of dishes included in a particular meal.

14.8 check your work progress

1. What are the qualities of a well planned meal?
2. Differentiate between seasonal foods and out of season foods.
3. List at least two points you will keep in mind in order to prepare an attractive and appealing meal.
4. Write short notes on food composition table bringing out the limitations of it.
5. Give the five food group system suggested by ICMR & explain the importance of it.
6. Explain the principles of planning a meal.
7. Discuss in detail the steps involved in planning a menu.
8. Give the importance of planning a menu.
9. What are food exchange lists? How are they used in planning diets?
10. Write the factors to be considered in planning a menu.
11. Describe any five methods to reduce the cost of a meal.

14.9 Reference Material

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14.10 ANNEXURE:

SAMPLE MEAL PLAN FOR ADULT MAN (SEDENTARY)

Meal Time	Food Group	Raw	Cooked Recipe	Servings Amounts
Breakfast	Milk	100 ml	Milk or	1/2 Cup
	Sugar	15 g	Tea or	2 Cups
			Coffee	1 Cup
	Cereals	70 g	Breakfast Item	
	Pulses	20 g		
Lunch	Cereals	120 g	Rice	2 Cups
			Pulkas	2 Nos.
	Pulses	20 g	Dhal	1/2 Cup
	Vegetables	150 g	Veg. curry	3/4 Cup
	Vegetables	50 g	Veg. salad	7-8 Slices
	Milk	100 ml	Curd	1/2 Cup
Tea	Cereals	50 g	Snack	
	Milk	50 ml	Tea	1 Cup
	Sugar	10 g		
Dinner	Cereals	120 g	Rice	2 Cups
			Pulkas	2 Nos.
	Pulses	20 g	Dhal	1/2 Cup
	Vegetables	150 g	Veg. curry	3/4 Cup
	Milk (Curd)	50 ml		
	Vegetables	50 g		
	Fruit	100 g	Seasonal	1 Medium

1 Cup = 200 ml

Note: For Non-Vegetarians - Substitute one pulse portion with one portion of egg/meat/chicken/fish
Use 35 g visible fat per day.
Breakfast Items: Idli - 4 Nos. / Dosa - 3 Nos. / Upma - 1-1/2 Cup / Bread - 4 Slices/ Porridge - 2 Cups / Corn flakes with milk - 2 Cups.
Snacks: Poha - 1 Cup /Toast - 2 Slices /Samosa - 2 /Sandwiches-2 /Biscuits - 5.

SAMPLE MEAL PLAN FOR ADULT WOMAN (SEDENTARY)

Meal Time	Food Group	Raw Amounts	Cooked Recipe	Servings
Breakfast	Milk	100 ml	Milk or	1/2 Cup
	Sugar	10 g	Tea or	2 Cups
			Coffee	1 Cup
	Cereals	50 g	Breakfast Item	
	Pulses	20 g		
Lunch	Cereals	100 g	Rice	1 Cup
			Pulkas	2 Nos.
	Pulses	20 g	Dhal	1/2 Cup
	Vegetables	100 g	Veg. curry	1/2 Cup
	Vegetables	50 g	Veg. salad	7-8 Slices
	Milk	100 ml	Curd	1/2 Cup
Tea	Cereals	50 g	Snack	
	Milk	50 ml	Tea	1 Cup
	Sugar	10 g		
Dinner	Cereals	100 g	Rice	1 Cup
			Phulkas	2 Nos.
	Pulses	20 g	Dhal	1/2 Cup
	Vegetables	100 g	Veg. curry	1/2 Cup
	Milk (Curd)	50 ml		
	Vegetables	50 g		
	Fruit	100 g	Seasonal	1 Medium

1 Cup = 200 ml

Note: For Non-Vegetarians - Substitute one pulse portion with one portion of egg/meat/chicken/fish
Use 25 g visible fat per day.
Breakfast Items: Idli - 3 Nos. / Dosa - 2 Nos. / Upma - 1 Cup / Bread - 3 Slices / Porridge - 1-1/2 Cups / Corn flakes with milk - 1-1/2 Cup.
Snacks: Poha - 1 Cup / Toast - 2 Slices/Samosa - 2 / Sandwiches-2 /Biscuits - 5.

Recommended Dietary Allowances for Indians (1989)

Group	Particulars	Body wt	Net energy	Protein	Fat	Calcium	Iron	Vitamin A		Thiamin	Riboflavin	Nicotinic acid	Pyridoxin	Ascorbic acid	Folic acid	Vit. B_{12}
								Retinol	β-carotene							
		kg	kcal/d	g/d	g/d	mg/d	mg/d	µg/d	µg/d	mg/d	mg/d	mg/d	mg/d	mg/d	µg/d	µg/d
Man	Sedentary work		2425							1.2	1.4	16				
	Moderate work	60	2875	60	20	400	28	600	2400	1.4	1.6	18	2.0	40	100	1
	Heavy work		3800							1.6	1.9	21				
Women	Sedentary work		1875							0.9	1.1	12				
	Moderate work	50	2225	50	20	400	30	600	2400	1.1	1.3	14	2.0	40	100	1
	Heavy work		2925							1.2	1.5	16				
	Pregnant women		+300	+15	30	1000	38	600	2400	+0.2	+0.2	+2	2.5	40	400	1
	Lactation															
	0-6 months	50	+550	+25						+0.3	+0.3	+4				
	6-12 months		+400	+18	45	1000	30	950	3800	+0.2	+0.2	+3	2.5	80	150	1.5
Infants	0-6 months	5.4	108/kg	2.05/kg						55 µg/ kg	65 µg/ kg	710 µg/ kg	0.1			
						500								25	25	0.2
	6-12 months	8.6	98/kg	1.65/kg				350	1400	50 µg/ kg	80 µg/ kg	660 µg/ kg	0.4			
Children	1-3 years	12.2	1240	22			12	400		0.6	0.7	8	0.9		30	
	4-6 years	19.0	1690	30	25	400	18	400	1500	0.9	1.0	11		40	40	0.2-1.0
	7-9 years	26.9	1950	41			26	600	2400	1.0	1.2	13	1.6		60	
Boys	10-12 years	35.4	2190	54			34			1.1	1.3	15	1.6	40	70	0.2-1.0
Girls	10-12 years	31.5	1970	57	22	600	19	600	2400	1.0	1.2	13				
Boys	13-15 years	47.8	2450	70			41			1.2	1.5	16				
Girls	13-15 years	46.7	2060	66	22	600	28	600	2400	1.0	1.2	14	2.0	40	100	0.2-1.0
Boys	16-18 years	57.1	2640	78			50			1.3	1.6	17				
Girls	16-18 years	49.0	2060	63	22	500	30	600	2400	1.0	1.2	14	2.0	40	100	0.2-1.0

Source: Gopalan C., B.V. Ramasastri and S.C. Balasubramanian, 1991, Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad, India.

Food Groups and their major nutrients

Food group	Main nutrients
1. **Cereal grains and products:** Rice, Wheat, Ragi, Bajra, Maize, Jowar, Barley, Rice flakes, wheat flour.	Energy, Protein, Invisible fat, Vitamin-B_1, Vitamin-B_2, Folic acid, Iron, Fibre.
2. **Pulses and Legumes:** Bengalgram, Blackgram, Greengram, Redgram, Lentil (whole as well as dhals), Cowpea, Peas, Rajmah, Soyabean, Beans.	Energy, Protein, Invisible fat, Vitamin-B_1, Vitamin-B_2, Folic acid, Calcium, Iron, Fibre.
3. **Milk and Meat Products:** Milk, Curd, Skimmed Milk, Cheese, Chicken, Liver, Fish, Egg, Meat.	Protein, Fat, Vitamin-B_2, Calcium
4. **Fruits and Vegetables:** Fruits: Mango, Guava, Tomato, Papaya, Orange, Sweet lime, Water melon.	Carotenoids, Vitamin-C, Fibre, Invisible fat, Vitamin-B_6, Folic acid, Iron.
Vegetables: (green leafy) Amaranth, Spinach, Gogu, Drumstick leaves, Coriander leaves, Fenugreek leaves.	Carotenoids, Vitamin-B_2, Folic acid, Calcium, Iron, Fibre.
Other Vegetables: Carrots, Brinjal, Ladies finger, Beans Capsicum, Onion, Drumstick, Cauliflower.	Carotenoids, Folic acid, Calcium, Fibre.
5. **Fats and Sugar:** Fats: Butter, Ghee, Hydrogerated fat, Cooking oils like groundnut, Mustard, Coconut.	Energy, Fat, Essential fatty acids.
Sugar: Jaggery and sugar	Energy

Unit – 15 : Balanced Diet

Structure of Unit

15.0 Objectives

After reading this chapter, you should be able to

- know the balanced diet
- understand the three food groups as **carbohydrates** (starches and sugars) for energy needs, **proteins** for growth and repair, **fats** for

energy storage and insulation understand the importance of consuming a balanced diet

- recognize that people need different balances at different stages of their lives.
- know the various factors which influence our RDA and the difference between requirement and RDA
- classify foods into appropriate groups
- discuss the use of groups and RDA in planning balanced diets

. 15.1 Introduction

Carbohydrates, proteins, fats, vitamins, water & minerals are the six major nutrients in human nutrition. It is important to learn why the body needs these nutrients from which foods these nutrients, may be obtained and how the body utilises them for its normal functioning and development. It very essential to know as to how to get these nutrients in the right amounts in our daily diet. Too little intake of any of these might lead to various deficiency diseases. Too much intake of the nutrients is also likely to show symptoms of other diseases. Foods should be evaluated in terms of their total contribution of all nutrients. Similarly, a diet is evaluated in terms of the contribution of its nutrients and also how far can these nutrients meet the body requirements of an individual.

This is very essential to learn that the quantity and the quality of the food stuffs in the diet of people vary according to their age, sex and occupation. For instance, a baby (one year old) needs much less amount of food than a school child and a school child who is five years old needs less than a grown up man. Similarly, an adolescent girl needs less than an adolescent boy, and also a man doing hard physical work requires more food than another man who does only sedentary work.

Nutrients are needed by humans in specific amounts to ensure good health and well being. These nutrient needs are met by eating the right kinds and amounts of foods. But how does an individual know what the right kind and amount of food should be eaten. If a diet is planned and given to an individual with the correct kinds and proportions of different nutrients, and he or she is asked to follow it every day, it will become monotonous. Also, a diet which is acceptable to one individual may be acceptable to another individual for many different reasons such as food preferences, customs, food habits, age, economic reasons, and allergies. If you think it is just too much trouble to make some simple changes to improve your family's diet, think again. Most people do not realize the incredible impact that a healthy diet has on our bodies, making the difference between poor health and good health .Along with regular physical activity, a healthy diet is the most important factor that determines your weight. If you are overweight or obese, your chances of

developing many diseases or conditions, including heart disease, diabetes, high blood pressure, osteoarthritis, and certain cancers, increase significantly.

15.2 Balanced Diet

A balanced diet is one which includes a variety of foods in adequate amounts and correct proportions to meet the day's requirements of all essential nutrients such as proteins, carbohydrates, fats, vitamins, minerals, water, and fiber. Such a diet helps to promote and preserve good health and also provides a safety margin or reserves of nutrients to withstand short durations of emergency.

The safety margin takes care of the days on which we fast, or on a certain day all nutrients may not be consumed. If the balanced diet meets the RDA for an individual, then the safety margin is already as the RDA is formulated keeping extra allowances in mind.

A balanced diet takes care of the following aspects.

1. It includes a variety of food items.

2. It meets the RDA for all nutrients.

3. Nutrients are included in correct proportion.

4. Provides a safety margin for nutrients.

5. It promotes and preserves good health.

6. It helps maintain acceptable body weight for height.

Taking into account the foods which commonly form part of Indian diets, the balanced diets have been suggested for various age groups of the population.

A balanced diet may be based on various items of food derived from each of the food groups, namely, foods at supply energy, proteins, vitamins and minerals and foods that supply roughage as given in figure 1. Figure 1 shows the full picture of classification of foods in five groups.

15.2.1 Importance of balanced diet

Reasons Why It's Important To Eat A Balanced Diet

- It is essential for a healthy body and a healthy mind. **You are what you consume!**

- A balanced diet is important to maintain health and a sensible body weight. No single food will provide all the essential nutrients that the body needs to be healthy and function efficiently. A balanced diet should contain protein, fats, carbohydrates and fiber in the form of fresh vegetables and fresh fruit, all in the right amounts, providing you with a good supply of essential amino acids, essential fatty acids, vitamins, minerals, and of course fresh drinking water.

- In addition, the nutritional value of a person's diet depends on the overall mixture, or balance, of food that is eaten over a period of time, as well as on the needs of the individual. A diet that includes a variety of different foods is most likely to provide all the essential nutrients.

- In summary, if you do not get enough of one of the food groups, or an adequate supply of essential nutrients, it can result in
    1. failure to flourish
    2. poor growth
    3. poor development
    4. poor physical and mental health
    5. infections
    6. disease
    7. or even death.

Therefore, consuming foods in proportion to their nutritional value helps to prevent infections, disorders and disease. On the other hand, if you have *too much* of one of the food groups, such as refined processed carbohydrates, it can lead to other problems, such as

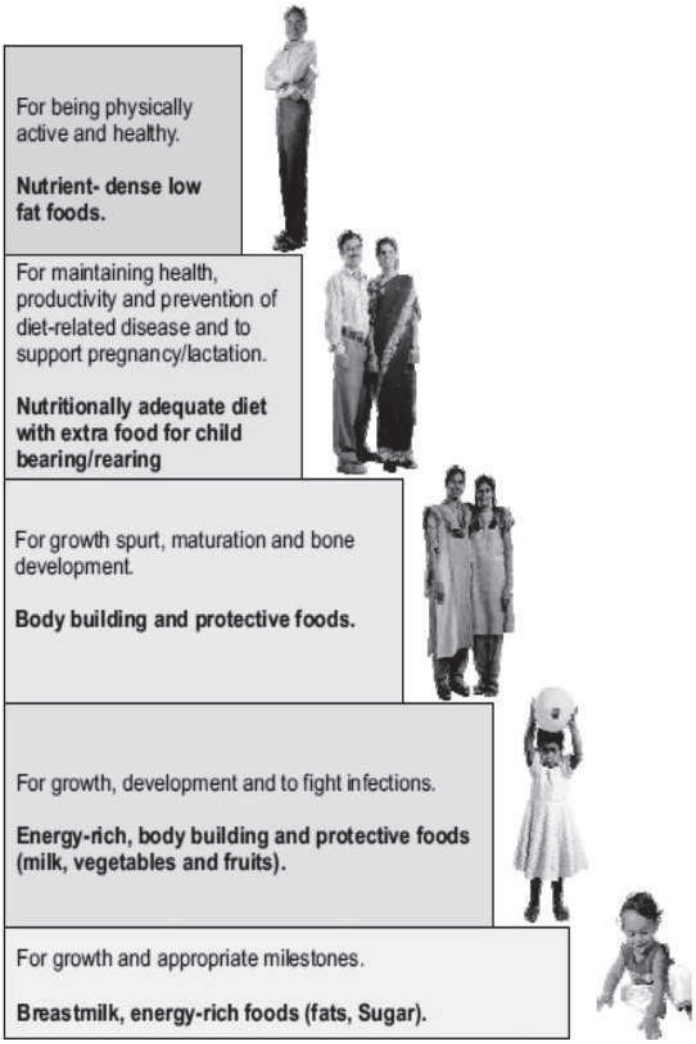
1. weight gain
2. insulin resistance
3. diabetes
4. obesity
5. heart conditions
6. many other diet related diseases
7. and death.

A balanced diet is one that provides the body with all the essential nutrients, vitamins and minerals required to maintain cells, tissues and organs as well as to function correctly. A diet that is lacking in nutrients can lead to many different health problems ranging from tiredness and lack of energy to serious

problems with the function of vital organs and lack of growth and development.

It is important to have a balanced diet meal because the diet helps us to achieve a long healthy life, controls body weight, heart rate and BP, Increases in exercise capacity and muscle performance and Improves blood sugar, lowers harmful cholesterol and triglycerides and increases the beneficial HDL cholesterol.

Importance of Diet during different stages of life



15.3 Basic Food Groups

One of the simplest ways to plan a balanced diet is to divide foods into groups. Foods are grouped on the basis of the predominant nutrients present in them. They may be classified into three, four, five, seven, or eleven food groups. This classification varies from one country to another depending on many factors. For example, in India we do not have milk and milk products or flesh foods as a separate food group because of religion, economic reasons, etc. The five food group classification is used in India as a guide to meal planning. Many factors have been considered while compiling these groups such as availability of food, cost, meal pattern, and deficiency diseases prevalent. Not all food in each group are equal in their nutrient content. That is why a variety of foods from each are group should be included in the diet.

A food group consists of a number of foods which have common characteristics. These common features may be the source of food, the physiological function performed, or the nutrients present.

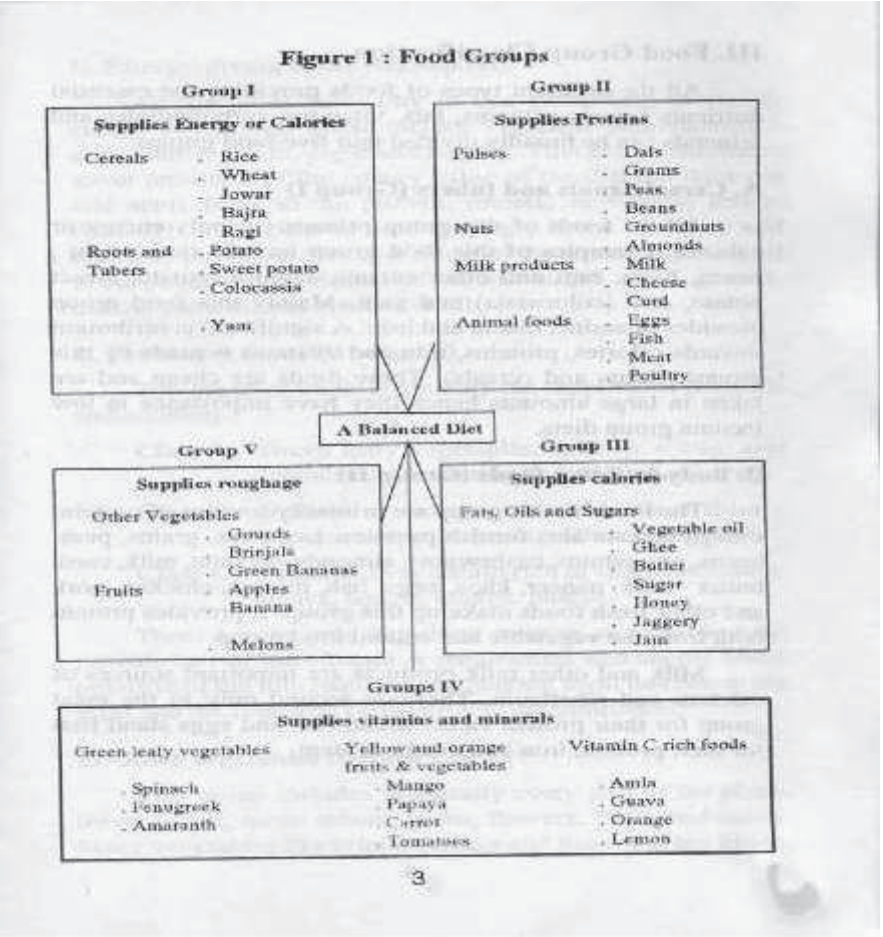
On the basis of the source of food, at least 14 groups can be identified, e.g., cereals, pulses, milk and milk products, eggs, flesh foods, nuts and oilseeds, sugars and sweeteners, fats and oil, root vegetables, green vegetables, fruits, condiments and spices, and miscellaneous foods. This does not simplify the planning of balanced meals.

A classification based on nutrients present will ensure that all nutrients are made available to the body and offer greater variety within the group.

There are five basic food groups.

1. Cereals and millets group
2. Protein or body building food group
3. Protective food group
4. Secondary protective food group
5. Fats and oils, sugar and jaggery group

Five basic food groups



15.3.1 Cereals and millets Group

This group includes all cereals and millets which form the staple diet for a large majority of Indians. The major nutrients proteins provided by this group are calories, protein, fiber, B- complex vitamins mainly thiamine, some minerals, and fibre. As the income decreases, the calories provided by this group increases.

The staple cereals consumed varies in different geographical areas and includes wheat, rice, maize, and millets such as jowar, bajra, ragi, and their products such as refined flour, semolina, broken wheat or dalia, parboiled rice, rice flakes or parched rice, puffed rice, popcorn, cornflakes, vermicelli, pastas, bread, and pizza. Other cereals are triticale, rye, oats, barely, etc.

One serving from this group is 30g of cereals /by- products of cereals and includes

1. A slice of bread
2. A medium phulka
3. Half cup cooked rice
4. Two poories
5. A bowl of breakfast

It is preferable to use two or more different cereals everyday, of which some should be whole grain for maximum nutritional benefits. Ragi is the only cereal which is rich in calcium and wheat is rich in iron as compared to rice .When cereals and pulses are consumed together in the same meal, the quality of protein increases dramatically.

At least six or more servings should be selected from this group. Each serving provides 2-3g of protein and 80-100kcal.

15.3.2 Protein or Body – building Food Group

This group includes both plant animal foods that are rich in protein, both quantitatively and qualitatively. All milk and milk products such as whole and skimmed milk, paneer, cheese, curds, buttermilk, milk powder, and mawa or khoa excluding butter or pure ghee which is included under fats and oils; pulses and their products, such as soya flour, tofu, soya grits, textured vegetable protein; meat, fish, poultry, game and organ meat, and eggs; and nuts and oilseeds such as groundnuts, sesame, and almonds.

A part from proteins, this group also provides B- complex vitamins, vitamin A, iron, and calcium. Animal proteins supply B12 and cholesterol.

One serving from this group is equal to 30g pulses, 1 egg, 40g mutton, or 1 cup of milk or curd. At least three serving should be included from this group daily.

The protein quality of a non-vegetarian diet is far superior to that a vegetarian diet, except when cereals and pulses are consumed together, the protein quality improves. Those who depend on pulses for meeting their protein requirement can improve the protein content of the meal by one or all of the following ways:

1. Including at least one serving from this group in every meal
2. Adding a small amount of animal protein in every meal
3. Combining cereals and pulses or cereals and animal protein
4. Including a variety of pulses, especially whole grain or split pulses with the husk
5. Sprouting pulses to increase availability of nutrients and provide vitamin C and B-complex vitamins speciallyB1,B2, niacin.

As a general rule, this group does not provide ascorbic acid or vitamin C to the diet. One serving from this group provides approximately 7g protein and 70-100kcal.

15.3.3 Protective Food Group

This group includes all vegetables and fruits that are rich in beta carotene and ascorbic acid. These nutrients increase the body's resistance to disease and protects the body against infection, hence the name protective, beta-carotene to vitamin A in the body.

The foods in this group are rich in carotenoid pigment which is orange or red colour to fruits and vegetables. In green leafy vegetables which are naturally rich in beta carotene, the orange colour of carotene pigment is masked by the green pigment of chlorophyll present in the leaf. Other rich sources are pumpkin, carrots, tomatoes, ripe jackfruit, mango, papaya, peaches, and apricots. This group also includes all citrus fruits such as oranges, sweet lime, grapefruit, lemon, guavas, amla, zizyphus, and pineapple which are rich in vitamin C.

Green leafy vegetables such as spinach, fenugreek leaves, radish leaves, amaranth, oniontops, colocasia leaves, drumstick leaves, mint, and cabbage are rich source of carotene. One serving from this group includes 50-70g of vitamin C rich fruit or vegetables which is equal to half a cup or one whole fruit in the case of citrus fruits or 100g green leafy vegetable.

Choose at least two servings from this group, one in the form of a green leafy vegetable and the other in the form of a vitamin C rich fruit which is uncooked. Apart from carotene and vitamin C, this group provides negligible amounts of calories, protein, fibre. Green leafy vegetables provide iron, calcium, and folic acid.

A serving from this group gives 25kcal and 1g protein.

15.3.4 Secondary Protective Group

All fruits and vegetables which do not come under the protective food group are included in this category. This group provides some carbohydrates, minerals, vitamins, and fiber to the diet. The main role of this group is to add variety to the diet. Fruits such as banana, chikoo, pears, grapes, melons, custard apples, apples, and apples are included in this group.

Vegetables such brinjal, cucumber, and lady's finger; all gourds such as ash gourd, bottle gourd, bitter gourd, ridge gourd, and sponge gourd; tender peas and all beans; and roots and tubers such as potato, onion, radish, and yam and colocasia are also included in this group.

One serving from this group is equal to 50-75g of vegetable or fruit which is half a cup of cut vegetables.

Two serving or more from this group should be included every day. One serving provides 25-50 kcal and 1 g protein.

15.3.5 Fats and Oils, Sugar and Jaggery

The foods in this group are a concentrated source of energy and mainly provide calories only. Some foods such as animal fats provide vitamin A and D. Vegetable oils provide essential fatty acids. Sugar provides only calories while jaggery and honey provide small amount quantities of minerals as well as.

This group includes sugar, jaggery, honey, molasses, and all forms of sugars as icing sugar, castor sugar, Demerara sugar, glucose, corn syrup, and all natural sweeteners. All foods which are present with the help of sugar such as jam, jellies, and marmalades are included in this group. One gram of sugar provides 4 kcal, and this energy is available quickly.

Fats and oils are a concentrated source of energy since one gram of fat gives 9 kcal. Hydrogenated fat, margarine, butter, cream, and clarified butter are sources of fat. Groundnut, coconut, sunflower, safflower, gingerly, rice bran, corn, soya, mustard, etc. Fats and oils should not exceed 30 percent of the total calories. This includes the visible fats in the diet. About 50 percent of fat intake should be from at least two or three vegetable oils to ensure consumption of essential fatty acids. 15-20 percent of total calories from fat is recommended.

The diet should provide approximately 25-30 g of sugar and 25 g of fats and oils per day. This amount will vary depending on the total energy requirement. One serving is one teaspoon sugar or 5 g sugar providing 20 kcal and one teaspoon or 5 g fat providing 45 kcal. This group does not provide any protein.

15.4 Guidelines for Using the Basic Food Group

1. Include at least one or a minimum number of servings from each group in each meal.
2. Make choices within each group as food within each group are similar but not identical.
3. If the meal is vegetarian, supplement vegetables proteins with suitable combinations to improve the overall protein quality of the diet. For example, serving cereal, pulse combinations or including small qualities of milk or curds in the meal.
4. Include uncooked vegetables and fruits in the meals.

5. Include at least one serving of milk to ensure a supply of calcium and other nutrients as milk contains all nutrients except iron, vitamin C, and fibre.
6. Cereals should not supply more than 75 percent of total calories.

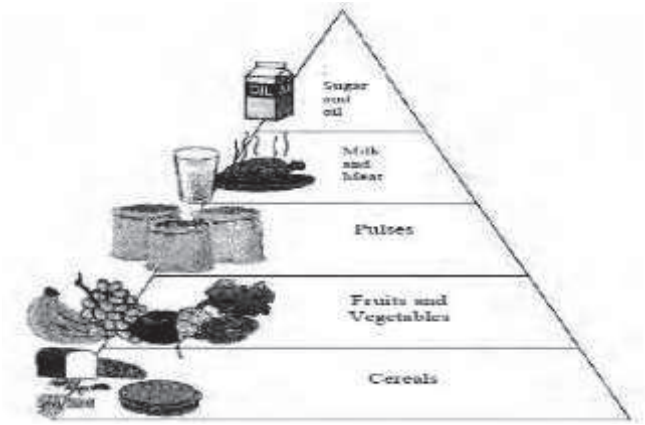
15.5 The Food Pyramid

Food pyramid is carefully drawn up plan of exactly what the human body needs nutritionally. It is a guide prepared by the United States Department Of Agriculture (USDA) which helps us plan our meals so that we get the correct amount of nutrients every day to keep us fit and healthy. The pyramid was designed to help us understand the concepts of variety, moderation and the inclusion of different types of foods in correct proportions in the daily diet. It does not have a set menu. In 2005 however, the food pyramid was updated and the two- dimensional food pyramid became three- dimensional. To show the added benefits of regular exercise, a figure running up a flight of stairs on the side of the food pyramid was added.

The earlier food pyramid had horizontal lines spanning the food pyramid with the food we eat the most at the bottom and the food that we should eat the least at the top.

Like the basic food groups, the food pyramid tells us what foods are included in the group, nutrients provided, the number of servings to be consumed per day and the size of each serving. The aim of using the pyramid is the same as the basic food groups.

Food Guide Pyramid



Source: Srilakshmi . B 2003.Dietetics, New Age International (P) Publishers Ltd.Chennai.

Bread, Grain, Cereals, and Pasta Form the Base

At the base of the food pyramid is the group that contains bread, grains, cereals and pastas. These foods provide complex carbohydrates, which are important sources of energy. 6 to 11servings of these foods in a day. One serving of this group can be

1 slice of bread, ½ cup of rice, cooked cereals or pasta; 1 cup of ready – to- eat cereals 1 flat tortilla

Fruits and Vegetables

Fruits and vegetables are rich in nutrients. Many are excellent sources of vitamin A, vitamin C, folate or potassium. They are low in fat and sodium and high in fiber. The food pyramid suggests 3 to 5 servings of vegetables each day. One serving of vegetables can be -

1 cup of raw leafy vegetables

½ cup of other vegetables, cooked or raw

¾ cup of vegetable juice

The food pyramid suggests 2 to 4 servings of fruits each day. One serving of fruit can be

1 medium apple, orange or banana, 1/2 cup of chopped, cooked or canned fruit

¾ cup of fruit juice, Count only 100 per cent fruit juice as a fruit, limit juice consumption.

Beans, Eggs, Lean Meat, and Fish

Meat, poultry and fish supply protein, iron and zinc. Non – meat foods such as dried peas and beans also provide many of these nutrients. The food pyramid suggests 2 to 3 servings of cooked meat, fish or poultry. Each serving should be between 2 to 3 ounces. The following foods count as one ounce of meat:

One egg, 2 tablespoons of peanut butter, ½ cup cooked dry beans, 1/3 cup of nuts

Dairy Products

Dairy products made with milk provide protein and vitamins and minerals, especially calcium. The Food Pyramid suggests 2 to 3 servings each day. If you are breastfeeding, pregnant, a teenager or a young adult age 24 0r under, try to have 3 servings. Most other people should have 2 servings daily.

1 cup of milk or yoghurt, one and half ounce of natural cheese, 1 ounce of process cheese

Fats and Sweets

A food pyramid's tip is the smallest part, so the fats and sweets in the top of the food pyramid should comprise the smallest percentage of your daily diet. The foods at he top of the food pyramid should be eaten sparingly because they provide calories but not much in the way of nutrition. These foods include salad dressing, oils, creams, butter, margarine, sugars, soft drinks, candies and sweet desserts.

The food guide pyramid can be extremely useful – whether you want to gain weight, lose weight or maintain your weight. Eating healthy diet simpler easier if you base your choices on the food pyramid.

The New Food Pyramid

The new food pyramid however, is completely different. Apart from that it has become three dimensional and has a figure climbing up side of it; the horizontal lines have been replaced by vertical lines starting from the tip of the pyramid and radiating downward.

The size of the section remains unchanged. Only in the new food pyramid, you now know that although you need to eat some food types more than others, even within those food groups there are some foods that you should only eat in moderation.

The new food pyramid is colour coded. The six coloured stripes denote the quantities of food you should consume. An orange stripe represents grain; a green stripe for vegetables ; a red stripe for fruits ; a yellow stripe denotes how much fats and oils you should have; a blue stripe for the milk and dairy products that allowed; and a purple stripe shows the quantities of meat, fish, beans, pulses that you should eat in a day.

Like the basic food group, foods are divided on the basis of their nutritive value in the pyramid. Today, the food pyramid is being replaced by a plate which health care professionals feel will be easier to follow and have a more positive impact on the nutritional status of the population.

The latest pyramid had six vertical stripes to present the five food groups plus oils. The plate features four sections (vegetables, fruits, grains, and protein) plus a side order of dairy in blue. The main message is that fruits and vegetables take up half the plate, with the vegetable portion being a little bigger than the fruit section.

And just like the pyramid where stripes were different widths, the plate has been divided so that the grain section is bigger than the protein section. Because nutrition experts recommended you eat more vegetables than fruits and more grains than protein foods.

The plate is simple and useful and helps an individual to view his or her own plate a little differently.

The aim is the same as the pyramid, to eat a variety of food groups at each meal. The plate can be used for breakfast, lunch, and dinner. If the breakfast does not include a vegetable, it could be included as a snack. Healthy, portion – controlled snacks are permitted.

The plate also shows how to balance your food groups. The protein section is smaller: You don't need as much from that group. Eating more fruits and vegetables will help one eat fewer calories overall, which helps you keep a healthy weight. Eating fruits and vegetables also gives lots of vitamins and minerals.

The divided plate also aims to discourage extra – large portions, which result in overeating and can cause weight gain.

15.6 Recommended Dietary Allowance (RDA)

While planning balanced diets, we need certain guidelines regarding the kinds and amounts of nutrients that we require for maintenance of good health. The allowance (RDA) is the guideline stating the amount of nutrients to be actually consumed in order to meet the requirements of the body. The RDA is based on requirements. The requirement for a particular nutrient is the minimum level that needs to be consumed to perform specific functions in the body and to prevent deficiency symptoms. It should also maintain satisfactory stores of the nutrients in the body.

Recommended dietary allowances are based on a person's requirements for different nutrients. In other words,

Recommended dietary allowance =Requirement+ Margin of safety

The margin of safety is added to take care of factors such as

1. Losses during cooking and processing
2. Short periods of deficient intake
3. Nature of the diet
4. Individual variations in requirements

For example, the requirement for iron in Western countries is 10mg for adult men and 15mg for adult women respectively, while Indian RDAs suggest an intake of 28mg for adult men and 30mg for adult women. This is because the form of iron consumed varies and the factors interfering with absorption of iron such as phytates in cereals and larger proportion of non-haeme iron present in Indian diet. The requirement for vitamin C or ascorbic acid is actually 20mg, but since the vitamin is easily destroyed during pre-preparation, cooking, and storage, the recommended intake is twice the requirement and is 40mg per day.

The RDAs apply to healthy individuals and are set enough to cover individu al variation. They are based on gender, age, body size, activity level, and special physiological state. Disease and drugs prescribed for treatment can alter the requirement for one or more nutrients.

15.6.1 RDAs estimation for specific nutrients

1. The RDAs are expressed in metric units such as kilocalorie (kcal), grams (g), milligrams (mg), and micrograms (ug).

2. They are based on gender and activity levels such as sedentary or light, moderate, and heavy.

3. The RDAs for B- complex vitamins B1, B2, and niacin are based on kilocalories or energy. The major role of these three vitamins is the release of energy from carbohydrates, proteins, and fats.

4. The RDA for B1 is 0.5mgper 1,000kcal, B2 is 0.55mg per1,000 kcal, and niacin is 6.6mg per1,000kcal.

5. The RDAs for protein are based on body weight. Adults need 1g per kg body weight while infants, children, adolescents, and pregnant and lactating mothers need more protein to meet the demands of growth and body building.
6. The RDAs, for practically all nutrients, increase during pregnancy and lactation to meet the needs of growing foetus during pregnancy and for production of milk during lactation. These additional needs depicted by a + sign in the RDA table take care of the physiological stress which results due to these conditions.
7. The RDAs for infants are expressed per kg body weight.
8. The RDAs for vitamin A expressed in terms of retinol (perform vitamin A) and beta – carotene (precursor or vitamin A). Beta carotene needs to be converted to vitamin A in the body. During this conversion certain losses occur and on an average only 25 percent are converted to vitamin A. The total vitamin A or retinol could be calculated using the formula given below:

Total vitamin A in ug = (ug of retinol+ ug of beta - carotene)/4

How much food each individual will need will depend on many factors which have been considered while computing the Recommended Dietary Allowances? Factors such as age, gender, and special physiological needs have been kept in mind. The RDA table gives us the quantity of different nutrients to be included in our daily diet. The second important factor we need to know to ensure the right selection of food is its nutritive value. Most foods contain more than a single nutrient.

These tables give us the percentage of important nutrients in the edible portion of all foods we consume. If we know the weight of the food we have consumed, we can calculate its nutritive value with the help of the food composition tables. This can be compared with the RDAs which will tell us whether our diet is nutritionally adequate or not. The RDA is a goal to be achieved and food is selected so that we reach the goal.

However, this process is time consuming and not at all practical as lengthy calculations is necessary. What is needed is a practical guide which can help individuals to select foods of their choice according to their nutritional requirements.

Since no single food provides all the nutrients in desirable amounts, and all foods differ in their nutrient content, it becomes necessary to divide food into groups to help us consume a balance diet.

15.6.2 RDA for various nutrients- Age, gender, physiological stage

Calories:

In estimating the calorie requirements, the following factors will have to be taken into account

1. Physical activity;
2. Body size and environment;
3. Age and sex;
4. Physiological state and
5. Climatic and environment

In view of the lower body size and warm climate prevalent in the tropical countries, the calorie requirements for the corresponding age groups are lower for persons living in India and other tropical regions as compared with those for persons living in temperate climate. The daily calorie requirements (Kcal) recommended by the Nutrition Expert Group I.C.M.R. is as follows:

Infants: (0-6 months) 120 / kg; infants (7- 12 months) 100 / kg

Children : 1 to 3 years- 1200; 4- 6 years, 1600; 7 to 9 years, 1800; 10 -12 years 2100.

Adolescents: Boys (13-15 years) 2560; (16-18 years) 3000

Adolescents: Girls (13- 18 years) 2200.

Adult males: 2400 -3900 depending on physical activity;

Pregnant woman: 2200, and Lactating woman 2600.

Proteins:

Proteins are required for maintenance, growth and in conditions of pregnancy and lactation. Periodical infections and infestations commonly prevalent among people living in the developing countries, decrease protein absorption and hence increase protein requirements. Physiological stresses like pregnancy and lactation also increase protein requirements. Protein requirements vary with the net protein utilization (NPU) of the dietary proteins. If NPU is low, the requirements are high and if the NPU is high, the requirements are low. The NPU of the proteins of Indian diets varies from 45 to 55, while that of Western diets containing liberal amounts of animal proteins varies from 60 to 70. The daily protein requirements of Indians of various age groups as recommended by the Nutrition Expert Group I.C.M.R. are as follows:

Infants- 0-6 months, 2.3-1.8g /kg.; 7- 12 months, 1.8-1.5g / kg ;

Children – age 1 -12 years 17- 14 g depending on age

Adolescents- Boys (13-18 years) 55 to 60 g

Adolescent – Girls 50g ;

Adult man- 55g;

Adult woman- 45g

Pregnant woman- 55g

Lactating woman -65g

Fat:

Fat provides the essential fatty acids such as linoleic, linolenic and arachidonic acids. Further, fats are essential for the absorption of fat – soluble vitamins like vitamin A, provitamin A (carotene) etc. Phrynoderma, nutritional

deficiency syndromes of the skin, is attributed to the dietary deficiency of the essential fatty acids. Excess of saturated fat and cholesterol consumption has been found to be associated with hypercholesterolemia and atherosclerosis in Western countries. The recommendations of the ICMR Nutrition Expert Group are as follows:

Adults- 10 percent of total calories in the diet from fat;

Adolescents- 15 percent of total calories in the diet from fat

Children (1- 11 years)- 15 percent of total calories in the diet from fat

Infants (birth 0- 1 year)- 30 percent of total calories in the feed from fat.

The dietary fat should be rich in essential fatty acids.

Calcium:

The utilization of dietary calcium in human subjects varies from 15 to 20 percent depending on age and physiological state. The daily calcium requirements recommended by ICMR Nutrition Expert Group are as follows:

Infants (0-1 year)- 0.5 to 0.6 g;

Children (1 to 12 years)- 0.4- 0.5g;

Adolescents- Boys and Girls (13- 15 years)- 0.6 – 0.7g;

Boys and Girls (16- 18)- 0.5- 0.6g;

Man and Woman- 0.4- 0.5g;

Pregnant and Lactating women 1.0g.

Phosphorus:

The requirements of phosphorus are closely related to those of calcium. It is generally agreed that phosphorus requirements are about 20 percent higher than calcium requirements. A large part of the phosphorus present in cereals, pulses and nuts is in the form of phytin. Only a small part of phytin phosphorus is available interferes with the utilization of dietary calcium and iron.

Iron:

Iron requirements are computed mainly by the factorial method. Iron lost in urine, sweat and menstruation is estimated. Iron requirements for growth are calculated from the iron retention in the body during growth .An average absorption of 10 percent of food iron is assumed in computing iron

requirements. The daily iron requirements recommended by ICMR Nutrition Expert Group are as follows:

Infants (0- 12 months): 1mg / kg

Children (1 -12 years): 15-20mg;

Adolescent –Boys (13-18 years): 25mg

Adolescent- Girls (13- 18 years): 35mg

Adult man: 20mg

Adult woman: 30mg

Pregnancy: 40mg

Lactation: 30mg

Vitamin A:

Vitamin A requirements are expressed in terms of retinol (vitamin A alcohol) or provitamin A (carotene). The recommended allowances of retinol (vitamin A) of ICMR Nutrition Expert Group are as follows:

Infants (0-12 months): 300-400 micrograms / day;

Children (1-3 years):250; 4-6 years: 300; 7–9 years: 400; 10-12 years: 600 micrograms/d.

Adolescent Boys and Girls: 75 micrograms / day;

Adult man: 750 micrograms / day;

Adult woman (including pregnancy) 750 micrograms / day

Lactating woman:1150 micrograms / day.

Thiamine:

The thiamine requirements are directly related to calorie requirements. The recommendations of the ICMR Nutrition Expert Group are 0.5mg /1000kcal. Thiamine allowances (mg / day) for various age groups are as follows:

Children 1- 3 years: 0.6; 4 - 6 years- 0.8; 7 – 9 years- 0.9;10 – 12 years-1.0

Adolescent – Boys, (13 -18 years): 1.3 -1.5

Adolescent Girls: (13 – 18 years) 1.1

Adult man: 1.2 -2.0

Adult woman: 1.0-1.5

Pregnancy woman: 1.2

Lactating woman: 1.4- 1.9.

Riboflavin:

Riboflavin requirements are directly related to the calorie requirements. The recommendations of the ICMR Nutrition Expert Group are 0.55MG / 1000 Kcal. The allowances (mg / day) for various age groups are as follows:

Children- 1- 3 years, 0.7; 4- 6 years, 0.8; 7- 9 years, 1.0; 10- 12 years, 1.2;

Adolescent – Boys, 13- 18 years, 1.4-1.7;

Adolescent –Girls, 13-18 years, 1.2;

Adult man- 1.3- 2.2;

Adult woman 1.0 -1.7;

Pregnancy, 1.2 -1.4;

Lactation, 1.4- 2.1.

Nicotinic Acid:

Nicotinic acid requirements are related directly to calorie requirements. The recommendations of ICMR Nutrition Expert Group are 6.6 MG / 1000 Kcal. In calculating nicotinic acid requirements, niacin derived from tryptophan should also be included at the rate of 1 mg of niacin / 60mg tryptophan present in the dietary proteins. The recommendation allowances of nicotinic acid (mg /day) are as follows:

Children (1- 3years), 8.0; (4- 6 years), 10.0; (7- 9 years), 10.0; (10- 12 years), 14.0;

Adolescent- Boys (13- 18 years), 17- 21;

Adolescent Girls (13- 18 years), 14.0;

Adult man: 15- 26;

Adult woman: 13- 20;

Pregnancy: 15;

Lactation: 18- 25.

Folic acid:

Folic acid requirements are expressed in terms of 'free' folic acid which is readily absorbed. Folic acid (free) allowances (micrograms / day) recommended by ICMR Nutrition Expert Group is as follows:

Infants (0- 12 months): 25

Children and adolescents: 50 – 100;

Man: 50

Woman: 100

Pregnancy: 150- 300

Lactation: 150

Vitamin B12:

Vitamin B12 occurs only in foods of animals origin while foods of plant origin do not contain this vitamin. For the absorption of vitamin B12, an intrinsic factor present in gastric juice is essential. The recommended allowances for vitamin B12 (micro grams / day) of ICMR Nutrition Expert Group are as follows:

Infants (Birth – 12 months): 0.2

Children and adolescent: 0.5 -1.0

Pregnant and Lactating women: 1.5

Vitamin D:

Vitamin D is essential for the absorption of calcium and phosphorus and for the formation of bones and teeth. Body needs of vitamin D are met partly from the vitamin D formed in the body by the exposure to sunlight in the tropical countries. The ICMR recommended allowance for vitamin D is 200 I.U. / day for all the age groups. This allowance in addition to that formed in the body by exposure to sunlight. Higher allowances 400I.U. have been recommended in Western countries.

RECOMMENDED DIETARY ALLOWANCES FOR INDIANS

(Macronutrients & Minerals)

Group	Particulars	Body wt. kg	Net Energy Kcal/d	Protein g/d	Visible 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	3 5
	Lactation 0-6 months		+600	77.9	30	1200	25
	6-12 months		+520	70.2	30		
Infants	0-6 months	5.4	92 Kcal/kg/d	1.16 g/kg/d	–	500	--
	6-12 months	8.4	80 Kcal/kg/d	1.69 g/kg/f	19		46 µg/ kg/day
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

RECOMMENDED DIETARY ALLOWANCES FOR INDIANS
(Vitamins)

Group	Particulars	Vit. A µg/d		Thiamin mg/d	Riboflavin mg/d	Niacin equivalent mg/d	Pyridoxin mg/d	Ascorbic acid mg/d	Dietary folate µg/d	Vit. B_{12} µg/d	Magnesium mg/d	Zinc mg/d
		Retinol	β-carotene									
Man	Sedentary work	600	4800	1.2	1.4	16	2.0	40	200	1	340	12
	Moderate work			1.4	1.6	18						
	Heavy work			1.7	2.1	21						
Woman	Sedentary work	600	4800	1	1.1	12	2.0	40	200	1	310	10
	Moderate work			1.1	1.3	14						
	Heavy work			1.4	1.7	16						
	Pregnant woman	800	6400	+0.2	+0.3	+2	2.5	60	500	1.2		12
	Lactation 0-6 months	950	7600	+0.3	+0.4	+4	2.5	80	300	1.5		
	6-12 months			+0.2	+0.3	+3	2.5					
Infants	0-6 months	--	-	0.2	0.3	710µg/kg	0.1	25	25	0.2	30	--
	6-12 months	350	2800	0.3	0.4	650µg/kg	0.4				45	-
Children	1-3 years	400	3200	0.5	0.6	8	0.9	40	80		50	5
	4-6 years			0.7	0.8	11	0.9		100		70	7
	7-9 years	600	4800	0.8	1.0	13	1.6		120		100	8
Boys	10-12 years	600	4800	1.1	1.3	15	1.6	40	140	0.2-1.0	120	9
Girls	10-12 years			1.0	1.2	13	1.6				160	9
Boys	13-15 years			1.4	1.6	16	2.0	40	150		165	11
Girls	13-15 years			1.2	1.4	14	2.0				210	11
Boys	16-17 years			1.5	1.8	17	2.0	40	200		195	12
Girls	16-17 years			1.0	1.2	14	2.0				235	12

15.7 Summary

Nutrients are needed in specific amounts to ensure good health and well-being. The nutrients needed by different age groups are mentioned in the RDA table. To enable us to consume these nutrients, food has been divided into five groups. These groups have been formulated on the basis of the nutrients present in them. If we select the number of servings recommended from each of the food groups, we can get a balanced meal. A balanced diet has all

nutrients in correct proportions and amounts to ensure good health and provide a margin of safety to take care of short periods of emergency. Food groups help us in getting a balanced diet. A choice must be made within each group since all foods in the group are not identical in nutrient content. The food pyramid and food plate have been designed to help us choose a healthy diet. A healthy balanced diet of these five food groups ensures essential vitamins, minerals and dietary fiber. The food group serving size will depend upon various factors like age, activity level, body size and gender. It is also important that one eat a variety of foods from within and across the food groups. As some foods from within a food group provide more nutrients than others.
This will ensure that one gets the maximum recommended nutrition from the food group; besides the food variety will make for an interesting meal.

In conclusion, it must be noted that allopathic medicine treats the symptoms rather than the root cause of the disease, which is usually caused by wrong eating habits leading to an accumulation of toxins within the system. Whereas a nutritious diet can rectify underlying causes of diseases and restore one to wholeness of mind and body. Once we realize the connection between a wholesome balanced diet and good health, our food will be our medicine and maintaining good health will be a matter of making the right food choices and leading a healthy lifestyle.

15.8 Glossary

- Activity level: Level of activity of a person, i.e., sedentary or light, moderate, and heavy. This is closely related to one's occupation.

- Balanced diet: A balanced diet is one which includes a variety of foods in adequate amounts and correct proportions to meet the day's requirements of all essential nutrients such as proteins, carbohydrates, fats, vitamins, minerals, water, and fiber. Such a diet helps to promote and preserve good health.

- Demerara sugar: Light brown sugar, a stage in sugar extraction.

- Food group: A classification based on nutrients present will ensure that all nutrients are made available to the body and offer greater variety within the group.

- Triticale Cereal: which is a cross between wheat and rye; used in breakfast cereals.

15.9 Practice Questions

1 List the five basic food groups giving four examples for each.

2. In which food group would you include the following:

   i. orange marmalade ii. Soft drinks

   iii. Orange juice iv. Nutri-nuggets

   v. French dressing

3. Explain how the use of food groups simplifies planning of balanced meals

4. Differentiate between the term RDA and requirement.

15.10 Reference Material

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Unit - 16 : Concept of Energy

Structure of Unit:

16.1 Introduction

Nutrition is defined as the processes by which an animal or plant takes in and utilises food substances. Essential nutrients include protein, carbohydrate, fat, vitamins, minerals and electrolytes. Normally, 85% of daily energy use is from fat and carbohydrates and 15% from protein. In humans, nutrition is mainly achieved through the process of putting foods into our mouths, chewing and swallowing it. The required amounts of the essential nutrients differ by age and the state of the body, for example: physical activity, diseases present (e.g. prostate cancer, breast cancer or weakened bones – known as osteoporosis), medications, pregnancy and lactation.

16.2 Objectives

- To avoid Diseases.
- To achieve/ maintain optimal health.
- To prevent illness and improving quality and length of life.

16.3 History of Energy Metabolism

Lavoisier who is called the "Father of Nutrition" laid the foundations for the basic principles of Energy Metabolism in the eighteen century through his discoveries of the important of oxygen gas in the process of combination. The period of the development of the concepts of energy metabolism, however, extended throughout the nineteen century with the work of many German scientists including Justus Von Libing and Max Rubner, yet the instruments used to measure the energy experiments of men and animal as well as the potential energy value of food products were only perfected in this century by men like Wilbur At water, Heney Aemsby, and other. Since this efforts Leonards Maynoard, Raymond Swift and other Scientists have advanced the knowledge of potential energy in foods and energy metabolism by obtained qualitative data on both.

Attention was diverted from work in the fields of energy metabolism when the first vitamins were discovered. Shortly before the First World War. During the period of the second world war, however when this country begin to help fee d the war distressed nations of the world as well as its own armies ,it became apparent that the available information on the energy composition substances and the energy needs of man was inadequate. In contrast to this an increasing awareness of the problems of overweight and obesity (caloric over nutrition) further stimulated the interest and focused attention on the need for new energy research. As a consequence there has been a broader study in this area of nutrition. There has been a reawaking of interest in energy metabolism during the past two decades.

16.4 Defination Of Energy And Contribution From Micro Nutrients

The capacity to do any work. Energy is required to do work and any sorts of work, which includes process that take place within our body

- Basically we need energy for voluntary and involuntary work.

- For maintenance of body temperature 984 degree Ferenhite).
- For the synthesis and removal of new tissues.

ENERGY TRANSFORMATION

Energy is the capacity to do work. The sum is the original sources of all energy, arising from nuclear reaction. Through the action of chlorophyll with sunlight, by the process known as Photosynthesis. Plant synthesize carbohydrates from carbon-di-oxide and water. The Carbohydrates stoud by the plants are then available as energy is desired from the plant and animal food. She or he eats Carbohydrates, fats and proteins are the energy yielding substances. In typical American diets Carbohydrates furnish 45 to 55 percent of the calories, fat 35 to 45 % and proteins about 15%.

FORMS OF ENERGY

Potential (storage) energy is continuously available in the body from the small amount of glycogen in muscles and liver, the sizable fat depots and the cellular mass itself. This potential energy is transformed to other forms to accomplish the work of the body.: for example mechanical energy for muscle contraction, osmotic energy to maintain the transport of fluids and nutrients ; electrical energy for transmission of nerve impulses ; chemical energy as in the synthesis of new compounds ant thermal energy for heat regulation.

Measurement Units, Calorimeter and Fuel factors:-

Kilocalorie:- By definition , A Kilocalorie (Kcal) is the amount of heat required to raise the temperature of 1 kg of water 1 degree Celsius (from 15 to 16 degree).

A calorie has been defines as the standard unit used to measured energy. The calorie used in nutrition is called the Kilocalorie or large calorie and is written with a capital letter (calorie or Cal.). This unit is one thousand times greater than the small calorie used in chemistry or physics.

"Calorie" is often used to describe the potential energy of food it is not a nutrient but rather a unit of measure of heat.

Joules:- The joule (J) is the unit of energy used in the metric system. By definition, 1J is the amount of energy expended when 1kg is moved a distance of 1m by a force of 1 newton; it is equal to 10^6 ergs. It is energy expressed in mechanical equivalents, not heat equivalents. The conversion of energy value of food composition table to joule will required sometimes. Students and practitioners in nutrition, however, must begin to think in terms of joules. The following factors apply for the interconversion of calories and joules:

1 calories (the unit used in physics)	=	4.184J
1 kcal	=	4.184 Kilojoules (KJ)
1000 Kcal	=	4.184 mega joules (MJ)
1KJ	=	0.240 Kcal
1MJ	=	240 Kcal

Thus, a dietary allowance of 2000 Kcal is 8368 KJ, or 8.368 MJ. For approximate calculation of factor 4.2 may be used instead of 4.184.

BOMB CALORIMETER:-

The fuel value of food is readily determined by means of an instrument known as Bomb Calorimeter. A weighed sample of dried food is placed in a heavy steel container called a “Bomb”. The bomb is held in place in a well-insulated vessel and is surrounded by a known volume of water. After the bomb is filled with oxygen, the sample is ignited and the heat is dissipated into the water. By note the calculate the energy value of the food by applying the definition for a calorie. The heat of combustion for the energy yielding nutrient is shown below:-

Physiological Fuel Factor:

Certain small losses occur in digestion so that it is necessary to reduce the value obtained in the bomb caloriemeter to those that are physiologically available. For the typical American diet the co-efficient of digestibility is 98% of Carbohydrate, 95% for fat and 92% for Proteins. In addition the end

product of protein metabolism such as urea and other nitrogenous products are combustible; their loss in the urine is equivalent to about 1.25 Kacl per gm protein. The Physiological fuel factor, first derived by At water are Carbohydrate and protein, per gram, 4 Kacl. (17 KJ); fat per gm, 9 Kcal; and Alcohol per Gram, 7 Kcal (29 KJ).

	Bomb	**Digestibility**	**Urinary**	**Physiological Value**
1g CHO	4.1Kcal	98%	-	4Kcal.
1g Protein	5.65Kcal	92%	1.2Cal/gm	4Kcal
1g Fat	9.45Kcal	95%	-	9Kcal

Physiological Value are Different Because: -

Absorption and Digestibility is not 100%.

In case of Protein the digestibility is least and there are some urinary losses also because some amino acids are deaminated and then it converts to urea is passed through urine. For calculation work we do not use bomb caloriemeter value. We use physiological Fuel value.

Specific Fuel Value: - Each food has a specific fuel values because it has a specific digestibility value in the body.

For example: Digestibility for the proteins in milk egg and meat is 97%, but for the protein of whole ground corn milk its digestibility is only 60%. Similarly digestibility of carbohydrates of whole wheat is 98%, but it is only 90% when whole flour is used.

Two methods can be used to measure energy requirement of the body.

1. Direct Caloriemetery Method

2. Indirect Caloriemetery Method

Direct Caloriemetery Method:-

It is the measurement amount of heat produce by the body in doing a particular activity. It is quite different to perform as in this the heat expenditure is measured like in bomb calorie meter. In this method the individual is placed in a especially in a chamber called a Respiratory calorie meter.

The chamber is so well insulated that no heat can either enter into or escape through walls. The room also have water pipes in which water flows and again the deficinate amount of water is flowing and the individual is asked to perform the activity in the room. The heat which is liberated in doing that activities as taken up by the water flowing and then we note the rise in temperature, we know the amount of water then by applying the def. we can calculate the value.

But there caloriemeter are very expensive to construct and required careful attention in carrying out the experiment. Hence they are used in few research centres.

Indirect Caloriemetery Method:-

This is more popular as it is sample to use apparatus is small and anybody can operate this. This is based on two assumptions.

1. For all the oxidative purpose O_2 is required.
2. This intake of O_2 is equal to CO_2 exhaled.

Various experiments have shown that 1lt of O_2 gives 4.825Kcal. So for calculating the energy required for any activity the total amount of O_2 consumed can be measured and then the energy requirement can be calculated.

For this we can use two different kinds of equipments:

1. Benedict's Roth Respirometer
2. Dougla's Bag

The difference between to it the benedict Respirometer measures the O_2 used in doing an activity.

In Benedict Roth method we have a oxygen cylinder and a tube is attached to the meter which records the amount of oxygen used and the mask is attached to person mouth and it uses the O_2 and we know the time and thus can measure the calories.

In Douglas we have the same apparatus but the CO_2 we exhale goes to the cylinder and we can calculated the amount of CO_2 used. And as we have CO_2 = O_2 then we can note the calories.

For eg: A man did cycling for 6 minutes using benedict's apparatus we know that O_2 used is 1400cc. And now we can calculate the oxygen required for 1 hour.

i.e. = 1400*10/1000 =14 liters of O_2

(We dividing by 1000 to convert cc into liter)

For measuring calories we multiply 14 by 4.825 Kcal. We get 68.55Kcal.

16.5 Factor Affecting Energy Requirement

It is affected by many factors such as:

1. BMR
2. Muscular activity
3. Mental Activity
4. Effect of Food (Specific Dynamic action of food or SDA)
5. Effect of Growth
6. Climate

16.6 Concept Of BMR (Basal Metabolic Rate)

The amount of energy required maintaining the body temperature, to carry out various cellular process and work of digestion and metabolism of food under specific condition is known as Basal Metabolic Rate. This includes the activities of various organs such as brain, heart, liver, kidneys, lungs, secretary activities of the glands. The peristaltic movement of the GI tract and the oxidation occurring resting tissues and the maintenance of muscles tone and body temperature. About 1/3 of this energy is used for the activities of organs. And remaining 2/3 is used for tissue oxidation processes in the resting period.

BMR can also be measured by indirect caloriemeter. The amount of O_2 consumed is measured in a given length of time. And then the calculation can be made but while measuring BMR, several factors must be kept in mind otherwise it will give faulty results and therefore BMR is always measured under controlled condition and standard condition has been setup and there are known as Basal conditions.

These Basal conditions are:

1. The patient should be post absorptive state i.e. after eating food 12-16 hours then. This is done to eliminate the influence of food and therefore the test is performed in morning before breakfast.
2. The patient should be reclining and revealed but awake because sleep reduces the metabolism by 10% while movements may increase the rate of oxidation. Half and hour to 1 hour rest before test.
3. Free from emotional upsets or fear of test itself.
4. Should be in a comfortable room environment.
5. The patient should be afebrile (no fever) as with each degree F rise in body temperature the BMR is increased by 7%

Supposing a Woman consumed 1200 cc of O_2 in a six minute test period.

Then for calculating BMR, we multiply 1200cc by 10 and for a whole day we multiply it by 24 and then divide it by 1000 to get the O_2 in liters.

1200ccX10X24/1000 = 288 lt. O_2 in 24 hours.

So 288X4.825 Cal= 1390 Kcal.

Experiment shown that BMR is 1 Cal per kg of weight of body per hour, thus the BMR of any normal Women is 1300 Kcal Per day and that of a Man is 1700 Kcal/ day.

Factor Affecting Bmr

The adult basal metabolic rate is approximately 1 Kcal (4.2KJ) per kg hour foe men and about 0.9 Kcal (3.8KJ) per kg hour for women.

1. Size, Shape and weight of the individual or Surface Area

   Surface area of an individual can be calculated by multiplying length X breath and we know that heat is continuously lost through the skin by radiation since the heat loss in proportion to the skin area or surface of the individual. A tall person has a greater surface area than a individual who has a same weight but is tall and fat, so BMR of a taller person is more than the latter person.

2. Sex and Body Composition

   The metabolic rate in women is about 6-10% lower in that of men. This is because women have more of adipose tissue in the body and the amount of activity muscle mass is less whereas man has more active muscular so they have more oxidation rate. Similarly an athlete who have greater muscles and lot of muscles have greater BMR. It is about 5% more than the normal person.

3. Age:

   The Basal Metabolism during rapid growth period is at a high level. The younger the individual higher will be his BMR per unit of body weight. In adults the rate of BMR is 1 Kcal per kg body weight per hour but in younger children this rate is much higher.

   a) Because the new tissues are being synthesis during growth period for which are need more energy.

b) The body surface area is also greater.

c) There is abundance of active tissues in infants and children.

4. Sleep:

During the sleeping hours the BMR is about 10% lower in the awaking state.

5. Body Temperature:

As the temperature increases BMR also increases. The tissues start distrusting catabolic rate increases and to repair the tissues the anabolic activities increases and thus BMR increases. External temperature has no effect on BMR because in any case temperature is brought down to normal in measuring BMR. And with each degree Ferenhite rise in temperature, BMR increased by 7%.

6. Endocrine Glands:

Thyroid gland plays a very important role and has a marked influence on the energy requirement of the body, Thyroid hormone regulate energy metabolism and it affects the rate of oxidation in the tissues, but in case it is hyper active as it happens in hyper thyroidism the metabolism in tissues will be faster. The rate of BMR will be increase to 75-100% and in hypothyroidism the body process and rate of oxidation will be much slower and BMR will be decrease to 30-40%.

a) Growth Hormones:

That stimulates the tissues formation are responsible for the higher metabolism that is seen in infants, younger children, and adolescent. They therefore increase BMR. An increase secretion of epinephrine that is synthesised by adrenal glands and it secrets when we are anxious, fear etc. may also increase the metabolic rate i.e. increase BMR. It is very momentary as it increases metabolism temporarily.

b) Disturbance of Pituitary Gland:

It can also modify metabolic rate. When girl have their menstrual cycle befor it the BMR decreases and then it further decreases before menses. Then it starts the BMR increases and it come to normal not very significant.

7. State of Nutrition:

An individual who has chronically under nourished is likely to have a lower metabolic rate. This is because of two reasons:

i. Due to adoptive mechanism of the body and (it decreases the BMR) if Calories are less.

ii. Because of less active tissues mass, not have active muscle of body as protein energy is less.

8. Pregnancy:

i. During the last trimester of pregnancy the BMR increases by 15-25%.

ii. In this time the anabolism activities is increases because of growth of foetus, memery glands and uterus, so action reduction increase.

iii. There are so many normal changes eg: growth hormone, sex hormone, thyroid hormone etc. so therefore BMR increases.

A. Physical And Muscular Activity:

Next to the basal metabolism, physical activities accounts for the largest energy requirements or expenditure. People who are vigorously active need much more energy than those who are less active or are sedentary worker. For eg. Nurses, labour, gardeners, mine workers, coolies etc. need more energy than officers, clerks, typists, teachers etc.

According to nature work can be divided into three categories:

i. Sedentary Work:- eg- Typists, Clerk, Teacher, Officers etc.

ii. Medium or Moderate Work:- eg- House wives, Gardeners, Nurses, Doctors etc.

iii. Heavy Work:- eg- Coolies, Farmer, Factory Worker, Miners, Digging etc.

Calorie Expenditure in Various Kinds of Activities:

Type of Activities	Cal/ hr.
1. Sedentary work Reading, Writing, Eating, TV, Radio Listening, Serving, Playing cards, Typing, Office Work and all other activities done While sitting and required no arm movement.	80-100 Kcal/ hr.
2. Light Work Preparing and cooking food dish washing, dusting washing small articles, ironing, walking slowly, personal care mislleneous office work and other activities which are done while standing an requires some arm movement. (Rapid typing)	110-160 kacl/hr
3. Moderate work Making bed, mopping and scrubbing, sweeping, light polishing and waxing. Laundering by machine, light gardening, carpentry work. Walking moderately, fast activities done whi le standing that requires moderate arm movement and activities done while sitting but required more rigorous arm movement.	170-240 kcal.
4. Vigorous Work	250-350 Kcal/hr.

Heavy scrubbing and waxing and polishing, hand washing of big articles. Walking fast bowling or games, golfing and gardening. 5. Strenuous Work Swimming, Playing tennis, running, bicycling, dancing, sketing, playing football, all workers.	350 and more Kacl/hr.

Energy Expenditure for many activities has been calculated in adults and children by Benedict's Roth Respirometer. And the data help in setting up of standards for energy for various ages:-S

Normally Women weighing 120 pounds (54 kg) she spends energy like this:

Awake lying still	56 kcal/hr
Sitting qurelerly	72 kcal/hr
Typing rapidly	102kcal/hr
Dish Washing	104kcal/hr
Sweeping	122kcsl/hr
Brisk Walking	217kcal/hrs
Swimming	362kcal/hr

Thus if we have a record of all the activities for a Men 24 hours, it is possible to estimate the daily caloric requirement of that individual but such calorie are very time consuming and at best they give only rough approximation of work done or energy requirement.

B. Mental Activity

In doing mental activity nervous system is involved and it is continuously working and its energy requirement is 20% of BMR. But

some People need more energy beyond basal rate for doing mental efforts. Specially those who become more tensed and anxious.

Eg: In exam, on solving problem, facing interview etc.

16.6 Effect of Food/Caloriegenic effect of food/ Specific Dynamic Action of Food (SDA)

Ingestion of food results in an increase the heat production Known as Caloriegenic effect of food or dietary induced thermogenesis. Traditional it has been refferd to as the Specific Dynamic Action of food (SDA) or Specific Dynamic Effect. It may be related in part to the digestion and absorption of food, increased heat production also occur when nutrients are given intravenously thus suggesting that stimulating of cellular metabolism may be prime importance. Protein when eaten alone has been shown to increase the metabolic rate by 30%, whereas carbohydrates and fats produce much smaller increase on the basis of mixed diets usually eaten, the Caloriegenic effect of food is approximately 10% to the total energy requirement.

C. Effect of Growth

Growth affects the total calorie requirement whenever new tissues is being synthesised, the calorie requirement is increased and when growth is rapid, the energy requirement is higher. Eg. Infancy; if we see the per kg value energy requirement,1 kg body weight then energy required for a child is much higher for infants or child as compared to an adult.

Adult Requirement- 35-40 kcal/kg body weight

Infants Requirement- 100-130 kcal/kg body weight

Tsherefore new tissues is synthesised rate of oxidation increase needed BMR is high.

Similarly during pregnancy, lactation, If more tissues destroys in fever, surgery etc. conditions where new tissues is being synthesised the energy requirement is increased.

D. Effect Of Climate

Under normal condition, the temperature of body is controlled by the amount of blood brought to the skin. Vasodilation of blood vessels occurs when environment temperature is high and vasoconstriction occurs when the temperature of outside is low. During winters most of the heat is lost by radiation or convection and in summers the body heat is lost through evaporation and it is well known that more heat is lost by evaporation when the air is dry, than when it is humid. During cold weather the body temperature is maintained by an increase in involuntary and often voluntary activity. We are more active in winter and lazy and lethargic in summer.

The blood vessels construct so that less blood reaches the skin. The muscles become tense and are shiner. There involuntary activities result in increased metabolic rate and more heat is produced.

We are more active, energetic and eat more in winters, so requirement of energy in cold weather for maintaining body temperature, involvement of activities.

During summers to reduce heat one should eat less, also during summers, person is lazy, can't function more so need less food.

16.6 THERMIC EFFECT OF FOOD:

The thermic effect of food (TEF) is the increase in energy expenditure associated with the construction of food. The TEF accounts for appropriate 10% of the TEE. The TEF is also refferd to as diet induced thermogenesis (DIT). Specific Dynamic Action (SDA) and the specific effect of food (SEF). TEF can be separated into obligatory and facultative or (Adaptive) Subcomponents. Obligatory thermogenesis is the energy required to digest,

absorb and metabolise nutrients, including the synthesis storage of protein, fat and Carbohydrate.

Speciy foods enhance and prolong the effect of TEF Meals with chilli and mustard may increase the metabolic rate as much as 33%more than 3 hours. Caffeine and nicotine also stimulate the TEF. When ingested every 2 hours for 12 hours, the amount of caffeine in one cup of coffee (100mg) has been shown to increase the TEF by8% to 11%. Nicotine has a similar effect.

16.7 Dietary Sources Of Energy

Energy Rich Foods:

Basically Carbohydrates and fats are the energy rich macronutrients. These includes: Whole grains cereals, millets, vegetables oils, ghee, butter, nuts and oil seeds and Sugars. Besides Energy, Cereals and millets also provides proteins, fibre, minerals, calcium, iron and B-complex vitamins whereas Fats provide fat soluble vitamins, essential fatty acids, nuts and oilseeds contains proteins, vitamins and minerals.

16.8 Concept Of Energy Balance

The body is in energy balance when the calorie supplied by food is exactly equal to the energy needed for all the involuntary and voluntary activities of the body. Weight is neither gained nor lost.

The primary problem of malnutrition is obesity. Its prevention required balance of energy intake and energy output. When the calorie expenditure is less than 1800-2000kcal. It is difficult to include all nutrients at recommend levels –especially for some of the trace elements. Thus more appropriate to increase exercise than it is to decrease calorie intake below 2000 if the goal is weight maintenance.

Health Hazards Associated With Overweight And Underweight

1. **Obesity:-** Obesity is a state in which there is a generalised accumulation of excess adipose tissues in the body leading to more than 20% of the desirable weight. Overweight is a condition where the body weight is 10-20% greater than the mean standard weight for age, height and sex. 0besity invites disability disease and premature death. Excess body weight is a hindrance, leading to breathlessness on moderate excretion and predisposes a person to diseases like atherosclerosis, high blood pressure, stroke, diabetes, gall bladder. Disease and osteoarthritis of weight bearing joints and various veins. Obesity is a chronic disease.

TREATMENT

Strategies for weight loss and weight maintenance are:-

- Diet Therapy
- Physical Exercise
- Stress Management
- Pharmaco Therapy
- Weight loss Surgery
- **Diet Therapy:-**

    i. **Very low calorie diet <800kcal:**

    Although more weight is initially lost on very low calorie diets, more is usually regained. Rapid reduction does not teach behaviour changes. Patient on very low calorie diet have increased risk for developing gallstones. Very low calorie diet (400 to 800 Kacl) can be used safely in extremely obese. Individuals (greater than 50% overweight) when under the case of physician and registered dietician.

ii. Reducing Diet:

Calorie restriction for weight reduction is the safest most efficient method. One pound of body fat is equivalent to 3500 kcal; therefore intake must be reduced by 500 kcal daily to produce a loss of one pound of body fat weekly (500 kcalX7 days- 3500kacl.). A calorie deficit of 1000 kcal /day is required to lose 2 pounds of body fat weekly. This is the maximum weekly weight loss recommended since a more restrictive diet may not be nutritionally adequate.

Loss of weight on low calorie Diet

BMI	Less cal/day	Weight loss/week	Weight loss in 6 month
27.35	300-500	0.5kg	10% wgt. loss
>35	500-1000	0.5-1kg	10% wgt. loss

Principle of Dietetic Management:-

Low calorie, normal protein, vitamin and mineral (except sodium) restricted Carbohydrate, restricted fat and libral fluid, high fibre diet are given in such case.

1. Energy: About 20 Kacl per kg ideal body weight is prescribed for a sedentary worker and 25 Kacl for moderately active worker.
2. Proteins: About 0.8-1kg protein/kg body weight is prescribed for tissue repair and for specific dynamic action

3. CHO: High CHO content foods like potatoes and rise are restricted. Sugar which gives empty calories should be totally avoided. Fruits rich in CHO like banana should be avoided.

4. Fat: Low fat or no fat diet should be given as calories are reduced. Food rich in fat like nuts and oil seeds avoided. Skimmed milk should be the choice.

5. Vitamins: With prolonged restriction of fats, there is likely to be a restriction of fat soluble vitamin A and D which may be supplemented.

6. Minerals: Restriction of sodium as common salt is helpful in weight reducing diet as excess sodium predisposes to retention of fluid. Calcium may depress certain hormone which consequently improves the body's ability to break down fat in cell and slow fat production.

7. Fluid: Fluid can be taken liberally as extra fluids are excreted by healthy kidneys. Also a glass of water befor meals helps to cut down food intake.

8. High Fibre: High fibre low calorie food like green leafy vegetables, fruits, vegetables, salads, whole grain cereals pulses can be included in the diet. Inclusion of high fibre foods in diet for obese has many advantages. They are:

    a. Low in calorie density

    b. Foods like greens provide many vitamins and minerals(which are different to meet with restricted food)

    c. Give satiety

    d. Help in regulating bowel movement.

    e. Reduce blood cholesterol

f. Promote chewing and decreases rate of ingestion.

Higher intake of fibre automatically cut down fat and calorie.

- **PHYSICAL EXERCISE**

Physical exercise is extremely beneficial in weight management because it helps to regulate appetite, increase the basal metabolic rate and reduce the fat deposit "Set point" level. Exercise also helps to reduce stress related eating since it provides physical outlet for working off the hormones physiological events produced by stress in the body.

- **STRESS MANAGEMENT:**

Stress is a major reason for over eating and relapse some example includes diaphragmatic breathing, deep muscle relaxation, mediation, yoga and physical activity. These techniques provide a distraction to the stressful event and may be helpful in alleviating myriad health related problems.

3. UNDERWEIGHT

A person who eats little for long period looks emaciated and shows underweight. Living habitually on an inadequate diet epically of protein result in low body weight. Underweight also results from debilitating diseases like tuberculosis, diabetes, malaborption syndrome or cancer. Infections are common among them. In these cases tonics are not useful as they only help to improve the appetite but they do not increase weight.

Psychological factors may contribute to eating very little food (anorexia nervosa). Some patients reject food leading to sever weight loss. Anorexia Nervosa is seen in girls between the age of 15 to 25years. Usually it arises from a desire to lose weight.

Underweight occur in people who are active, tense nervous and who never take rest. Their working efficiency is poor and the productivity is less. They cannot work continuously for a long period.

DIETARY MODIFICATIONS: -

A high calorie, high protein, high fat diet with libral vitamin intake is recommended.

1. **Energy:-** The calorie requirement vary depending upon the activities, for increasing weight the total Calorie intake should be in excess of the energy requirement. An additional 500kcal/day is recommended

2. **Proteins:-** Instead of 1g of protein, over 1.2g/kg recommended for tissue building. Good quality protein is completely utilised by the body and as far as possible best protein sources must be liberally included in the initial stage.

3. **Fats:-** Even through fat content is increased easily digestible fats are to be included. Fried and fatty foods are not recommended as they may cause diarrhoea. Fatty food should not be taken at the beginning of a meal as they reduce appetite. High calorie fatty foods such as cream, butter, margarine and oil helps to increase the weight.

4. **CHO:-** High CHO sources must from the basis of the diet. Leafy vegetables should be restricted preference to be given to potato and yam. Dried fruits, sweet. Nuts, desserts, jam, jelly, cereals, cereal products and nonvegetrian foods are rich sources of energy and can be easily or liberally included in the diet. The number of meals should be increased. Two feeds incorporating soups, juices or sweets in between major meals improve the nutritive value of the diet.

5. **Vitamins and Minerals:-** With a liberal diet there is no need for extra vitamins and minerals supplements.

6. **Fluids:-** Fluids should not be taken before or with a meal but only after a meal so that food intake is not reduced. Enough fluids must be taken so as to avoid constipation.

16.9 Need For Introducing Nutritionaly Balanced And Health Specific Diets

A balanced diet is one which includes a variety of foods in adequate amount and correct proportion to meet the day's requirement of all essential nutrients such as protein, Carbohydrates, fats, vitamins, minerals, water and fibre. Such diet helps to promote and preserve good health and also provides a safety margin or reserve of nutrients to with stand short duration of emergency.

The safety margin takes care of the days on which we fast, or on a certain day all nutrients may not be consumed. If the balanced diet meets the RDA for individual, than the safety margin is already included as the RDA is formulated keeping extra allowances in mind.

A Balanced Diet Takes Care Of The Following Aspects

1. It includes a variety of food items.
2. It meets the RDA for all nutrients.
3. Nutrients are included in correct proportion.
4. Provided a safety margin for nutrients.
5. It promotes and preserves good health.
6. Maintains acceptable body weight for heigh
7.
8. t.

16.9.1 Critical Evaluation Of Fast Food

- Urbanisation has increased the intake and demand for processed foods.
- There is a trend replacing traditionally cooked foods with processed foods.
- A processed food contains a variety of food additive.
- Processed food may not be nutritionally balanced unless fortifies.
- Sugars, a processed food, provides empty calories

Frequently consumption of fast foods or processed food will be depress appetite, thereby reducing the consumption of normal nutrition diet. Apart from not being nutritious, processed food also contains various food additives. Food additives consumed beyond permissible limits may have adverse effect on health. The national food regulatory authorities periodically review these limits. It is important to remember that even small amount of different additives, when obtained through a variety of processed foods, can subsequently contribute to the burden of foreign chemicals in the body. When various processed foods are consumed regularly as a part of our daily diet, there is a danger of the level of intake of these additives going beyond the specified safe level, which could result in a health risk to the consumer.

16.9.2 Summary

1. Energy values in nutrition are expresses as kilocalories or kilojoules. The kilocalories (1,000 times the small calorie) expresses energy in heat units. The kilojoules expresses energy in mechanical units. One kilocalorie is equal to 4.184 kilojoules.
2. A calorie is the same whether it comes from carbohydrates, fats and proteins. Carbohydrates and proteins furnish 4 Kcal (17KJ) per gram and fat 9 Kcal (38KJ) per gram.
3. Weight for weight, foods that are dry or greasy are relatively high in calories; for example cereals, cookies, cakes, pastries, sweets, butter,

fatty meats. Food that have a high concentration of water are much lower in calories; for example, fruits and vegetables.

4. The basal metabolism is the amount of energy the body uses at rest. It ranges from about 1300 to 1700 Kcal (5.4 to7.1MJ) for adults and account for about half or more of the total calories needed by the average Indian.

5. The body is in energy balance when the calories supplied by food are exactly equal to the energy needed for all the involuntary and voluntary activities of the body. Weight is neither gained nor lost.

6. If the calorie intake is greater than the body needs, weight is gained, and if the calorie intake is less than body needs weight is lost.

16.9.3 Review Questions

1. Define or explain what is meant by calorie; joules; calorimeter; bomb caloriemeter; respiration caloriemeter; indirect Caloriemetery; heat of combustion; physiologic fuel factor; basal metabolism; resting metabolism.

2. What are the standard conditions for performing a basal metabolism test? What factors might make the basal metabolism of two adult individual of the same age vary? How does age itself affect the basal metabolism?

3. Explain how the following factors affect the total energy requirement: muscular activity; food; climate; clothing; growth; muscle tension; endocrine secretions. Which of these has the greatest effects.

4. Why would you except the calorie requirement of many poor people to be higher during cold weather than that of people in better economic circumstances?

5. What is the best indication of adequate calorie intake?

6. One serving of Pudding provides 30g Carbohydrates, 10g Fats and 20g Proteins. Calculate the calories provided by two such servings.

7. How are the fuel values of food estimated? Explain any two methods.

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Unit - 17: Introduction to Food Laws and Regulation

Structure of Unit

17.1 Introduction

Food Standards have been formulated in the interest of the public, to protect them from consuming improperly handled food and thereby prevent food borne illnesses form spreading. There are several acts and regulations that are in force. In any given area, local health authority ensures that these acts are followed.

Violation of these acts is against the law and any person who fails to comply with codes may have to pay a heavy fine or undergo prosecution. The food operator has a lot to gain by cooperating with the regulatory agencies and conforming to the rules laid down by them.

17.2 Objectives

- Protection of public Health.
- By ensuring food safety.
- To impart knowledge to the students on various acts, rules, regulations, standards, orders and laws related to food articles governing their manufacture, import, export, storage, distribution and sale.

17.3 National- Pfa And Essential Commodities Act (Fpo, Mpo Etc.)

Effective means of food quality can be achieved by legislative measures, certification schemes and public participation and involvement in the programme.

The government of India is fully aware to the possibilities of food being adulterated. It has therefore, empowered several agencies and promulgated a number of acts order to control this menace. Agencies and instruments have also been created to lay down packaged is also covered by a number of regulations.

PREVENTION OF FOOD ADULTRATION ACT (PFA ACT)

One of the early acts to be promulgated in this connection was the Prevention of Food Adulteration Act of 1954, which has been in force since June 1, 1955. The objective of act was to ensure that food articles sold to the customers are pure and wholesome. It also intended to prevent fraud or deception and encourages fair trade practices. The act was amended in 1964, 1976 and again in 1986 in the light of experience gained, to plug loopholes of escape in the act to insure stringent punishment for those indulging in this nefarious practices. The act prohibits the manufacture, sale and distribution of not only adulterated food but also foods contaminated with microorganism and toxicants and misbranded foods. P.F.A. also specific microbes standards for pasteurised milk, milk powder, skimmed power, skimmed milk powder, infants milk power, tomato sauce, jam, malted milk food and afltoxin for ground nut etc.

A central food laboratory established under the act is located at Calcutta for the purpose of reporting on suspected food products. The central Food Technological Research Institute, Maysore, has been recognised as another laboratory for the testing of adulterated foods for the Southern Regions. "A central committee for food standards" has been constituted under the Act and has been charged with the function of advising the central Government on matters relating to the Food standards. Provision has been made in the Act for the appointment of Food Inspector by the state Government and their powers have been defined. The State Government will set up food testing laboratory and will appoint Public Analysis with adequate staff to report on suspected foods.

According to the Prevention of Food Adulteration Act, an article of food shall be deemed to be adulterated.

1. If the article sold by a vendor is not of the nature, substance or quality demanded by the purchase and is to his prejudice, or id not of the nature, substance of quality which it purports or is represented to be.

2. If the article contains any other substance which affects, or if the article is so processed as to affect injuriously the nature, substance or quality thereof.

3. If any inferior or cheap substance has been substituted wholly or in part for the article, so as to affect injuriously the nature, as substance or quality thereof.

4. If any constitute of the article has been wholly or in part abstract so as to affect injuriously the nature, as substance or quality thereof.

5. If the article had been prepared, packed or kept under unsanitary conditions whereby it has been contaminated or injurious to health.

6. If the article consists wholly or in part of any filthy, putrid, disgusting, rotten decomposed or diseased animal or vegetables substance or is insect- infested or otherwise unfit for human consumption.

7. If the article is obtained from a diseased animal.

8. If the article contains any poisonous or any ingredients which renders its contents injurious to health.

9. If the container of the article is composed, whether wholly or in part of any poisonous or deleterious which renders its contents injurious to health.

10. If any colouring matter other than that prescribed in respect thereof and in amounts not within the prescribed limits of variety is present in the articles.

11. If the article contains any prohibited preservative or permitted preservative in excess of the prescribed limits.

12. If the quality or purity of the article falls below the prescribed standard or its constituted are presented in quantities which are in excess of the prescribed limits of variability.

ADMINISTRATIVE HIERARCHY

The Food health authority is appointed at state level who is the Director of public Health and Preventive Medicine. He is responsible for the good quality and standards of foods available to the consumers. Under FHA, there is a Local Health Authority appointed in each city, in every state. The Food Inspector is appointed by the Central or State Government by notification in official gazette. The Food Inspector undergoes a three month training in food inspector and sampling.

POWER OF FOOD INSPECTER

1. To take sample of any article form

    a) Any person selling such articles

    b) Any person who is in the course of delivering or preparing to deliver such article to a purchase or consignee.

    c) A consignee after delivering of any such article to him.

2. To send as sample for analysis to the Public Analyst (PA) of l ocal area. When the Food Inspector wants to lift suspected food, the

shopkeeper must first be told. There should be witness present, where the Food Inspector lifts the sample. 150g of the sample is necessary to be sent for analysis. 600g of sample is collected usually and sent to Ripon Buildings, corporation of Madras, or Kings Institute Guindy, Madras or Central Food Laboratory, Calcutta or Central Food Technological Research Institute, Mysore. There is a sampling procedure to collect the samples and then they are sealed it in a bottle. The sealed bottle has a label on it which has the code number of the Inspector address of the shop or location and date and time of the collection are written.

When individual doubt adulteration in food stuffs, they have to inform the Food Health Authority. Samples can be sending for analysis only after getting order from Health Authority. If persons are found guilty of selling such adulterated food, the persons involved can be convicted. Severity of sentence would depend on the gravity of the offence. For example, a vendor found adulterating the food with ingredients injurious to health would be liable for much heavier sentence than a vendor involved in only mixing an inferior not injurious to health.

ESSENTIAL COMMODITIES ACT, 1954

The main objective of this Act is to maintain supply of essential commodities to the public by proper regulation, prevention of black market and making it available to the public at a reasonable price. A number of control orders have been formulated under this Act. Some of them are-

- Fruits Products Order(1955)
- Sugar Control Order(1966)
- Meat Product Control Order(1973)
- Cold Storage Order (1980)
- Vegetable Oil Product Control Order(1988)
- Milk and Milk Product Order(1992)
- Edible Oil Packaging Order(1998)

FRUIT PRODUCT ORDER

The Government of India promulgated a Fruit order in 1946. In 1955, the order was revised. The Fruit Product order (FPO) lays down statutory minimum standard in respect of the quality of various fruit and vegetable products and processing facilities. Packaging fruits and vegetables of standard below the minimum prescribed standards is an offence punishable by law. Periodic inspection by government inspectors in registered

establishment is carried out to ensure conformity of standard by processors.

Manufacture of fruit and vegetable product can be carried out only after a valid licence is issued by the licencing officers after himself satisfying with regard to the quality of product, sanitation, personnel, machinery and equipment, work area as required in the order.

This order is operated by the Food and Nutrition Board of the Ministry of Food Processing Industries. Licensee is empowered to put the FPO standard mark on the product.

MEAT PRODUCT ORDER

This makes it illegal to transport meat unless it has been prepared and processed according to the provisions of the order and carries the mark of inspection.

It provides means to:

a) Delete and destroy meat of diseased animals.

b) Ensure that the preparation and handling of meat and meat products be conducted in a clean and sanitary manner.

c) Prevent the use of harmful substance in meat foods.

d) See that every cut of meat inspected befor sale to ensure its wholesome.

The order also lays down rules and conditions for procedure to be adopted for the selection of disease-free animal, slaughter house practices for further treatment of the meat so as to maintain the meat in a wholesome manner, devoid of pathogens.

COLD STORGE ORDER (1980)

The Cold Storage Order, 1980, promulgated under the essential Commodities Act, 1955, has the objective of ensuring hygienic and refrigeration conditions in a cold store, regulating the growth of cold storage industry and rendering technical guidance for the scientific preservation of food stuff in a cold store and prevents exploitation of farmers by cold store owner. Agricultural Marketing Adviser to the Government of India is the licensing officer under this order.

In addition to the mandatory acts and order cited above, agencies such as Bureau of Indian Standard, the Directorate of Marketing and Inspection have also laid down quality standard for foods. These are, however voluntary.

BUREAU OF INDIAN STANDARD

The Bureau of Indian Standard is laid for vegetable and fruit product, spices and condiments, animal product and processed foods. Once these standards are accepted, manufactures whose products conform to these standards are allowed to use BIS label on each unit of their laboratories at Delhi, Bombay, Calcutta, Madras, Chandigarh and Patna or in number of public and private recognised by them. The certificate scheme is basically voluntary in character but for a number of items affecting, it has been made compulsory by the Government of India through various statutory measures such as E.C. Act or PFA rules.

Some of the items which required compulsory BIS certification under PFA are:

- Food colours and food colour preparation
- Nature food additives
- Infants milk food
- Infant formula
- Milk cereal based weaning food
- Milk powder
- Condensed milk

THE AGMARK STANDARD

The word "AGMARK" is derived from Agriculture Marketing. The AGMARK standard was set up by the Directorate of Marketing and Inspector of the Government of India by introducing an Agriculture produce Act in 1937. The words "Agmark" seal ensure quality and purity. A sample AGMARK seal is given below:

AGMARK BESAN
SL. NO. B-162002
GRADE-STANDARD
PLACE OF PACKAGING
DATE OF PACKAGING
NET WEIGHT
THIS LABEL IS THE PROPERITY OF THE GOVERNMENT OF INDIA.

A lot of care is taken in laying down the AGMARK grade and in affixing the AGMARK quality label. The quality of a product is determined with reference of the size, variety, weight, colour, moisture, fat, content and other factors are taken into account. The

act defines quality of cereals, spices, oil seeds, oil, butter, ghee, legumes and eggs and provides for the categorisation of commodities into grades depending on the degree of purity in each case. The grades incorporated are grades 1, 2, 3 and 4 or special, good, fair and ordinary. The standards also specify the types of packaging to be used for different products. The physical and chemical characteristics of production are kept in mind while formulating the AGMARK specifications.

The Directorate of Marketing and Inspection of Central Government has 21 laboratories and 50 sub officers spread all over the country. The central AGMARK Laboratory at Nagpur continuously carries out research and development works in this field.

Grading of commodities like ghee, butter, vegetables oil, spices and honey is voluntary. On the other hand, grading of commodities like tobacco, walnuts, spices, basmati rice essential oils, onions, potatoes are means for export compulsory under AGMARK ensures the quality to the importers.

EXPORT INSPECTION COUNCIL

The council has been constituted to check the quality of a number of food material meant for export. The council has powers to reject any food which does not measure up to standard prescribed for the food. Canned food such as mango juices, frozen food such as shrimp, pomferts are subjected to scrutiny by this body before export.

17.4 INTERNATIONAL C ODEX ALIMENTARIUS

FAO/WHO Food standard programme is called CODEX ALIMENTRIUS. The codex Alimentrius which means “Food Law” or “Food Code” I Latin is combines set of standards, codes or practices and other model regulation available for countries to use and apply to food the international trade.

The duel objectives of the codex Alimentrius commission are to protect the health of consumers and facilitate and international trade.

Codex commodity standard covers such as fruit juices, cereals, meat products etc. General standards cover areas application to most foods such as labelling, additives, contaminants, methods of analysis. It covers aspect such as food hygiene and technological practices. They are used by processors to ensure that are food are microbiologically safe and are fit for human consumption e.g., codex code of hygiene practice of low-acid canned foods. Maximum Residue Limits (MRLS) have been set for pesticides.

Specification for "Food Grade Quality" of additives form an important part of codex work.

17.5 International Organisation For Standardization (Iso)

The International Organisation for Standardization (ISO) is a worldwide federation of national standards bodies from more than 140 countries, one from each country.

ISO is a non- governmental organisation established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. ISO's work results in international agreements which are published as International Standards.

ISO 9000 AND ISO 14000

The ISO 9000 and ISO 14000 families are among ISO's most widely known and successful standard ever. ISO 9000 has become an international references for quality requirement in business to business dealing, and ISO 14000 looks set to achieve at least as much, I f not more, in helping organisations to meet their environment challenges.

The vast majority of ISO standards are highly specific to a particular, material, or process. However, the standards that have earned the ISO 9000 and ISO 14000 families a worldwide reputation are known as "generic management system standards". "Generic" means that the same standard can be applied to any organisation, large and small whatever its product- including whether its "Product" is actually a service- in any sector of activity, and whether it is a business enterprise, a public administration, or a government department. "Management System" refers to what the organisation does to manage its processes, or activities. "Generic" also signifies that no matter what the organisation is or does, if it wants to establish a quality management system or an environment management system, then such a system has a number of essential features which are spelled out in the relevant standards of the ISO 9000 and ISO 14000 families.

ISO 9000 is concerned with "quality management". This means what the organisation dos to enhance customer satisfaction by meeting customer and applicable regulatory requirements and continually to improve its performance in this regards. ISO 14000is primarily concerned with "environment management". This means what the organisation does to minimize harmful effects on the environment caused by its activities, and continually to improve its environmental performance.

Both ISO 9000 and ISO 14000 concern the way an organisation goes its work, and not directly the result of this work. In other words, they both concern processes and not products- at least, not directly. Nevertheless, the way in which the organisation manages its processes is obviously going to affect its final product. In the case of ISO 9000, it is going to affect whether or not everything has been done to ensure that the product meets the customer's requirements. In the case of ISO 14000, it is going to affect whether or not everything has been done to ensure a product will have the least harmful impact on the environment, either during production or disposal, either by pollution or by depleting natural resources.

The earlier three standards ISO 900, ISO 9002 and ISO 9003 have been integrated into the new ISO 9001:2000

17.6 World Tr ade Orgsnization (Wto)

The World Trade Organisation came into being in 1955. One of the youngest of the international organisations, the WTO is the successor to the General Agreement on Tariffs and Trade (GATT) established in the wake of the Second World W ar. While the WTO is still young, the multilateral trading system that was originally set up under GATT is well over 50 years old.

The past 50 years have seen an exceptional growth in world trade. Merchandise exports grew on average by 6% annually. Total t rade in 2000 was 22 times the level of 1950. GATT and the WTO have helped to create a strong and prosperous trading system contributing to unprecedented growth.

The system was developed through a series of trade negotiations, or rounds, held under GATT. Th e first rounds dealt mainly with tariff reductions but later negotiations included other areas such as anti-dumping and non-tariff reductions included Uruguay Round- led to the WTO's creation.

The WTO's overriding objective is to help trade flow smoothly, freely, fairly and predictably. It does this by:

- Administering trade agreement
- Acting as a forum for trade negotiations
- Settling trade disputes
- Reviewing national trade policies
- Assisting developing countries in policy issues, through technical assistance and training programmes.
- Cooperating with other international organisations.

10 BENEFITS OF THE WTO TRAIDING SYSTEM

1. The system helps promote peace.

2. Disputes are handled constructively.
3. Rules make life easier for all.
4. Freer trade cuts the costs of living
5. It provides more choice of products and qualities.
6. Trade raises incomes.
7. Trade stimulates economic growth
8. The basic principles make life more efficient
9. Government are shielded from lobbying
10. The system encourages good government.

The WTO agreements cover goods, services and intellectual property. They spell out the principle of liberalization, and the permitted exceptions. They include individual countries commitments to lower tariffs and other trade barriers, and to open and keep open services markets. They set procedures for setting disputes. They prescribe special treatment for developing countries. They required government to make trade policies transparent. And they share a common three-part structure.

17.7 COSUMER PROTECTION ACT, 1986

The main objective of the Act is to promote and protect the rights of the consumer, with regard to defective goods, deficiency of services, overcharging or any unfair trade practices.

Complaints can be referred to the District consumer redressed forum. The forum can order the opposite party for removal of the defect, replacement of the goods, return of the prices or charges or order payment of the compensation for the loss or damage suffered due to deficiency of services. Appeals can be made to state commission and then to the National Commission.

In India, consumer awareness about the various aspects of the prevention of food Adulteration Act is lacking. If consumer cooperation is not forthcoming, controlling adulteration would prove to be an uphill task.

17.8 Summary

The function of the regulatory agencies is to ensure the wholesomeness of food and maintenance of sanitary conditions during its preparation, service, transportation or storage. These agencies work in the interest of the public and prevent the spread of food-borne illnesses. The regulatory and advisory agencies of the government recommended standards and administer controls that directly or indirectly affect all food operators. The medical officer health is the food authority or local authority for municipal corporations. He or she is

assisted by food inspectors are analysed in the state public health laboratories to check whether they conform to the set standards.

To control food quality, and to prevent adulteration and misbranding of food, various standards have been laid down for different food commodities. The legislation that most directly affects the food handlers is the PFA Act, 1954 and Rules 1955, which have been modified and updated from time to time. All food service operators required a permit or licence to manufacture, stock, sell or distribute food. This licence is issued by the local health authority. Hotels and restaurants are graded on the basis of rules formulated by the municipal corporation called the Municipal heath Laws. Licence may be suspended or cancelled if rules and conditions specified in the licence are not observed.

17.9 Review Questions

1. List the points put forth by PFA act according to which an article of food is considered adulterants.
2. What are food standards? Discuss the various food standards and their nature.
3. What are BIS standards? How are they useful to us?
4. Describe "AGMARK" in maintaining standards of food.
5. What is FPO? Explain its function.
6. Describe the Consumer Protection Act. List the agencies engaged in consumer protection and their scope of work.
7. What is WTO? List the Benefits of the WTO Trading system.

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Unit - 18: Hygiene And Sanitation In Food Sector

Structure of Units

18.1 Introduction

Everyone who works with food is responsible for ensuring that consumers are protected from contaminated food and the risk of food poisoning, which causes extreme discomfort, absence from work or school and, in some cases, death. People get sick from food poisoning because the food they've eaten has contained bacteria, viruses or chemicals. It can take from an hour to a few days to develop food poisoning, depending on the cause, and the best way of preventing food poisoning is to use safe food handling practices. Bacteria are the biggest problem, because they are so common, and are found in soil, on animals, people and even clothes. In the kitchen, bacteria often come from vegetables and raw meat. Sometimes these bacteria can move from raw ingredients to cooked food, in a process called cross contamination.

18.2 Objectives

- To raise awareness of key food hygiene issues and to employees with an introduction to food hygiene.
- To address the growing need to make learning more relevant to specific business environment and meet the National Standards.
- To provide through understanding of food hygiene procedures emphazing the importance o monitoring staff and controls.

- To provide participants with basic understanding on Good Manufacturing Practices to ensure the finished products met the same requirements.
- To make the students aware on “Food hygiene principles and concepts ” and practices

18.3 Principle of food Hygiene

The word sanitation comes from the Latin word sanitas, which means “health”. Sanitation means creating and maintaining hygienic and healthful conditions. It is an applied science and relates physical, chemical, biological and microbial principles to food, the environment and health. Sanitation is more than just cleanliness. Food or chemicals that can cause illness or food spoilage.

Sanitary practices and hygienic conditions are becoming more and more important because food is being processed, prepared and sold in larger volumes than before. Some microorganism cause food spoilage and food-borne illness, but others are beneficial in food processing and preparation. Sanitation can reduce the growth of microorganism on equipment and dirt on food. This can reduce the contamination of food by microorganisms that cause food-borne illness and food spoilage. Sanitary principles also apply to waste disposal and can help reduce pollution and improve ecological balance.

A sanitation program is a planned way of practicing sanitation. The benefits of a good sanitation programme include the following:

- Compliance with statutory regulations.
- Preventing food-borne illness outbreak.
- Improving quality and shelf life of foods.
- Reducing energy and maintenance costs.
- Increasing quality and confidence.

18.4 Ghp For Commodities, Equipments, Work Place And Personnel, Cleaning And Disinfection

SOURCE OF FOOD CONTAMINATION

The raw material itself is the most common source of contamination. For example, the muscles of healthy animals are nearly free of microorganism while alive as its white blood cells and antibodies control infection. These mechanisms are, however, lost during slaughter whereby microorganisms first reach the meat if contaminated knives are used to bleed animals. Since the blood is still circulating, it quickly carries these microorganisms throughout the animal's body. In case of poultry, microorganisms are easily spread from one carcass to another during

de-feathering and evisceration (removal of intestine). Thus the ingredients including spices can carry harmful or potentially harmful microorganisms and toxins. The amount and types of these microbes and toxins depends on where and how the ingredient was harvested and how the ingredient was processed and handled.

EQUIPMENT:

Equipment can be contaminated during production and while it is not being used. While equipment may be designed to be hygienic, it still can collect microorganism and other debris if not cleaned regularly and thoroughly. Therefore, it is necessary that an appropriate cleaning programme is developed and implemented. Whenever, equipment cannot be removed, Cleaning-in-place system should be implemented.

PERSONNEL:

Besides the foreign objects, the most common source of microbial contamination in foods is the employees. The hands, hair, nose and mouth carry microorganism that can be transferred to food during processing, preparation, packaging and services by touching, breathing, coughing, or sneezing. Therefore, sanitary practices such as hand washing, use of hairnets and disposable plastic gloves are essential.

AIR AND WATER:

Water is used for cleaning and as an ingredient in many processed foods. However, if the water is not pure, it can contaminate foods. If the water source is contaminated it should be treated by suitable means.

INSECT AND RODENTS:

Food and food waste attract flies cockroaches to kitchens, foodservice operations, food processing facilities toilets and garbage. The insets transfer dirt from contaminated areas to food through their waste products; mouth, feet, other body parts and saliva. Rats and mice carry dirt and diseases with their feet, fur and faeces. They transfer dirt from garbage dumps and sewers to food or food processing and food service areas. It is vital that an appropriate pest management system is developed and implemented.

SEWAGE:

Raw, untreated sewage carries high microbial load and may contaminate water, food or equipment through faulty plumbing. If raw sewage drains or flows into drinking water lines, wells, rivers, lakes and ocean bays, the water and seafood will be contaminated. To prevent this kind of contamination, toilet facilities and septic tanks should be separated from wells, stream and other water sources.

CLEANING:

Cleaning compounds are made for specific jobs, such as washing floors and walls or use in high- pressure dishwashers. Good cleaning compounds are economical, easy to measure, and dissolve well. They are approved for use on food surfaces, are not corrosive, and do not cake, leave dust, or break during storage.

Different cleaning compounds work well for different areas and different types of equipment. When choosing a cleaning compound, it is important to

consider the type of soil (dirt), the water supply, how the cleaning compound will be used, the area and the kind of equipment being cleaned.

CLEANING AGENT TERMS:

The hygiene personnel need to understand the following terms used to describe cleaning compounds:

- **Chelating agent** (sequestering agent or sequestrate): Chemical added to cleaning compounds to prevent the salts of calcium and magnesium in hard water from forming deposits on equipment surface.
- **Emulsification:** Breakdown of fat and oil drops into smaller droplets that are disperse in the cleaning solution. The soil still there, but the practices are smaller and are dispersed in the solution, rather than settling on the surface.
- **Rinsibility:** The ability of a cleaning compound to be removed for a surface without leaving a residue.
- **Surfactant:** A complex molecule that is blended with a cleaning compound to reduce the energy of the bonds around the soil and allow closer contract between the soil and the cleaning compound.
- **Suspension:** The process of loosening lifting and holding soil practices in solution.
- **Water Hardness:** The amount of inorganic salts (such as calcium chloride, magnesium chloride, sulphates and bicarbonates) in water.
- **Water Softening:** Removes or inactivates the calcium and magnesium ions in water.
- **Wetting (penetration)** Caused by a surfactant that allows the cleaning compounds to wet or penetrate the soil and loosen it from the surface.

TYPES OF CLEANING AGAENT:

Most cleaning agents used in the food industry are blended products. Manufacturers combine ingredients to make a specific product for a particular type of surface or dirt.

The following types of cleaning agents are used most often in food service facilities and processing plants:

a) **Alkaline Cleaning Agents:** Alkaline cleaning solutions have a pH between 7 (neutral) and 14 (most alkaline**).** There are several types of alkaline cleaners viz.

- **Strongly alkaline cleaners:** These cleaners have strong dissolving power and are very corrosive. If these cleaners come in contact with skin they can cause burns, ulcers and scarring; prolonged contact may cause permanent damage. Inhaling the fumes or mist damages the lungs.

  An example of a strongly alkaline compound is sodium hydroxide (caustic soda), which destroys microbes, dissolve proteins, and is good dispersing and emulsifying soil.

  Silicates make sodium hydroxide less corrosive, better at penetrating soil, and better at rinsing away soil. These cleaner are used removed heavy soil, such as those in commercial ovens and smokehouse, but they are not good at removing mineral deposits.

- **Heavy-Duty Alkaline Cleaners:** These compounds have moderate dissolving and are either slightly corrosive not corrosive at all. However, if they are in contact with the skin for long, they may remove necessary oils from the skin, leaving it open infection.

  These cleaners are often used for cleaning in place or high pressure or other mechanized system. They are very good at removing fast but do not remove mineral deposits. Sodium carbonate is quite low in cost, is widely used in heavy-duty and

manual cleaning procedures, and is used to buffer cleaning compounds.

- **Mild Alkaline Cleaners:** Mild alkaline cleaning solutions such as sodium bicarbonate are used to clean lightly soiled areas by hand. These compounds are good at softening water but do not remove mineral deposits.

b) Acid Cleaning Agents:

Acid cleaning agents remove materials that are dried on or encrusted surface and dissolve mineral scale. They are especially good at removing mineral deposits formed by alkaline cleaning compounds. When hard water is heated above 80 degree Celsius, some of the mineral are deposited. These deposited stick to metal surface and leave a rusty or whitish scale. Acid cleaners dissolve the minerals in the deposits so that they can be easily removed.

Organic acids (such as citric, tartaric acids) are also excellent water softeners, rinse off easily and do not corrode surface or irritate the skin. Inorganic acids are excellent at removing and controlling mineral deposits, but they can be very corrosive to surfaces and irritating to the skin Acid cleaning compounds are used for special purpose rather than for all- purpose cleaning. Acid cleaning agents are less effective than alkaline ones against the soil caused by fats, oils and proteins.

- **Strongly Acid Cleaners:** These agents corrode concrete, most metals, and fabrics. Heating some acid cleaners produces corrosive, toxic gases, which can damage the lungs. Strongly acid cleaners remove encrusted surface matter and mineral scale from steam equipment, boilers and some food-processing equipment. When the solution is too hot, the mineral scale may redeposit and form a tarnish or whitish film on the equipment being cleaned.

- Phosphoric acid and hydrofluoric acid both clean and brighten certain metals. However hydrofluoric acid is corrosive to stainless steel and dangerous to handle because it tend to release hydrogen gas. Phosphoric acid is more used as it is not very corrosive and works well with many surfactants.

- **Mild Acid Cleaners:** These agents are slightly corrosive and may cause sensitively reaction some acid cleaners attack skin and eyes. Examples of mildly acid cleaning agents are hydroxyacetic, acetic, and gluconic acids. Organic acids are good manual cleaners are expensive than the other acid cleaning compounds, and can soften water.

c) Solvent Cleaners:

Solvent cleaners are based in ether or alcohol. They work well on soil caused by petroleum products, such as lubricating oils and greases. Most of the time, food establishment use alkaline cleaners to remove organic soils. But they use solvent cleaners to remove large amount of petroleum deposits in areas free of proteins- based and greasy soils, i.e. in the maintenance shop and on motors, gear boxes, pallet trucks, and fork trucks. Solvent cleaners may be mixed with wetting agents, water softeners, and other additives.

d) Soap And Detergents:

Soaps and detergents emulsify fats, oils and grease so that they are easily washed away. Soaps and detergents usually contains chemical builders to make them clean more effectively. Soap and detergents for household cleaning have a pH of 8 to 9.5.

e) Choosing A Cleaning Agent:

It is important to choose the right cleaning agent for the type of soil. A good rule to remember is that like cleans like. Therefore, an acid soil requires an acid cleaner, while an alkaline cleaning agent works best to remove an alkaline soil. Alkaline, general purpose cleaning agents

work best to remove organic soils. Heavy-duty alkaline cleaning agents work best for heavy deposit of fats and proteins (organic soils). Acid cleaning agents remove mineral deposits (inorganic soil) and other soils that are not removed by alkaline cleaning compounds. Phosphates complex with organic chlorine are the most common types of cleaner-sanitizers.

SANITIZING:

The cleaning removes the soil deposits. Sanitizing on the hand, destroys microbes that are left on the cleaned surface. If the surface is still dirty, the soil protects the microbes form sanitizing agents. Therefore, the equipment and surface must be thoroughly clean for sanitizers to work properly.

The major types of sanitizers are:

HEAT:

Heat is an inefficient sanitizer because it takes so much energy. The efficiency of heat depends on the humidity, the temperature required and the length of time it takes to depends on the humidity, the temperature required and the length of time it takes to destroy microbes at the temperature. Steam and hot water are the most common types of heat used for sanitization (sterilization). However, sanitizing with steam is expensive because of high energy costs. Hot water (heated to 82^{o} C or higher) immersing is a good way to sterilize clean small components viz. knives, tougs, spoons, and utensils. The time needed to sterilize an item depends on the temperature of water. If equipment or surfaces are sterilized at lower temperature, they must be kept at heat temperature for longer duration. If they are sterilized for a shorter duration, the temperature must be higher. This is known as “time-temperature relationship”. Examples of time and temperature combination used for sterilization are 15 minutes eat at 85^{o} C or 20 minutes at 82^{o} C.

RADIATION:

Radiation in the form of ultraviolet light or energy cathode or gamma rays destroys microorganisms. It, however, is not entirely effective in food

processing and food service facilities as the light rays must actually hit the microorganism and therefore kills only the microorganisms that are very close by. Further, some bacteria are more resistant to radiation and need a longer exposure for the radiation to destroy them. Moreover, dust, grease and opaque or cloudy solutions absorb radiation prevent it from killing microbes.

CHEMICALS:

Food processing and food service operations use various chemical sanitizers for different areas and types of equipment. The effectiveness of chemical sanitizers depends on:

- **Exposure Time:** Colonies of microbes die in a logarithmic pattern i.e. if 90% of microbes die in 10 minutes, 90% of the remaining microbes die in next 10 minutes and so on. Therefore, in this example only 1% of the original number of microbes is still after 20% minutes.

- **Temperature:** Chemical sanitizers kill microorganism more quickly at higher temperatures. While bacteria also grow quickly when temperature is moderate and warm but higher temperature usually speed up their death more than their growth, so that overall microbes die more quickly at higher temperatures.

- **Concentration:** Sanitizers at higher concentration kill microorganisms more quickly.

- **pH:** Even small changes in activity or alkalinity can affect the activity of sanitizer. Chlorine and iodine compounds are generally less effective when the pH is higher.

- **Cleanliness:** If equipment and surface are not thoroughly clean, soil can react with hypochlorites, other chlorine compounds, iodine compounds and other sanitizers. This reaction neutralizes the sanitizer such that it does not work properly.

- **Water hardness:** Hard water makes sanitizers less effective. The calcium and magnesium salts in hard water neutralize

quaternary ammonium compounds. If the water has over 200ppm of calcium, the hygiene staff should add a sequestering or chelating agent.

The major types of chemical sanitizers are as under:

i. **Chlorine Sanitizers**

Examples of chlorine sanitizers are liquid Chlorine, hypochlorites and inorganic or organic chloramines. These compounds have different antimicrobial activities. Hypochlorites are the most active of chlorine compounds and are the most widely used. Calcium hypochlorite and sodium hypochlorite are the most commonly used compounds.

Chlorine compound are often preffered over the sanitizers because of the following:

- They include compounds that kill all the types of vegetative cells.i.e. cell except spores
- Easly available as liquid or granules.
- Hard water usually does not make them less effective.
- Usually cheap .

However, chlorine based sanitizers have some disadvantages such as

- They are unstable, heat breaks them down and organic soil makes them less effective.
- Light breaks them down so they need to store in dark place.
- They corrode stainless steel and other metals.
- They can only be in contact with food handling equipment for a short time, otherwise they corrode the food handling equipments.

ii. **Iodine compounds**

The most common iodine based sanitizers are iodophors, alcohol iodine solutions and aqueous iodine solutions. In concentrated forms, iodophors have a long shelf life but once they are dissolved the iodine may vaporised. Iodine is lost rapidly when the temperature is above 50^{o}C. The colour of iodine solution shows when the sanitizer is there. The solution loses iodine during storage and use and therefore the hygiene personal should check and adjust the strength of iodine solution befor use. Iodine is a very good hand sanitizer and hand dipping agent because it does irritate the skin.

Iodine compounds, however, have following disadvantages.

- They are more expensive than chlorine compounds.
- They may cause off-flavours in some food products.
- They vaporize at approximately 50^{o}C
- They are very sensitive to pH changes.

iii. Quaternary Ammonium Compounds:

The quaternary ammonium compounds often called Quats are good for cleaning and sanitizing floors, walls, furnishing and equipment. They are especially good at penetrating porous surface. Quats are natural wetting agents and also work as detergents. The most common Quats are the cationic detergents, which are poor detergents but excellent germicides.

The advantages of Quats Compounds are as follows:

1. They are highly soluble.
2. These are colourless, tasteless and odourless compounds.
3. They have low toxicity and corrosiveness.
4. They are effective at high pH.
5. Rinsing is not necessary at dilution below 200ppm.

However they also have some disadvantages:

1. They are ineffective in bacteriophase.
2. They cannot be used in hard water.
3. They are incompatible with certain synthetic detergents.
4. E.coli and psychrophils which thrive at low temperature takes longer to destroy.

PERSONNEL HYGIENE:

The word hygiene means using sanitary principles to maintain health. Personal hygiene refers to the cleanliness of a person's body and clothes. Food workers need to be healthy and clean to prepare safe food. Hands, breath, hair, coughs and sneezes all carry microorganisms. Even if a food handler does not feel sick, he or she could still be carrying microorganisms that can cause illness it they get into food.

Employees who are ill should not come to work. They should not touch food or equipment and utensils used to process, prepare and serve food. Food can carry illnesses, including-

- Respiratory diseases, e.g., cough, sore throats, pneumonia, scarlet fever, and tuberculosis.
- Gastrointestinal diseases, e.g., vomiting, diarrhoea, dysentery.
- Typhoid fever.
- Infectious hepatitis.

After people recover from the diseases, they often become carries. This means that they still carry the diseases- causing microorganisms in or on their body. When employees are ill, they carry many more microorganisms, so they are much more likely to contaminate food. Anyone with a sinus infection, sore throat, nagging cough or other coil symptom is probably carrying a heavy load of a virus. People who have diarrhoea or an upset stomach are also probably

carrying large numbers of microbes. Even after the symptoms have gone away, some of the microorganisms that caused the illness may stay in person's body and could contaminate food.

To understand why employees need good hygiene it is vital to consider the following sources of microbial contamination:

Skin:

The skin constantly deposits sweats, oil and dead cells on its outer surface. When these materials mix with dust, dirt and grease, they form an ideal place for bacteria to grow. Therefore, bacteria form skin can contaminate food. If secretions build up and bacteria continue to grow, the skin can become itchy or irritate. Food handlers may rub or scratch the area and then transfer bacteria to food when they touch it. Contamination food has a shorter shelf life or may cause foodborne illness. Poor skin care and skin disorder also cause bacterial infections like boils.

Boils are severe local infections caused by infections in follicles or skin glands after the outer layer of skin (epidermis) is damaged, for example by irritating clothing. The body forms a barrier around the boil to prevent the infection from spreading. A boil should never be squeezed. If it is squeezed, the infection may spread and caused a cluster of boils called a carbuncle. Cuts and septic spots also provide an ideal place for bacterial multiplication. To prevent contamination of food by harmful bacteria, employees should therefore cover boils, cuts and septic spots with waterproof dressings.

Therefore, Workers must bath daily as body odour is offensive and skin is the main breeding ground for bacteria. Use of good soap is important to wash away sweat and dirt, to emulsify secretion of the sebacious glands and to make cleaning of skin easy.

Hair:

Hair can be breeding ground for bacteria found on the skin. Unclean hair cause dandruff and lice, and make the scalp itch. Running hands through hair or scratching the scalp is a common habit because of which staphylococci present

on the scalp may spread and hair may fall into food. The presence of hair in food is obnoxious and can be avoided if food handlers wear caps, scarves or use nets. These would discourage the employees form touching their scalp and contaminating food. A head covering helps hair out of food, prevents contamination by staphylococci, keeps hair free form kitchen grease and prevents long hair form getting entangled in machinery.

Hair should be neatly tied up if long. Hair length for men should be up to mid-ears. Hair should be shampooed regularly. Moustaches and beards should be clean and trimmed. Men without moustaches or beards should be clean shaven. Kitchen staff is not permitted to grow beards.

Teeth and Mouth:

Teeth should brush regularly and thoroughly cleaned with a moderately hard brush. This should be done twice a day, i.e.. First thing in the morning and last thing before retiring. Food particles get lodged in the teeth and cause decay. Deposition of tartar requires attention or teeth may loosen at the root. Toothbrushes must be kept clean and should be changed frequently. The tongue tents to get coated and can be cleaned with a tongue cleaner. The mouth should be rinsed well and gargling is a must after every meal. These habits ensure good dental health; prevent painful cavities and bad breath.

Hands:

The hands may pick up bacteria when they touch dirty equipment, contaminated food, clothing, or various parts of the body. Employees should wash hands frequently with soap and use a hand-dip sanitizer after touching these things so that they do not contaminate food.

Food handlers must wash their hands regularly and especially

- After going to the toilet
- On entering to food processing/preparation area and before handling any food or equipment
- In between handling raw and cooked food

- After combing or touching the hair
- After eating, smoking, coughing or blowing the nose
- After handling waste food or refuse
- After handling cleaning chemicals.

Fingernails:

Fingernails are a frequent source of contamination or cross-contamination. They should be trimmed and kept clean. A long nail with ragged edges tends to harbour more germs. Nail polish should be avoided in production areas as it may mask accumulated dirt or it could chip and enter the food (some nail polishes are toxic). It has been observed that if nails are varnished, food handlers do not like using brushes or trimming their nails. Hence use of nail polishes should be discouraged.

Jewellery:

Any jewellery which comes into contact with should not be worn. Finger rings can accumulate dirt, like dough accumulating in a ring while kneading, which could later enter the food. There is also a danger of stones or small parts of rings, earrings and necklaces falling into food. Bangles and bracelets get heated soon and come in the way of work. Wrist watches should not be worn in the kitchen. They can fail off, wrist watch faces can break and glass can accidently get into the food. Also the skin underneath remains moist and may harbour bacteria.

Smoking:

Smoking should be prohibited in food processing, handling and packing areas. Not only is this to prevent cigarette ends and ash contaminating food but also because:

- People touch their lips while smoking and they may transfer harmful bacteria to food.
- Smoking leads to coughing and droplet infection

- Cigarette ends contaminating with saliva are placed on working surfaces.
- An unpleasant environment may be created for non-smokers.

The only place to smoke in a food premises should be the rest room.

Protective clothing:

All employees working in food establishments must wear a clean and appropriate uniform while on duty. The uniform should be such that

a) it protects the worker form external heat, grease and vapours form the work environment.

b) Saves wear and tear of clothes of the employee

c) Protects the food any bacteria present on the workers cloths.

For this, it should be large enough to ensure that food will not come into contact with any clothes worn underneath.

The choice of uniform will vary for different areas of work. It should be light, comfortable, and durable and should be made from absorbent material. It should be easy to wash and must be laundered and changed daily. White or light colours are selected as stains shows up readily on them and they need to be changed frequently.

Requirement for Hygiene:

Management must have protocol to make sure employees use hygienic practices. Supervisor and manger should set an example for employees by excellent hygiene and health practices themselves. They should provide proper laundry, locker room and hand washing facilities to make it easy for employees to stay clean hygienic.

All employees should have physical examination before they are employed to check that they have good physical, mental and emotional health. All employees who work with food should be checked regularly for science of

illness and infection and other science of poor health. Employees should maintain personal hygiene in the following ways:

a) Maintain good physical health through good nutrition, enough rest and physical cleanliness.

b) Report illness to their employees before working with food so that assignments can be adjusted to protect food form being contaminated.

c) Practices good hygiene so that they do not contaminate food.

d) Wash their hands during their work shift after using the toilet; after handing the garbage and other dirty items; after handling uncooked meat, egg products or dairy products; after handling money; after smoking; after coughing and sneezing; and when leaving or returning to food production/ service areas.

e) Maintain personal cleanliness through daily bathing, washing hair atleast twice a week, cleaning finger nails daily, use or cap or hair net while handling food and wearing clean under clothing and uniforms.

f) Not touch food service equipments and utensils with their hands and use disposable gloves if they have to touch food other than dough.

g) Follow rules such as “no smoking” and do anything else needed to protect the food form being contaminated.

Pest Control:

Pests contaminate food with hair, fur, dropping, eggs, and dead bodies. The common pest found in food processing and food service establishments includes

- **Insects:** flies, cockroaches, wasp, silver fish, ants, weevils, etc.
- **Rodents:** rats and mice
- **Birds:** pigeons and sparrows

Regular surveys of food premises must be carried out to ensure that they are pest free. In particular, food storage rooms and darks, undistributed areas should be examined.

The pest control is essential for the following reasons

- To prevent the spread of diseases
- To prevent the waste of food
- To prevent the damage generally caused by gnawing of electric cables and pipes.
- To prevent loss of customers who would detest eating in premises infested with cockroaches, flies, rodents etc.

General pest control

Pest required food, shelter and security. Denial of these environmental factors will prevent their survival and is the first line of defence against possible infestations. Following environmental control need to be exercised.

- Food premises must be designed and constructed to minimize the risk of contamination from pest.
- External windows, where necessary, must be fitted with removable insect proof screens.
- Doorway should be protected with handling plastic strips or air curtains and the bottom of door should be protected with rubber padding to prevent any pest entrance from below.
- Excess holes and other opening should be sealed with mortars, metal sheets or mash.

Good House keeping

To reduce the risk of infestation, it is important to prevent and deny pests the condition they like and in particular to ensure that:

- Premises and refuse area are kept in a clean and tidy condition. Lids are always kept on waste bins, which should be washed after empting, together with the surrounding areas . Waste must not be allowed to accumulate.
- Food is displayed or awaiting preparation should always be kept .
- Spoilages are cleared away promptly.
- Drains are kept clean and in good condition.
- Sightings of pests or pest damage are reported to maintain immediately.

Physical and chemical pest control:

Physically control methods are generally preferred as the pest is caught, either dead or alive and is consequently not able to die in food, equipment or in some inaccessible place. Examples of physical control include ultra violet, electric fly-killers (insectocuters) and rodent traps.

Unfortunately, physical methods are not always successful and poisons have to be used. Rodenticides are used to kill rats and mice and insecticides to kill insect. Care must always be exercised when using chemicals to ensure, there is no risk of contaminating food. Food and small utensils must always be removed when using insecticide, especially sprays and the premises and fixed equipment must be thoroughly cleaned after use.

Pest Control for Standard Raw Material:

The following pest control measure should be enforced to protect stored raw material from pest infection:

- All deliveries of raw materials and packaging material should be checked to ensure their freedom from pest infestation.
- Food should stored off the floor and clear of wall to facilitate proper cleaning at all times and prevent any pests like rodents, cockroaches, silverfish, and ants from finding a hiding place.

- Food should be stored well covered, in rodent proof containers with lids that are always replaced after use.
- Stored material should be checked regularly for gnawing marks, holes, chewed pieces of cardboard or paper and damaged stock removed.
- The storage area should be well lit and any cracks in walls and ceilings should be sealed towards off any pests, particularly cockroaches.
- As far as possible the above preventive measures and physical controls should be applied to control pest infestation. However, in unavoidable situations, the insecticides should be used carefully ensuring that they do not contaminate the stored food material.
- Professional pest controllers should be engaged for undertaking safe usages of insecticides. Staff should also be trained in pest control and made aware of the dangers of insecticides and its proper usage.

Common Insecticides for Pest Control:

Insecticides are defined as any substance or mixture of substance intended for preventing, killing, repelling or controlling insects

18.5 Safety aspects of Processing Water, Waste Water and Waste Disposal

STORAGE AND DISPOSAL OF WASTE:

Suitable receptacles should be provided, both inside and outside food premises, for the disposal of waste food and debris. Disposal polythene sacks or plastic bins are usually provided for internal use and dustbins for external use.

Refuse containers used internally must be emptied as frequently as necessary and always at least once a shift. After emptying, reusable containers must be thoroughly cleaned before being brought back into the food processing area. Care should be taken that receptacles used for storage or collection of refuse should not be reused for the storage of food.

WATER:

Water is a lifeline of the catering industry. The purpose of serving delicious, nutritious meals prepared and served under hygienic conditions is totally lost if the water served along with it is contaminated. If safe drinking water is not available for consumption, it results in ill health. In, India, 80% of all diseases originated from water. Therefore, providing a safe and adequate water supply to all catering establishment and the community at large should be given top priority by the concerned authorities.

Safety Aspect of Water:

For hygienic purpose the examination of water is generally done along the following lines:

1. **Physical Quality:**

    a) Turbidity is measured on the Jackson candle turbidity meter. It should be less than five units.

    b) Colour is measured in a colorimeter and should be less than five units.

    c) It should have no disagreeable odour

    d) It should be palatable and free from disagreeable taste.

2. **Chemical Qualities:**

    a) Chlorides: maximum permissible limit is 600mg/l. but standard is 200mg/l. of water.

    b) Hardness: total hardness should not exceed 300mg/l. water.

    c) Free and saline ammonia should not exceed 0.05mg/l.

    d) Albuminoid ammonia is a measure of decomposable organic matter that is to be oxidised. It should nor exceed 0.1mg/l.

    e) Nitrites should not exceed 1mg/l. it indicates old contamination.

f) Nitrites should be zero.

g) The amount of oxygen absorbed is an approximate test for the amount of organic matter present. Oxygen absorbed at 37 degree Celsius in three hours sshould not be more than 1mg/l.

h) Dissolved oxygen should not be less than 5mg/l.

i) Toxic substances like arsenic, seleniu m, cadmium, lead and mercury should not exceed the prescribed limits.

3. **Bacteriological Qualities and indicator:**

a) Coliform organisms include all aerobic, facultative and anaerobic gram negative, non sporing, motile and non-motile bacteria capable of fermenting lactose at 35^{o}C to 37 ^{o}C in less than 48 hours. This group includes the faecal group(example, E.coli) and non-faecal group (example, Klebsiella aerogens.)

Water Standard:

The food production and processing industries are concerned particularly with three board aspects of water technology namely:

1. Its microbiological purity and safety.
2. Its chemical impurities which affect suitability in processing.
3. Its contamination load after use.

Water entering a food processing plant should meet standards for portable water. Therse must be limitation harmful chemicals for safety of portable water. This water must be free from contamination with sewage, pathogenic organisms, and organisms of intestinal origin. Microorganisms have an absolute demand for water, without water no growth can occur.

18.6 Summary

Implies cleanliness at every stage of food handling and preparation i.e. production preparation, storage, service and disposal. The following items

need special attention. Safe and portable water supplies, wholesome ingredients, hygiene handling of foods, clean equipment, and clean surroundings.

To ensure that wholesome food is served, it is necessary to protect food from contamination at all stages from purchasing, storing, pre-preparing, preparing and serving it, storage of food is an important factor which needs to be consider if the emphasis is on serving high quality products.

18.7 Review Questions

1. Describe the Food Hygiene and Sanitation.
2. Discuss the Source of Contamination of Food.
3. Explain the types of Cleaning Agents.
4. What is Sanitizer? Explain the types of Sanitizers used in Food Industry.
5. Define Personal Hygiene? Why Employees Need Personal Hygiene to Considered the sources of microbial contamination.

18.8 References:

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