CHAPTER-1

Q1 Define food science and what is its scope in the hospitality industry?

Q2. What other fields of study are related to food science and how are they related to it?

DEFINITION AND SCOPE OF FOOD SCIENCE

Food Science- Can be defined as the application of the basic sciences and engineering to the Study of the fundamental physical, chemical and biochemical nature of foods and the Principles of food processing.

Food Technology- is the use of the information generated by food science in selection, Preservation, processing and packaging and distribution as it effects the consumption of Safe, nutritious and wholesome food.

Food science is a broad discipline which contains within it many specializations such as – Food Microbiology – is the study of the microbial ecology related to foods, the effect of Environment on food spoilage and food manufacture, the physical, chemical and biological Destruction of microorganisms in foods. Along with the microbiological examination of Food stuffs as well as public health and sanitation.

Food Chemistry- Covers the basic composition, structure and properties of foods and the Chemistry of changes occurring during processing and utilization. It includes general Chemistry, organic chemistry, and biochemistry.

Food Processing- Covers general characteristics of raw food materials, principles of food Preservation, processing factors which influence quality, packaging, water and waste
Management and sanitation procedures. It also outlines GMPs or Good Manufacturing Practices.

Food Analysis- Deals with the principles, methods, and techniques necessary for qualitative, physical and chemical analysis of food products and ingredients. The analysis should be related to the standards and regulations of food processing.

Food Engineering- Involves the study of engineering concepts and unit operations used in food processing. These principles include material and energy balances, thermodynamics, fluid flow, as well as heat and mass transfer.

Psychology and Sociology- Prove to be important in an affluent society where there is choice of food as well as in areas where customs and taboos are sometimes responsible for malnutrition although there may not be any shortage of essential nutrients.
CHAPTER-2

CARBOHYDRATES

Q1. What are carbohydrates in terms of their chemical structure?

Q2. Classify carbohydrates based on their complexity. What are the properties and uses of each type in different food preparations?

Q3. What is gelatinization and retro gradation?

Q4. What is dextrinisation? Where is it used in food preparation?

It means to convert a starch into dextrins, which are any of various soluble Polysaccharides obtained from starch by the application of heat or acids and used mainly as Adhesives and thickening agents.

Gelatinization is when starch grains (rice, flour, pasta) are mixed with a liquid and Heated the starch then heats and explodes and eats the moisture, this results in the jumping Of the liquid.

Examples of gelatinization; pancakes, rice smiles, steaks, lemon meringue pie.

Retro gradation is a reaction that takes place in gelatinized starch when the amylose And amylopectin chains realign themselves, causing the liquid to gel, generally an Undesirable effect.
CHAPTER-3

FATS

Based on origin fats can be Animal fats or plant fats.

Based on degree of saturation there are three basic types of dietary fats

- Monounsaturated fats (MUFAs),
- Polyunsaturated fats (PUFAs) and
- Saturated fats (SFAs)

The fat molecule is composed mostly of hydrogen atoms attached to carbon atoms in a carbon chain. On this molecule there are open spaces, like parking spaces. When all the available spots, or parking spaces, on the carbon atom are filled (i.e., saturated) with hydrogenated atoms, the fat is said to be saturated. If one or more places on the carbon are not filled with hydrogen, the fat is called unsaturated. A fat molecule with one empty space is called a monounsaturated fat and if two or more spots on the atom are empty, the fat is known as a polyunsaturated fat.

Saturated fatty acids are firmer at room temperature. Each carbon atom has two hydrogen atoms attached making them very stable and those with 16 or more carbon atoms have a high melting point.

Saturated fats are mainly the animal fats. They are found in meat, seafood (especially the shell fish such as lobsters, crabs, etc.), whole-milk and milk products (cheese, pander, and ice cream), and egg yolks. Some plant foods which are high in saturated fats are coconut, coconut oil and palm oil.
Trans - fatty acids are fats produced by heating liquid vegetable oils in the presence of Hydrogen. This process is known as hydrogenation. The more hydrogenated an oil is, the Harder it will be at room temperature.

Most of the Trans fats in our diets are found in commercially prepared baked foods Like maw cakes and patties, margarines, vanaspati ghee (dalda), snack foods (farsaan, like French fries and onion rings, also contain a good deal of Tran’s fats. Trans fats are the worst for cholesterol levels because they raise bad LDL and lower good HDL. While you should Limit your intake of saturated fats, it is important to completely eliminate Trans fats or Partially hydrogenated oils from your diet.

Unsaturated fatty acids are fluid at room temperature. They have one hydrogen atom missing Requiring the formation of a double bond. These are generally unstable as there are points in The molecule where addition of hydrogen /oxygen or other reactive substances can take Place. This can cause rancidity and flavor reversion.

Unsaturated Fats - Polyunsaturated and Mono-unsaturated Unsaturated fats are found in Products derived from plant sources, such as vegetable oils, nuts, and seeds. There are two Main types:-
A. Polyunsaturated fats (present in sunflower, corn, and soybean oils) and
B. Monounsaturated fats (present in rice bran, canola, peanut, and olive oils).

Studies on intake of these fats have shown to decrease LDL levels and increase HDL levels, Hence are labeled as good fat

Common examples of cooking fats include olive oil, lard, canola oil, walnut oil, butter,
Margarine and shortening….Fats are generally trimesters of glycerol and vegetable oils.
Margarine and vegetable shortening, which can be derived from the above oils, are used mainly for baking.

**RANCIDITY**

The development of any disagreeable odor and flavor in fats and oils or fatty phases of food is called Rancidity.

Rancidity is of two types -

A. Hydrolytic rancidity: - it is caused by lipases (substances that break down fats) which break down the fat into fatty acids and glycerol. The fatty acid are volatile at room temperature and cause off-flavor.

Example – rancidity in butter and products containing milk fats

Prevention -

a) Heating - as it destroys lipases

b) Cooling – which retards the action of lipases

Oxidative rancidity/Autoxidation- initially fats take up oxygen at a very slow rate.

However after an induction phase rapid oxidation takes place resulting in off-flavors and odors.

Example- oils
Factors effecting autoxidation-

a) Traces of Metals like copper, nickel, iron catalyze rancidity by reducing Induction period, increasing the rate of formation of free radicals (known as Pro-oxidants as they encourage oxidation.)

b) Hematic compounds catalyze oxidative reactions even during the frozen state.

c) Light accelerates the development of rancidity. U-V rays and short wave light Blues are most harmful as the cause photolysis (break down) of peroxide of free Radicals.

Prevention – The addition of antioxidants prevents auto oxidation as they inhibit the chain Reaction of oxidation.

Examples- Tocopherols - naturally present in vegetable e oils.

- Butyrate hydroxyanisole (BHA)
- Butyrate hydroxytoulene (BHT)
- Propyl gal late

SMOKING OF FATS

High temperatures of frying can cause fats to undergo hydrolysis and Polymerization of the fatty acids, releasing glycerol eventually. The glycerol molecule then Loses water forming a very irritating aldehyde called ACROLEIN. The release of volatile fatty Acids and caroling results in the smoking of fat. The temperature at which this occurs is Known as the smoking point of fat or the SMOKE POINT.

FLAVOUR REVERSION

Flavor reversion is a special type of oxidative deterioration of edible fats.
It is characterized by the development of an objectionable flavor- before the onset of oxidative rancidity.

**Factors effecting flavor reversion-**

a) Metals like iron, copper

b) Presence of U-V rays

c) Heat

d) Oxygen

Flavor reversion is more prominent in some fats like Soybean oil has a tendency to have ‘Beany’, ‘haylike’and eventually ‘fishy’ off flavors.

Prevention- the addition of sequester ants such as-

Ethylene dioxide tetra acetic acid (EDTA)
Processing of fats

**REFINING**

Oil can be extracted from oilseeds or extracted by dissolving in solvents. However these oils contain fat like substances such as phospholipids like lecithin (fat-protein complexes) to remove these they are wetted with water. The impurities become insoluble in the oil and settle out. This process is known as DEGUMMING.

Further an alkali solution is added which settles additional impurities from the oil. These include free fatty acids - that combine with the alkali to form soaps which can be removed by filtration or centrifugation.

This treatment of oil with an alkali is known as REFINING

**WINTERIZATION**

Fats and oils are made up of a mixture of various triglycerides. The triglycerides containing more saturated fatty acids and long chain fatty acids tend to crystallize and settle out when the oil is chilled. Since crystallization must be avoided in fats such as salad oils, they should be pre-treated by cooling and removing crystals before the product is bottled. The process of pre-treatment to remove crystals from the fat is known as WINTERIZATION

**FRACTIONATION**

Sometimes a solvent like acetone is used to dissolve the fat and then chilled to produce a crystalline fraction. The filtrate is recovered and chilled at lower temperature to get a second fraction and the process repeated again and again. This results in a purer recovery. Thus fractionation is an improvement on winterization.
HYDROGENATION
The addition of hydrogen to saturate fatty acid double bonds is HYDROGENATION. It is
Done to-

a) Change the viscosity of fat (hardening)

b) Increase the melting point of fat

c) Increase the shortening properties –as in margarine

Process of hydrogenation-

The de-aerated hot oil is whipped with hydrogen gas with a nickel catalyst in a
Closed vessel known as a converter, when the desired degree of hardening is reached the
Unreacted hydrogen gas is removed from the vessel by vacuum and the nickel catalyst is
Filtered out.

However, hydrogenation changes the nutritional properties of some fats and some
Unsaturated fats lose essential fatty acids like linoleic acid making it less beneficial to health.
PROTEINS

Proteins are complex organic nitrogenous substances. They contain carbon, hydrogen, oxygen, nitrogen and sculpture and some contain phosphorus also. Proteins are made up of building blocks called “amino acids”. The amino acids contain a basic (amino-NH$_2$) group at one end and an acidic (carboxyl-COOH) Group at another end, in their molecules. Also there is also a third group referred to as the side denoted by the letter R.

\[ \text{H} \]
\[ \text{NH}_2 \text{ C} \quad \text{COOH} \]
\[ \text{R} \]

The R group differentiates one amino group from another.

DENATURATION AND COAGULATION

The proteins in their original state are known as ‘Native’ proteins. The protein molecules undergo a change in their structure when they are subjected to different conditions such as exposure to heat, light and change in temperature, beating or agitation. These changes take place in two stages.

DENATURATION-

The peptide chain of proteins unfolds itself to some extent but the linkage does not break, the properties of the denatured protein do not change to a large extent (the protein can come back to its original state if the conditions are mild and if the conditions are reversed particularly if the molecular weight of the of the native protein is large).
COAGULATION

The unfolded parts of the protein molecules recombine in different ways. New bonds are formed within the molecule and a new molecular shape is produced. Many protein molecules collect together to form a solid mass or gel. These changes are known as Coagulation of proteins.

Therefore, coagulation is the later stage of protein coagulation.

Factors affecting denaturation and coagulation:

Heat

If milk is boiled for a short time then denaturation of protein takes place. But in Preparations such as basenji and boiled egg, exposure to host for a longer time causes Coagulation. This also happens in case of meat, fish and eggs during cooking.

Beating

When egg is beaten for a short period, denaturation of protein takes place. If left for some time it becomes liquid again due to reversibility of denaturation. But when beaten Excessively the egg first forms soft peaks and on further beating forms stiff peaks. At this Stage the change is irreversible.

Acid or alkali

In the preparation of pander if a little lemon juice is added the milk gets denatured. If more lemon juice is added and the milk heated a solid mass of pander is formed due to Coagulation. In preparation of curd once the solid mass is formed the process is irreversible.

Note-

Amphoteric nature of proteins-

Proteins can act as acid or alkali due to the presence of both acid and basic groups. This amphoteric nature can allow proteins to withstand sudden changes in ph. and prevent
Undesirable changes. They can bind +vet and –vet ions to maintain texture, volume and appearance of food. For example in mayonnaise the addition of egg yolk serves as an emulsifying agent and stabilizes the emulsion. Milk also contains protein which stabilizes the fat and water emulsion.

However at a specific pH (which differs for every protein) the electric charge on the protein is neutral (i.e. no positive or negative charge) this point is known as the ISOELECTRIC POINT. At the isoelectric point the protein molecules are very unstable. Then they precipitate or form curds. (This is because the molecules become close enough to form hydrogen bonds that hold them into clumps)

Curdling is used in making of curd, cheese etc.

GEL FORMATION

Not only starches, even proteins have the property of forming gels.

When protein dispersion is heated and cooled, the viscosity (thickening) of the solution increases to a point at which some rigidity is obtained and a gel is formed. This is known as gel formation.

Some of the proteins are fibrous while others form fibers during gel formation. These fibrous proteins form a three dimensional network on cooling and water gets entrapped in between the network.

Gel formation is used in the preparation of egg custard, gelatin jelly, bread pudding

The gel tends to shrink if the attractive forces between the protein molecules are increased, due to continuous standing or change in ph. The shrinkage results in expulsion
Of some of the entrapped water. This is known as ‘synergizes’. Gel formation is affected by a number of factors like temperature and time - a gradual decrease in temperature below 35-40°C is required over a period of time before chilling.

Concentration - the firmness of the gel depends on the percentage of gelatin as in ice-cream. The percentage of gelatin used is less than 1.5-2 per cent and a longer setting time is allowed. Excess gelatin in gelatin gels produces gumminess with longer storage.

Acid - the addition of acid produces softer gel. The acid gelatin dispersions take a longer time to set.

Salts - salts make the gel more firms. Milk contains some salts that are the reason why gel is more firm if milk is used for preparing gelatin mixtures.

Sugar - the rate of setting is decreased if higher concentration of sugar is used in preparations and more gelatin is also required.

Enzymes - enzymes present in fruits effects gel formation. Certain enzymes like bromine present in pineapple do not allow gel to form as they digest the protein. To avoid this fruit is heated and then added, so that the enzyme is destroyed. This is the reason why raw pineapple is not added to gelatin based desserts.


EGG

The egg is a nutrient-dense food, containing high quality protein and a wide range of essential vitamins, minerals and trace elements. Therefore eggs can make a significant
Contribution to a healthy diet. Nutritional requirements vary considerably between men, women and children and can also vary in individuals from time to time.

The nutritional value of eggs and the contribution that they make to the diet is illustrated by the following table. The data on the nutritional content of a single egg is based on a medium egg and all percentage composition figures relate to the contents, excluding the shell.

<table>
<thead>
<tr>
<th>Constituent of Egg</th>
<th>Amount Per egg</th>
<th>% of Reference Nutrient Intake Amount Per 100g egg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>For adult female 19-50 years</td>
</tr>
<tr>
<td>Weight1</td>
<td>51.6</td>
<td>-</td>
</tr>
<tr>
<td>Water</td>
<td>G 38.8</td>
<td>-</td>
</tr>
<tr>
<td>Energy</td>
<td>Joules/ 324/78 Calories</td>
<td>4</td>
</tr>
<tr>
<td>Protein</td>
<td>G 6.5</td>
<td>14</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>G Trace</td>
<td>-</td>
</tr>
<tr>
<td>Fat</td>
<td>G 5.8</td>
<td>**</td>
</tr>
<tr>
<td>Inc. saturated fat.</td>
<td>G 1.7</td>
<td>**</td>
</tr>
<tr>
<td>Monounsaturated fat g</td>
<td>2.3</td>
<td>**</td>
</tr>
<tr>
<td>Polyunsaturated fat. g</td>
<td>0.9</td>
<td>**</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Mg 202</td>
<td>**</td>
</tr>
<tr>
<td>Dietary fiber</td>
<td>G</td>
<td>None</td>
</tr>
<tr>
<td>---------------</td>
<td>---</td>
<td>------</td>
</tr>
<tr>
<td><strong>MINERALS AND TRACE ELEMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>Mg</td>
<td>72</td>
</tr>
<tr>
<td>Potassium</td>
<td>Mg</td>
<td>67</td>
</tr>
<tr>
<td>Calcium</td>
<td>Mg</td>
<td>29</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Mg</td>
<td>103</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>6.2</td>
</tr>
<tr>
<td>Iron</td>
<td>Mg</td>
<td>1.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>Mg</td>
<td>0.7</td>
</tr>
<tr>
<td>Copper</td>
<td>Mg</td>
<td>0.04</td>
</tr>
<tr>
<td>Iodine</td>
<td>µg</td>
<td>27</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg</td>
<td>6</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Mg</td>
<td>83</td>
</tr>
<tr>
<td>Sculpture</td>
<td>Mg</td>
<td>93</td>
</tr>
<tr>
<td><strong>VITAMINS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td>µg</td>
<td>98</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>µg</td>
<td>0.9</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Mg</td>
<td>0.57</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Mg</td>
<td>None</td>
</tr>
<tr>
<td>Thiamin (B1)</td>
<td>Mg</td>
<td>0.05</td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>Mg</td>
<td>0.24</td>
</tr>
</tbody>
</table>
### Energy value of eggs

A medium egg has an energy value of 78 kilocalories (324 kilojoules) and the consumption of one egg daily would contribute only around 3% of the average energy requirement of an adult man; 4% for an adult woman.

With their significant protein, vitamin and mineral content and relatively low saturated fat content, eggs are a valuable component in a healthy diet.

### Protein

Eggs are an excellent source of protein. Egg protein is of high biological value as it contains all the essential amino acids needed by the human body. Eggs therefore complement other food proteins of lower biological value by providing the amino acids that are in short supply in those foods. 12.5% of the weight of the egg is protein and it is found...
In both the yolk and the albumen. Although protein is more concentrated around the yolk, there is in fact more protein in the albumen.

On the evaluation scale most commonly used for assessing protein, egg is at the highest point, 100, and is used as the reference standard against which all other foods are assessed.

**Vitamins**

Eggs contain most of the recognized vitamins with the exception of vitamin C. The egg is a source of all the B vitamins. It is a particularly rich source of vitamins B12 and B2 (Riboflavin) and a useful source of folate. The egg is also a good source of the fat-soluble vitamins A and D and provides some vitamin E.

**Minerals**

Eggs contain many of the minerals that the human body requires for health. In particular eggs are an excellent source of iodine, required to make the thyroid hormone, and phosphorus, required for bone health. The egg is a significant source of selenium, an important antioxidant and provides some zinc, important for wound healing, growth and fighting infection. Eggs also contain iron, the vital ingredient of red blood cells, although the availability of this iron to the body is still being investigated.

**Fat**

11.2% of the egg content is fat. The fat of an egg is found almost entirely in the yolk; there is less than 0.05% in the albumen.
Approximately 17% of an egg’s fatty acids are polyunsaturated, 44% monounsaturated and Only 32% saturated.

**Cholesterol**

Eggs also contain cholesterol and lecithin, which are fat-like substances that are Essential to the structure and function of all cells in the body. However these substances are Not dietary essentials, as our bodies are able to synthesize them. Cholesterol helps to Maintain the flexibility and permeability of cell membranes and is also a raw material for The fatty lubricants that help to keep the skin supple. Cholesterol is essential for the Production of sex hormones, cortisol, vitamin D and bile salts.
CHAPTER-5

FOOD PROCESSING

Q1. Define food processing? What are its objectives?

Q2. What type of treatment is given to food before it is consumed?

Q3. How do the following effect food constituents:-

   A) Heat
   B) Acid
   C) Alkali

FOOD PROCESSING

Food processing covers general characteristics of raw food materials; principles of Food preservation, processing factors which influence quality, packaging, water and waste Management. It includes GMP’s (good manufacturing practices) and sanitation procedures.

The objectives of food processing:-

   - To preserve the natural properties of foods
   - To preserve foods against spoilage, deterioration or wastage
   - To improve the quality of foods
   - For better handling, processing and packaging of food
   - To make foods more acceptable or convenient for consumers

FOOD TREATMENTS-

The different treatments that are given to food during processing are carried out at Various processing units. Some of these unit operations are:-
1) MATERIALS HANDLING

Harvesting, transportation and movement of food through the processing unit. Including storage under sanitary conditions at specific temperature and pressure which Does not allow the food to be damaged. 
Machines used-trucks, ships conveyers.

2) CLEANING

Food must be cleaned before use in order to undo the harm done to them by the Open environment. 
It can be done with the help of washing, vacuum, magnetic attraction, mechanical Separation etc. Depending upon the product and the nature of dirt. Cleaning of water, Surfaces of food processing should also be done. 
Methods used: 
Mild alkaline detergents are most commonly used as cleaning aids. Egg. Caustic soda, Soda ash etc.

3) SEPARATING

Separation may be solid from solid, solid from liquid, liquid from liquid, gas from Solid or liquid etc. 
It is achieved by procedures such as:-
Peeling, shelling, sieving, sorting grading
Filtration
Pressing
Centrifugation or
Vacuum removal respectively.
A photocell is used to separate out discolored or moldy products such as nuts.

Screens, holed and slits are used to separate items of separate sizes.

An IYE peeler is used to peel skins of fruits and vegetables and removed by a jet of water.

Various porous and permeable membranes are used to separate acids and salts.

4) DISINTEGRATION

Subdividing large pieces of food into smaller units or particles. It involves:

a) Cutting using knives, high velocity water jets, laser etc.

b) Grinding using heat produced from friction, dry ice or co2 is used later.

c) Pulping

d) Homogenization i.e. passing food through high pressure holes or using ultra sound Energy to break up particles.

5) A) PUMPING

Moving of solids and liquids from one location or processing step to another by

Pumping using a variety of pumps.

b) MIXING

Using conical blender to mix dry ingredients.

For mixing liquids a propeller type agitator mounted in a stainless steel vat is used.

Some mixers also beat air into the product while it is being mixed. Egg in ice creams.

6) HEAT EXCHANGE

A. Heating: can be used to

a) Drive off moisture and develop flavors. Egg roasting of coffee and toasting of cereals.

b) Making foods more tender and palatable. Egg meat.
c) To inactivate toxic substances. Egg soybean.

d) To destroy microorganisms and preserve the food. Egg pasteurization.

**VARIOUS KINDS OF HEAT TREATMENT**

a) A. Pasteurization is a kind of sterilization, where the milk is subjected to a mild heat treatment, during which, the pathogenic and nonpathogenic bacteria are destroyed.

b) Nowadays high temperature short time method (HTST) is used for pasteurization.

Milk is heated to 71°C and held at this temperature for 15 seconds.

c) Holding method—milk is heated to and held at this temperature for 15 seconds.

d) Holding method—milk is heated to 63°C and held at that temperature for 30 minutes.

e) Ultra high temperature method (UHT)—milk is held at a temperature of 90°C or above for 1 second or less.

f) In all the methods milk is cooled rapidly to a temperature of 10°C or lower and stored at that temperature.

g) CANNING—It employs temperatures above 100°C. Steam under pressure are used to create such high temperatures.

h) ROASTING—Originally this term was meant to cook meat over an open fire on a spit. Now it refers to cooking in an enclosed oven and so is ‘dry heating’.

I) D. BAKING

j) E. FRYING

k) F. MOIST FOOD CONCENTRATION.

l) G. FOOD DEHYDRATION—removal of water.
Tasting, direct injection of steam, direct contact with flame or electronic energy are methods employed for heat exchange in food. The heat supplied can be through conduction, convection radiation or a combination of these.

**B. COOLING** - Refrigeration and freezing of foods is done to prolong their keeping quality. However, some foods owe their characteristics to their frozen state. (Stored below 12°C)

Air blast freezers freeze and store at -26°C. Many food plants also use nitrogen for freezing, which prevents even delicate foods like mushrooms from getting spoiled.

**C. EVAPORATION** - It helps to concentrate foods by removal of water. Also, it removes undesirable elements that are volatile in nature. Different ways in which evaporation can be done are:

- Sun drying – like for salt
- Heated kettle – like for candy making from sugar syrup (if vacuum is used it is called vacuum pump evaporation)

**D. DRYING** - Total water removal is called drying.

Different types of dryers are used to dry foods, for example, dried milk.

- Spray dryer uses subdivision of liquid by pumping it into the top of a tower at which point the liquid is atomized by a spray nozzle. Now hot air is introduced into the tower, which dries the droplets of food. The dehydrated particles fall to the bottom of the tower while the moisture is extracted separately.
- A drum drier or roller can be used for drying.
- Tunnel ovens can also be used.

In vacuum freeze drying the food pieces are first frozen, and then dehydrated under vacuum in the frozen state, the ice does not melt but goes off as vapor – this is known as
Sublimation. This method protects the color, flavor and texture of foods like juice products, brewed coffee etc.

7. FORMING

Forming includes giving specific shape and appearance to foods. It can be done using-tableting machines, compacting and molding into shapes. Excursion cooking - the formulated dough or mash is extruded under pressure, with or without supplementary heat, this gelatinizes the starch and as the shaped food emerges from the extruder, boiling water is introduced in the cooker. The food gets puffed up and is then oven dried. Egg breakfast cereals. Casing is used for sausages.

8. PACKAGING

Food is packaged for different purposes like containment for shipping, dispensing, and utilization, changing sizes and improving the usefulness of the product. Packaging also helps protect against microbial contamination, physical dust and dirt, insect attack, light, moisture, flavor loss and physical damage. Materials used for packaging - metal cans, glass/plastic bottles, paper, paperboard, plastic, metallic films or a combination of these. It involves, weighing, sorting, vacuum packaging etc.

FOOD PRESERVATION

Preserving using additives - a preservative is defined as any substance which is capable of inhibiting, retarding, or arresting the growth of micro-organisms or masking the evidence of any such deterioration of food. Apart from preservatives there are other factors that affect foods and help in food preservation,
<table>
<thead>
<tr>
<th>S.NO</th>
<th>FACTOR</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat (Spices)</td>
<td>High temperatures destroy harmful micro-organisms due to Coagulation of cellular proteins and inactivation of enzymes required For the metabolism of these organisms. Heat also causes dehydration Which makes water unavailable for microorganisms to survive in.</td>
</tr>
<tr>
<td>2</td>
<td>Acids (Acetic Acid, citric Acid)</td>
<td>Acids reduce the ph. level of foods below the growth range and also Inhibit metabolic activity.</td>
</tr>
<tr>
<td>3</td>
<td>Salt (Pickles)</td>
<td>I. It causes high osmotic pressure causing plasmolysis (breakdown Of cell walls) of cells.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II. It dehydrates food by drawing out water and dehydrates microbial Cells.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III. It ionizes to yield chlorine which is harmful to microorganisms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IV. It reduces solubility of oxygen in the moisture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V. It interferes with the activity of proteolysis enzymes.</td>
</tr>
<tr>
<td>4</td>
<td>Sugar (Preserves)</td>
<td>I. It causes high osmotic pressure causing plasmolysis (breakdown Of cell walls) of cells</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II. It dehydrates food by drawing out water and dehydrates microbial Cells.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III. It interferes with the activity of proteolysis enzymes.</td>
</tr>
</tbody>
</table>
CHAPTER-6

EVALUATION OF FOOD

Evaluation of food is done in order to judge the quality, value and acceptability of food.

When food is selected the use of all the physical senses is involved. These include sight, touch, smell, taste as well as hearing. Food factors detectable by our senses are called Sensory factors and are categorized as;

- Appearance factors
- Textural factors
- Flavor factors

Quality can be defined as degree of excellence and includes things such as taste, appearance, and nutritional content.

Value is a composite of cost and quality. Highly priced goods have more value if their quality is also high.

Quality evaluation is necessary for;

- Checking the acceptability of food
- For research
- For product development
- For judging new products.

The following chart represents the various factors to be judged when evaluating food-
QUALITY FACTORS

APPEARANCE

TEXTURE

FLAVOUR

OTHER FACTOR

SIZE AND SHAPE

SIZE & SHAPE

COMPRESSION

SHEARING TENSILE STRENGTH

TASTE & SMELL

NUTRITIVE SANITARY KEEPING

COLOUR & GLOSS CONSISTENCY
Methods of evaluation:

I) Grading according to size using high speed automatic separating and grading Machines

ii) By weight. Egg. Determining the weight of a dozen eggs

iii) Degree of curvature used to grade shapes such as in pickles.

COLOUR AND GLOSS

Methods of evaluation:

I) If the food is a transparent liquid such as wine, beer or grape juice or if a colored Extract can be obtained from the food, various types of calorimeters or spectrometers can Be used for color measurement. - Taube of the liquid is placed in a slot and light of a Selected wavelength is passed through the tube. The light is differently absorbed depending On the color of the liquid and the intensity of the color. The difference in response to the Intensity of light helps to check the quality of the food.

ii) If the food is solid or liquid, color is measured by comparing the reflected color With closest color of tiles or chips. The color of the food is defined as the color of the Identical tiles or falling between two nearest colored tiles. Egg. Grading of tomatoes from Green to red.

iii) Light reflected from a colored object can be measured in terms of its three Dimensions-hue, value and intensity giving each numerical values in tri-stimulus Calorimeter. It uses instruments like hunter lab meter or color difference meter. Graphs Can also be drawn for changes I color due to ripening, storage of food etc.
Just like color, gloss can also be measured using light measuring instruments. Egg. Gelatin Desserts, buttered vegetables.

**TEXTURAL FACTORS**

Texture refers to those qualities of food that we can feel with our fingers, tongue, Palate and teeth. If the texture differs from the expected one it usually means a defect in Quality of the food.

**Methods of measurement**-

1) If the food is squeezed and it remains in one piece it is called compression. A Succulometer measures succulence by squeezing juice out of food.

2) If the force is applied so that one part of the food slides over another it is called Shearing. A tender meter applies compression and shear to measure tenderness. Eg. In Peas.

3) A force applied away from the material results in tearing or pulling apart of the food. The force required measures the tensile strength of the food.

4) A universal testing machine can be used to measure the firmness, crispness and other Textural parameters.

These instruments are connected to a moving recording chart that draws a time – Force curve which represents the RHEOLOGICAL PROPERTIES of the food.

(Rheology is the study of the deformation and flow of matter. The rheological properties of a Liquid are dominant features that can be quantified to characterize its behavior, and the Response of a liquid to a forced shearing flow is the basis for determining the specific Rheological properties of a given liquid.)
CONSISTENCY

In food appearance consistency is measured by the viscosity of the food. Higher Viscosity means higher consistency.

(Viscosity is a measure of the resistance of a fluid which is being deformed by either shear Stress or extensional stress. In everyday terms (and for fluids only), viscosity is "thickness." Thus, water is "thin," having a lower viscosity, while honey is "thick" having a higher Viscosity. Viscosity describes a fluid's internal resistance to flow and may be thought of as a Measure of fluid friction.)

Methods of measurement-

I) Measure the time taken by the food to run through a small hole of a known Diameter.

ii) Measure the time taken by more viscous fluids to flow down an inclined plane using The Bootlick consist meter. Egg. For ketchup, honey, sugar syrup.

iii) Resistance of food to a falling weight such as a ball

iv) Resistance to rotation of a spindle or twist on a wire suspending the spindle.

Various instruments used for measuring viscosity are called viscometers.

v) A penetrometer like a tender meter uses multiple needle probes to check the Tenderness of meat after cooking.

vi) A bomb geometer measures the firmness of gels like gelatin desserts.

vii) Use of sonic energy also helps to know the firmness of the food depending on how Much sound energy is absorbed by the food.

viii) Listening to the thumping sound as in cheese when hit. Egg. Swiss cheese.
**FLAVOUR FACTORS**

Flavor is a combination of both taste and smells and is largely subjective, hence difficult to measure. Flavor is affected by color and texture also.

Flavor is determined by the mixture of salt, sour, bitter and sweet taste and other components along with characteristic aromas.

**Methods of measurement-**

I) Gas chromatography measures the specific volatile compounds in food.

ii) Salt concentration can be measured electrically by its effect on the conductivity of electricity by the food solution.

iii) Sugar content in solution is measured by its effect on the refractive index of the food.

iv) Acid can be measured by titration (neutralizing) with an alkali or the pH scale.

v) In order to measure the acceptance quality of food a panel of tasters is employed to taste the food products. A typical tasting session has separate booths with colored light for the tasters and facilities like unsalted crackers are given to neutralize the taste after each sample tasting. The food sample is given through a window and samples are coded to avoid any influence of brands. The tasters give grading and comments on each sample of food. When all evaluation forms are filled the panel leader tabulates the results and a number ranking is scale for the flavor is made. It is called a HEDONIC SCALE.

vi) Often two samples of food are compared in a preference test. However if three samples are taken, two similar and one different, then there is better distinction of flavor. This is called a TRIANGLE TEST.
OTHER QUALITY FACTORS

Nutritive quality-
Is assessed by chemical or instrumental analysis for different nutrients. Animal Feeding tests for measuring protein quality and biological testing is also used.

Sanitary quality-
Is measured through the count of bacteria, yeast, mound and insect fragments as well As sediment levels of unwanted particles in food-rays can be used to detect impurities like Glass chips, stones and metal pieces.

Keeping quality
Is measured by subjecting the food to extremes of temperature, humidity and other Variables under storage and handling conditions in accelerated storage tests.

QUALITY STANDARDS
These include

☐ Research standards set up by companies to help ensure excellence of their products In a highly competitive market.

☐ Trade standards are set by members of an industry to prevent the lowering of Standards of quality.

☐ Government standards set up to protect health and prevent deceit of consumers.

☐ GMPs set up to ensure proper manufacture and to judge quality of output.
CHAPTER-7

EMULSIONS

The term emulsion is applied to a system consisting of one liquid dispersed in another liquid with which it is immiscible. Emulsions are of two types:

I) Temporary emulsions - these emulsions are formed when two liquids are shaken but separate on standing.

Egg. French dressing-emulsion of vinegar, vegetable oils, salts and spices.

ii) Permanent emulsions - a third substance called an emulsifier or emulsifying agent is added to stabilize the system and keep one liquid dispersed in another on a permanent basis.

The emulsifier reduces the interfacial tension between the particles of the two liquids.

The emulsifier has amphiphillic properties i.e. Part of the emulsifier molecule is soluble in water (hydrophilic) while the other part is soluble in fat (lipophilic). Thus it keeps the two liquids dispersed.
EMULSIFYING AGENT

Hydrophilic    Lipophilic

Therefore the emulsion becomes permanent.

EMULSIFYING AGENTS

If the emulsifier is hydrophilic it promotes the dispersion of oil in water.

If the emulsifier is lip phobic it promotes water in oil emulsion.

Examples of oil in water emulsions - milk, cream, ice-cream, mayonnaise, salad dressing.

Water in oil emulsion - butter, margarine.

Examples of emulsifiers -

Ionic - salts of fatty acids, phospholipids & protein.

None - ionic - Sorbian esters, mono esters & digesters of propylene glycol.

Use of emulsifying agents in food -

Lecithin and polysorbate 60 in salad dressing to keep vegetable oil suspended in water.

Eggs are added to cake batter to emulsify fat with milk.

Mon glycerides and triglycerides added to cake mixes and salad dressings.

Lecithin derived from soybeans is used in chocolates and margarine.

In mayonnaise egg yolks act as emulsifiers of oil in acids i.e. Lemon juice or vinegar.
When oil is mixed with water it normally separates out as oil is hydrophobic. However on addition of an emulsifying agent such (as lecithin as in mayonnaise and Cakes), the hydrophobic end of the emulsifier attach themselves to the fat molecules while Their hydrophilic ends attach to the water. As a result spherical structures are formed, in Which the lipid is enclosed and the emulsion does not separate out. In the micelle the oil Enters the central core while water surrounds the core. The emulsifier molecules are Sandwiched between the two. Micelle formation is a key step in the digestion of dietary fat.
CHAPTER-8

COLLOIDS

A colloidal system is a heterogeneous system they are mixtures that appear to be Solution but are actually colloidal dispersions.

The material that forms the base of the system is called the dispersion medium or the Continuous phase.

The material that forms the colloidal condition is called the dispersed medium or the Discontinuous phase.

Since there are three states of matter-solid, liquid and gas-eight classes of colloids Are formed. However, gases form solutions not colloids

Solid-liquid
Gas-liquid
Gas-solid
Solid – gas
Solid – solid
Liquid- solid
Liquid- gas

SUSPENSION

When the particles of solid are separated into large aggregates of particles and Dispersed in a liquid the food system is referred to as a suspension. Egg- mixture of flour in Water.
Depending on the relative affinity of the dispersed phase and the dispersed medium
Colloidal suspensions are of two types-
A. Lyophilic- solvent loving. For e.g. Water loving like skimmed milk, egg yolk, brewed
Coffee. These have high viscosity as there is more friction between the particles of the
Dispersed phase.
B. Lyophobic-solvent repelling. For e.g. Water hating like oil dispersed in water. These
Are less viscous.

SOLS

In a colloidal system, when solid particles are dispersed in a liquid and the colloid
Appears clear or opaque to the naked eye it is referred to as sol. However sols are not true
Solutions. Under the microscope, the dispersed particles are large enough to scatter and
Polarize the incident light to some extent. (This effect is called the TYNDALL EFFECT). for
Example-gelatin in water

Further when viewed under an ultra-microscope the colloidal particles are in a state
Of rapid and irregular movement this is called BROWNIAN MOVEMENT.

Altering the degree of dispersion of colloids-

In a sol having water as the continuous phase, the colloidal particles have an
Electrically charged surface. With the addition of a small amount of electrolyte (like sodium
Chloride that separate in water into + vet Na and –vet Cal) the oppositely charged ions are
Absorbed on the surface of each particle creating a potential difference between the surface
Of the particles and the solution. This is known as ZETA POTENTIAL. This stabilizes the
System.
If an acid is added to the colloidal dispersion the dispersed phase precipitates (settles out) this is because of the ions released by the acid.

Other factors that affect the degree of dispersion of colloids are:

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>INCREASED DISPERSION</th>
<th>DECREASED DISPERSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Fat globules in milk</td>
<td>Egg White coagulation</td>
</tr>
<tr>
<td>Mechanical Operation</td>
<td>Gelatin in water</td>
<td></td>
</tr>
<tr>
<td>Grinding, beating, stirring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acids</td>
<td>Gluten in fermentation</td>
<td>Acid in milk-curdles</td>
</tr>
<tr>
<td>Alkali</td>
<td>Gluten</td>
<td></td>
</tr>
<tr>
<td>Enzymes</td>
<td>Proteinase increases dispersion of Rennin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in Milk-Curdles</td>
<td></td>
</tr>
</tbody>
</table>

Gluten in flour
CHAPTER-9

BROWNING

During cooking or processing, the color of the food darkens, this change is known as browning.

Browning is sometimes desirable (like in maple syrup, coffee, brown crust of bread, Potato chips, baked goods, roasted nuts etc.) And sometimes undesirable (like in drying Fruits and vegetables, in canning, in concentrating orange juice)

Types of browning

1. Enzymatic browning
2. Non-enzymatic browning / Maillard’s reaction
3. Caramelization

ENZYMATIC BROWNING

This browning takes place in the presence of oxygen when fruits or vegetable tissues are cut during freezing, thawing or canning.

The fruits and vegetables classify-loose discolor when cut and are exposed to Air. Further, tannin and other phenol compounds undergo oxidation, by enzymes present in The tissues. This chemical reaction results in the formation of quinine which is responsible For surface discoloration. This kind of browning reduces the overall acceptability of the Food.

The presence of iron or rust catalysis the reaction.

The browning can be prevented by the following ways:-

1. When cutting vegetables like potatoes, plunge them into water immediately after. If They still classify wash under a stream of running water.
2. Cut all vegetables and fruits with a stainless steel knife.

3. When cutting fruits like apples apply a light ascorbic acid solution on the cut surface. Lemon juice or a light citric acid solution can also be used. (The coating of the surface prevents oxidation of the phenol containing compounds by the enzymes.

**NON-ENZYMATIC BROWNING**

This type of browning can be both desirable as well as undesirable, and can take place during cooking, processing, or storage of food. The Maillard reaction takes place between the carbonyl group of a reducing sugar and the amino group of protein, amino acid or peptide. It need not involve oxygen and takes place in a series of steps involving addition, rearrangement, fragmentation and finally polymerization.

This browning occurs in coffee, maple syrup, brown crust of bread, potato chips, baked goods, Indian breads, condensed milk and cheers.

However, Maillard reaction can cause deterioration and off-colors in orange juice and dried fruits due to uptake of oxygen during storage.

**Caramelization**

Caramelization is a chemical change that occurs in compounds containing sugar when they are heated to high temperature (160°C-177°C or 320-350°F) when heated without water, the sucrose crystals melt and a chemical breakdown begins. Continued heating then creates many different chemical compounds as a result of the breaking of the ring structures of the monosaccharides. This further leads to the caramelization of organic acids. This also does not require oxygen.

The browning takes place in vegetables with high sugar content like potatoes, carrots, onions apart from sugars.
Summary

Oxygen + phenols=quinines-enzymatic browning

Carbonyl group amino group =polymerization-mallard’s reaction

Sugar + dry heat =breakdown of sugar and organic acids-caramelization

**FLAVOUR**

Flavor or flavor is the sensory impression of food or other, and is determined Mainly by the chemical senses of taste and smell. The "trigeminal senses", which detect Chemical irritants in the mouth and throat, may also occasionally determine flavor. The Flavor of the food, as such, can be altered with natural or artificial flavorings, which affect These senses.

Flavor is defined as the combined effect of taste and aroma of food.

The flavor and aroma of food usually declines when it is handled processed or Stored, like in coffee, milk, and cooked meats.

However in certain exceptions the flavor of food is enhanced on processing like Cheese is ripened, wine is aged, or meat is aged.

Lu Bowie, has given the five main tastes as-

1. Salty
2. Bitter
3. Sour
4. Pungent
5. Sweet

Other tastes include
Metallic

Meaty or maim (Japanese term)

Astringent

Hans Henning- a German physiologist has given a list of six fundamental kinds of aroma:

1. Spicy
2. Flowery
3. Fruity
4. Resinous
5. Foul
6. Burned

Flavor in different foods-

1. Tannin-
   A mixture of strong astringent acids found in plants, particularly tea leaves, red grape skins and the bark of trees. It has the ability to coagulate proteins and is responsible for the keeping quality of fine red wines.

2. Tannic acid
   One of the acids in tannin used for flavoring and as a clarifying agent in beer, wine, cider, and other brewed drinks.

3. Caffeine-
   Coffee owes its characteristic flavor to caffeine although by itself caffeine without its aroma has a faint bitter taste. Coffee also contains alkaloids, volatile aromatic
Products and substances belonging to the phenolic series. It stimulates the central Nervous system. The composition of coffee is –

15.30%-nitrogenous substances
11.40%-fatty matter
70-2%-caffeine.

4. Capsaicin-contained in chilies and is responsible for their fiery flavour. It is an oily Substance insoluble in water. The heat of the chilly is measured in Sackville units.

5. Alien – responsible for the flavor of garlic. Garlic contains 0.1-0.36% volatile Alien (S-ally L-cysteine sulfoxide) enzymes (e.g. alliances, peroxidase and Myrosinase) adjoins, protein minerals vitamins etc.

6. Amygolalin- is present in bitter almonds and can be hydrolyzed to yield deadly Hydrocyanic acid (HCN)

7. Sin grin – is present in raw cabbage, which in the presence of heat is converted to Isothiocynate and ultimately to hydrogen supplied- a strong unpleasant smelling Compound. Therefore cabbage should be cooked for a short time, covered with a Lid.

8. Alcohol- wine has alcohol which refers to potable liquid containing ethyl Alcohol (C6H5OH) it denotes a class of organic compounds distinguished by the Presence of hydroxyl group. Alcohol is produced as a result of fermentation.

9. Proteins- the basic chemistry of meat exploits the properties of proteins mainly Actin and myosin which help in muscle movement by forming act myosin. The Fiber bundles of protein are supported by collagen (a connective tissue)

Protein accounts for 18% of total weight of lean meat 75% is water, and 3% if fat.
Collagen on heating becomes gelatin

Glycogen stored in muscles is converted to lactic acid which lowers the pH of muscles from 7 to 5.5 causing denaturation of proteins along with the B Vitamins, Nicotinic acid and meat bases. Therefore the change in the flavor and texture of Meat on heating.

10. Sculpture compounds- the onion family has strong flavors in the raw state but Reduce on heating. Onion contains many organic sculpture compounds like Trans-S, Cysteine sulphoxide, S-methyl cysteinesulphoxide and cycloallin. Except for Cycloallin the sculpture compound are converted into simpler forms by the enzyme Alliance when the onion is crushed or cut. The lachrymation effect- i.e. tear Producing effect of onion is due to thiopropanal S-oxide produced from its Precursor Trans-S (l-progeny) cysteine sulphoxide by the action of allinase.

CONDIMENTS

Condiments are aromatic substances added to food to improve its flavor.

The term “seasoning " is applied to substances which are added at the time of cooking While “condiments” apply to those added at the table to food already prepared.

Condiments are classified according to their dominant flavors:-

1. Acid- vinegar, lemon juice
2. Bitter (aromatic) - pepper, paprika
3. Bitter- garlic, shallot, wheels onion, spring onion, leeks
4. Fat- oil, butter, fats
5. Readymade condiments –English sauces (Worcestershire, Harvey) ketchups, curry
Powders, prepared mustards, soy sauce etc.

6. Salt condiments-sodium chloride, sea salt

7. Sweet condiments-sugar, honey.

**SUMMARY**

<table>
<thead>
<tr>
<th>FOOD</th>
<th>FLAVOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEA</td>
<td>TANNIN</td>
</tr>
<tr>
<td>COFFEE</td>
<td>CAFFEINE</td>
</tr>
<tr>
<td>MEAT</td>
<td>ACTIN, MYOLIN, COLLAGEN</td>
</tr>
<tr>
<td>WINE</td>
<td>ALCOHOL</td>
</tr>
<tr>
<td>FISH</td>
<td>PROTEIN, PUFA, VITAMIN A, VITAMIN D</td>
</tr>
<tr>
<td>CABBAGE</td>
<td>SINIGRIN  ISOCYNATE &amp; HYDROGEN SULPHIDE ON OVERCOOKING</td>
</tr>
<tr>
<td>ONION</td>
<td>SULPHUR COMPOUNDS THIOPRORANAL S-OXIDE ON CUTTING</td>
</tr>
<tr>
<td>GARLIC</td>
<td>ALLIN</td>
</tr>
<tr>
<td>CHILLIES</td>
<td>CAPSACIN</td>
</tr>
</tbody>
</table>