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What is Food Technology

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What is Food Technology

Food Technology can be defined only by understanding the **Food Science.**

Food Science is the study of principles of *food processing & physical, chemical, and biochemical nature of foods, etc.* by applying the basic sciences and engineering.

a) *Food processing principles* include heat transfer, mass transfer, fluid flow, mixing, separation process, etc.

b) *Physical properties* of foods include color, texture, rheology of foods, etc

c) *Chemical properties* of food maybe its pH, ash content, protein content, etc.

d) *Biochemical properties* include the study of structural and chemical properties of biomolecules like carbohydrates, proteins, nucleic acid, lipids, etc.

From the study of Food Science, we get some information.

Then, ***Food technology*** uses that information in selecting, preserving, processing, packaging, and distribution.

Food Science and Food Technology are nowadays used interchangeably. Other specializations are required to study, like Food engineering, Nutrition, Food microbiology, etc.

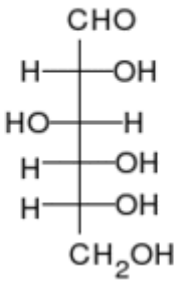
Subjects & Career in Food technology

The core subjects in Food Science and Technology course are as follows-

1. Food Chemistry
2. Food Analysis
3. Food Microbiology
4. Food Processing
5. Food Engineering

Food Chemistry-

We study the composition, structure, and properties of foods. Also, the chemistry of changes that occur during the processing and utilization is examined.

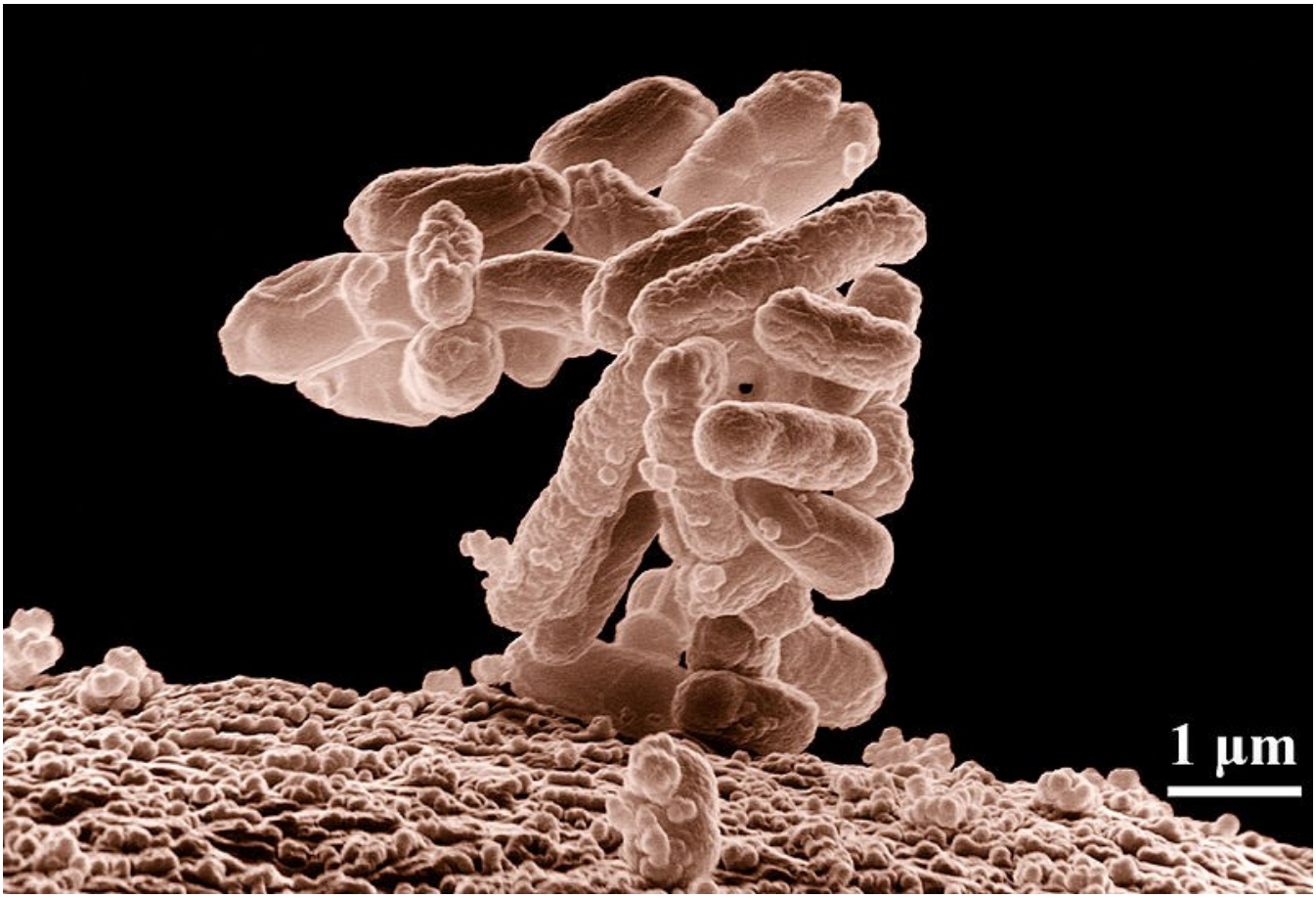


Food Analysis-

Covers the principles, procedures, and techniques to analyze the food products quantitatively by either physical or chemical analysis. Determination of moisture is one if the common procedures used in food analysis labs

Food microbiology-

Here, we see how food spoilage by the microbes can be prevented, how to examine the food products in terms of public safety. To understand food microbiology, the study of general microbiology is a must.



Food Processing-

We see characteristics of raw food materials, their preservation methods, factors related to processing, quality check and packaging, etc.

Food Engineering-

Here, we study engineering concepts and unit operations that are used in food processing. The main principles are material and energy balances, fluid flow, thermodynamics, heat and mass transfer. But we should learn physics and calculus as prerequisites.

Other additional courses in food technology & food science-

- Food Laws & Regulation
- Sensory Analysis
- Toxicology
- Biotechnology
- Food Physical Chemistry
- Advanced Food Engineering

Food technology jobs -What do Food Technologists do?

Around 2 billion people do not have enough food to eat & as many as 40000 people die every day from diseases related to inadequate diet, for example, lack of sufficient proteins, etc.

We are well known for the condition due to protein deficiency called Kwashiorkor. Marasmus is another widespread disease due to protein-calorie malnutrition.

Food technologists around the world are working on finding new innovative and feasible solutions to eradicate diseases like Kwashiorkor, Marasmus, etc. in addition to making the life of people more convenient in terms of food consumption and behavior.

Let's see the involvement of Food technologists in following cases-

Finding solutions for Lactose Intolerance

Food technologists have dried liquid milk to make the concentrated source of protein and calories, but it comes out to be expensive.

Also, many people have lactose intolerance, in which they cannot digest the lactose, and they develop flatulence.

So, these challenges are in front of the food technologists, for which they are finding solutions.

Searching alternate cheap sources of Protein

Protein sources are mostly expensive.

However, few fish species which are not commonly eaten can be used to make flour and can be used as a source of protein cheaper than above. The food technologists are working on it.

Incaparina challenge for food technologists

Incaparina, a cereal-based formulation, was made of a mixture of maize, cottonseed flour, and sorghum. This mixture was mainly used in Latin America since 1950.

Many food technology research activities along with clinical and acceptability trials showed that Incaparina was much effective in the treatment of severe protein malnutrition in children.

Miltone, an innovative product developed by Food Technologists

Miltone was a food packet prepared by Indian scientists, which comprises of ingredients like, cow/buffalo milk, hydrolyzed starch syrup, and peanut protein. This product is still widely available in India.

The main motive behind the preparation of such a product like Miltone is to overcome the shortages of milk. This was done by mixing milk with an emulsion of protein extracted from groundnut.

Miltone has a similar composition as that of toned milk. Milk has 3.5% content protein content, while 2% fat and 5% sugar content.

Convenience Foods, a boon or a lazy plate?

Food technologists continuously work to find out new products that ease the steps in either processing or during the ingestion of foods.

For example, pre-packed fruit juices are very convenient to consume and discard thereafter. Similarly, processed and pre-cooked rice offer immense time-saving.

Taking Food technology to the skies & beyond

Food technologists have immensely contributed to the space shuttle programs. For example, by sealing food into vacuum packs, and, at the time of consuming, only water is added and shaken, making the food, ready to eat.

Choosing between natural or artificial sweetener (Aspartame)

Nowadays, it is common to develop new products and alter their vitamins or mineral content.

For example, high caloric foods are not suitable for people having cardiovascular problems. So, the professionals of food technology try to reduce the caloric content by using non- nutritive components.

Used soft drinks are sweeter because of the addition of non-nutritive sweeteners like Aspartame or Saccharin. So, these non-nutritive sweeteners are far better than the nutritive sweeteners like sucrose. Aspartame contains the same number of calories as sucrose, but it is 200 times sweeter.

A very less amount of Aspartame is used to produce the same amount of sweetening effect, as it may be done by sucrose. And the caloric content is also reduced.

Replacing fats in ice-cream with Proteins

Many food technologists have tried to reduce the caloric content of fats also. Generally, the caloric content of fat is nine calories/gram. Whereas protein as four calories/g.

So, the food technologists tried to replace the fat in ice creams with particular proteins. Since fat globules in the ice cream give a smooth texture to it, proteins can also provide the same texture if they are specially treated.

Hence, by using the proteins instead of fat globules in the ice cream, food technologists are able to decrease the caloric content of the ice cream from 9cal/g to 4cal/g.

Adding Supplements when required

Cereals are used widely used as breakfast due to their nutritional content. Food technologists have tried to add additional desirable minerals and vitamins into these breakfast cereals to provide an all-day supply of several nutrients.

Special care is taken to prevent any change in the flavor or appearance of the cereals upon adding the vitamins or minerals.

Food Technology & Controlled Atmospheric packaging

Food technology has come a long way since its inception and application in a variety of foods. One of its primary and widely used applications is the Controlled atmosphere Storage of the Fruits and vegetables.

A controlled atmosphere packaging of fruits and vegetables is a type of storage in which the concentrations of oxygen, carbon dioxide or nitrogen can be regulated. Also, the temperature and humidity of the room or packaging can be manipulated according to the desired needs.

The fruits like mangoes are harvested and stored at a place; they still respire till the oxygen-depleted. When the fruits respire, they take the oxygen inside and release the carbon dioxide.

So, even after harvesting, they continue to mature and ripen due to their respiration, i.e., the intake of oxygen.

So, by using Control Atmosphere Storage as an application of Food technology, the air in the atmosphere is depleted of the oxygen content and enriched with extra carbon dioxide.

Hence the respiration of the fruits is slowed, and the ripening process is also delayed.

The innovative use of food technology has sharply decreased the spoilage of fruits and vegetables by enhancing their storage time up to years.

For example, when lettuces are transported in a refrigerated truck from one point to another, low oxygen-controlled atmosphere storage is used.

Liquid Nitrogen preservation and food technology

One of the best gifts that food technology has given in the preservation of foods is the rapid freezing of vegetables or other delicate foods with the help of liquid nitrogen or different low temperature (cryogenic) liquids.

When the fruits or vegetables are frozen, the ice crystals are formed between the cells, which make the tissues of fruit or vegetable pulpy in texture.

RAPID VS SLOW FREEZING

a) If the freezing is slow- then large crystals form between the cells & they can rupture the cell wall.

So, when the fruit/ vegetable is thawed to remove the frozen stage, the fruit looks very pulpy, and in turn, the liquid starts draining from it. Tomatoes show pulpy texture when frozen slowly.

b) If the freezing is rapid- tiny ice crystals are formed, so their surface area is max, which immediately freezes the cell components, including the cell wall.

So, the cell wall doesn't get a chance to get ruptured, and when the fruit/ vegetable is thawed, it retains its original texture, and no soft pulping is seen.

Hence, the rapid freezing is better than the slow freezing.

Preventing Food Poisoning Outbreaks

Food technology knowledge helps us to judiciously apply its principles to food processing, storage, and preservation methods to prevent food poisoning outbreaks.

Poisoning is the occurrence of a disease or illness due to the consumption of food. Generally, disease-causing viruses, bacteria, parasites, etc. are responsible for food poisoning.

Food technology professionals are responsible for the prevention of such outbreaks from pathogenic organisms, to handle the outbreaks, ensuring proper regulations are followed, etc.

Outbreaks are majorly caused by improper food preparation, handling, and storage, and the significant outbreaks happen in restaurants, cafeterias, or hospitals.

Poisoning by E coli is very common, which can cause severe fatal cases too.

For example, once undercooked beef was served in the hamburgers, which took many lives in a restaurant. The cause of the deaths was the type of E. coli bacteria, called

O157: H7, which mainly arises in raw beef, etc.

Another bacterium is Salmonella enteritidis, which arises due to undercooked eggs or poultry contaminated with it.

Clostridium botulinum is a type of bacterium that arises mainly in canned foods. The food technology professionals around the world are trying to minimize the defects in the canned foods to prevent Clostridium botulinum poisoning.

This is mainly a processing defect and occurs when the canned food products are not heated enough to kill the anaerobic Clostridium bacterium.

Note that the Clostridium botulinum bacterium is an anaerobic bacterium, i.e., it only survives in an oxygen-less environment.

Food technology professionals study each outbreak and respond to prevent possible future outbreaks.

Kapchunka fish outbreak

One such example is of Kapchunka fish outbreak due to the Clostridium botulinum.

Kapchunka is a white fish, and it is prepared without cutting any of its internal organs. So firstly, it is soaked for some time in a salt brine and then dried in air. Then packaging is done as it is and stored at room temperature.

According to the source, botulismlegalhelp.com,

Uneviscerated, salt-cured, whole fish products have been linked to the following fatal botulism outbreaks in the past.

Case-1: The United States, 1981–1087:

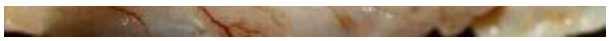
Three outbreaks of botulism causing three deaths and 11 illnesses are linked to Kapchunka, an uneviscerated, salt-cured, air-dried whole whitefish.

Case-2: Egypt, 1991:

Two botulism outbreaks resulting in 91 illnesses and 18 deaths are linked to Faseikh.

Faseikh is made by fermenting uneviscerated fresh mullet, followed by a salt-curing.E.coli sign at cattle shelter showing information to wash hands for the avoidance of diseases

We know that Clostridium botulinum is anaerobic, so it grew in the intestinal tract of the fish and produced toxins, which resulted in one individual and several ill in the above case.



Thus, special care is to be paid by food technology and other related food professionals.

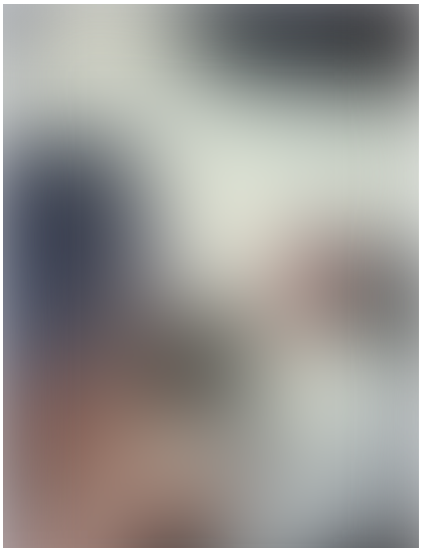
Indirect modification of Foods like butter or egg yolk

The modification in the feeds of animals to obtain rich products from them is another field of continuous research by the food technology professionals.

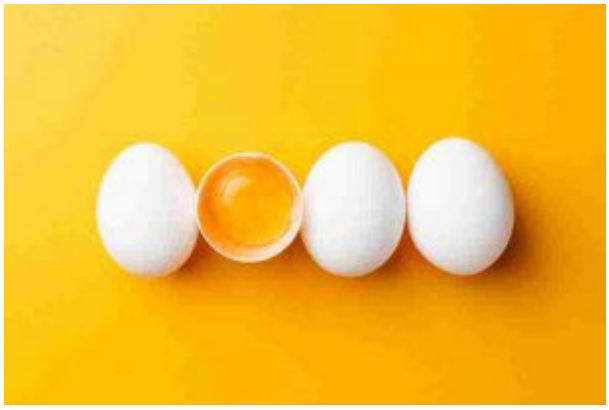
For example, the color of butter varies in the winter and the summer seasons. In the winter seasons, the sunlight is less available to the feed, so not so much green pasture grows, which in turn allows the butter to turn to pure white color, which is not widely desired by people.

People mostly love yellow butter because of the carotenoid content in it, which comes because of the green pasture.

But in winters, the carotenoid content is less, so butter looks white. So, the food technology researchers recommend feeding the cow/ buffalos with carotenoid-rich feed, to increase the yellowness of the feed.



Similar is the case for the egg yolks, which look yellow due to the carotenoid content present in them.



To ensure the yellow color of the egg yolk, food technologists try to incorporate carotenoid-rich feed to the chicken.

Researches in Food technology

Food technology principles allow the researchers to develop and modify desired flavors. For example, developing a cooked meat flavor with the help of fats and carbohydrates are used to produce fruity flavors.

Fermentation in Food industries

Beverages like wine require the fermentation process. The fermentation process takes one of the most significant shares in the current global food technology market.

Apart from wine, cheese manufacture also requires the fermentation process to curdle the milk and obtain the final product.

The conventional method of production of cheese requires the rennet enzyme to coagulate the milk. The rennet enzyme is obtained from the inner lining of the calf's stomach.

But to allow mass production if the cheese, rennet enzyme is also required in a considerable amount. So, food technology professionals are trying to produce enzymes that are readily produced and available artificially.

So, recombinant DNA technology is used to create new strains of enzymes that require less fermentation capacities and cost as compared to the conventional rennet enzyme production and utilization.

Hence, these purified enzymes are used in the cheese manufacture by the food technologists.

Apart from cheese and wine, other fermented products are bread, sauerkraut, sausages, etc.

Some concerns to the Food technologists

One of the concerns the food technologists are facing is the availability of the raw materials and the cost associated with it.

For Example–

Baker's yeast, also called Saccharomyces cerevisiae, is widely used as a leavening agent in bread.

It helps to produce carbon dioxide (CO2), which is trapped inside the layers in the breads.

So, the concern is regarding the preparation of the Baker's yeast. The Baker's yeast is commonly grown on molasses. We already know that molasses is produced as a by-product in sugar manufacturing.

But nowadays, the sugar manufacturing process is diverted in such a way to produce alcohol directly, without producing the molasses. So, the prices of molasses are rising, which is a significant challenge in front of food technology professionals.

One option that is available in front of the researchers of food technology is to search for other carbohydrates on which the Baker's yeasts can be grown.

Electrodialysis & Membrane Separation

The field of food technology is always aiming higher to achieve safer and healthier food for the public.

For example, food technologists are trying to separate ions of specific food drinks. We know that food drinks contain ions say the cations and anions.

If the desire is to remove anions from the drinks and retain the cations, different methods are used nowadays by the food technologists like electrodialysis, membrane separation, etc.

The electrodialysis process involves two electrodes in which one is positive while the other is negative.

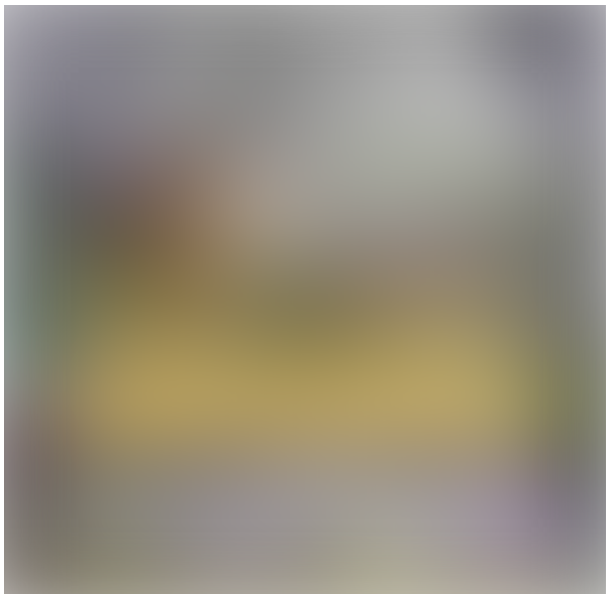
So, in order to separate the desired ions from the fluid drinks, different charged plates are set up in the electrodialysis system. Sometimes, multiple electrodialyses is also performed, in which the food fluids are to filtered manifolds.

Membrane separation is also utilized by the food technology researchers to separate the desired ions. The membranes have specificity for desired ions, and hence they are separated because anode and cathode are attached at the ends.

Modernization in Food Industries

Nowadays almost all the food processing companies and their manufacturing units are computer-controlled in almost all or in semi-way.

The machinery is full computer-controlled in the fryer for the potato chips or tortillas frying or for crunchy Doritos.



Watch this video on '*Heat and Control*' fryers by clicking below- (Source- Heat and Control)

DRUM ROLLERS-

We also get different flavored chips in the market, because different seasonings are sprinkled on them with the help of **drum rollers.**

The drum rollers (seasoning drums) have weight-sensitive sensors, and they continuously check the amount of seasoning that is passing through the detectors.

If the flow rate of the chips passing through the conveyor is increased suddenly, then the seasoning flow is also manipulated as per the algorithmic calculations.

Other automated food manufacturing plants deal with baked goods, frankfurters, ice-cream, margarine, etc.

But despite the automated manufacturing plants, there will always be the requirement for food scientists, food quality control inspector, food safety supervisor, manufacturing supervisor, factory stock checker, accounts department, etc.

Main components of a Food Industry

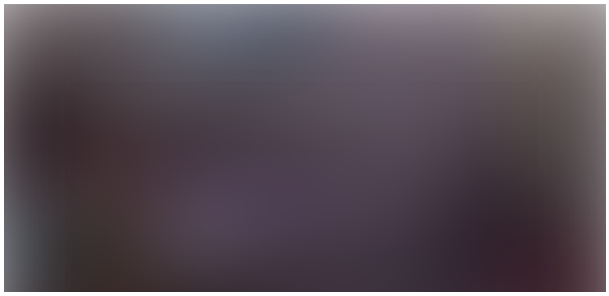
The functioning of any food industry can be divided into four segments-

1. Raw material production
2. Manufacturing
3. Distribution
4. Marketing

Raw material production-

The raw material may be either agricultural produce like rice or wheat harvest, and, fishing also includes in it.

So, plant and animal cultivation are both involved in the process of Raw material Production.



Gardening is also one of the components that is counted in the raw material production.We have to decide about our desired plant or animal breed which we have to grow in order to get the final produce.

Manufacturing-

Now, since we have obtained the raw material in the above step. Now in the Manufacturing process, the raw material is converted into a more finished or refined processed product.

Manufacturing processes involve the whole series of unit operations that are directly related to the activities to the food technologists and the core syllabus of food technology.

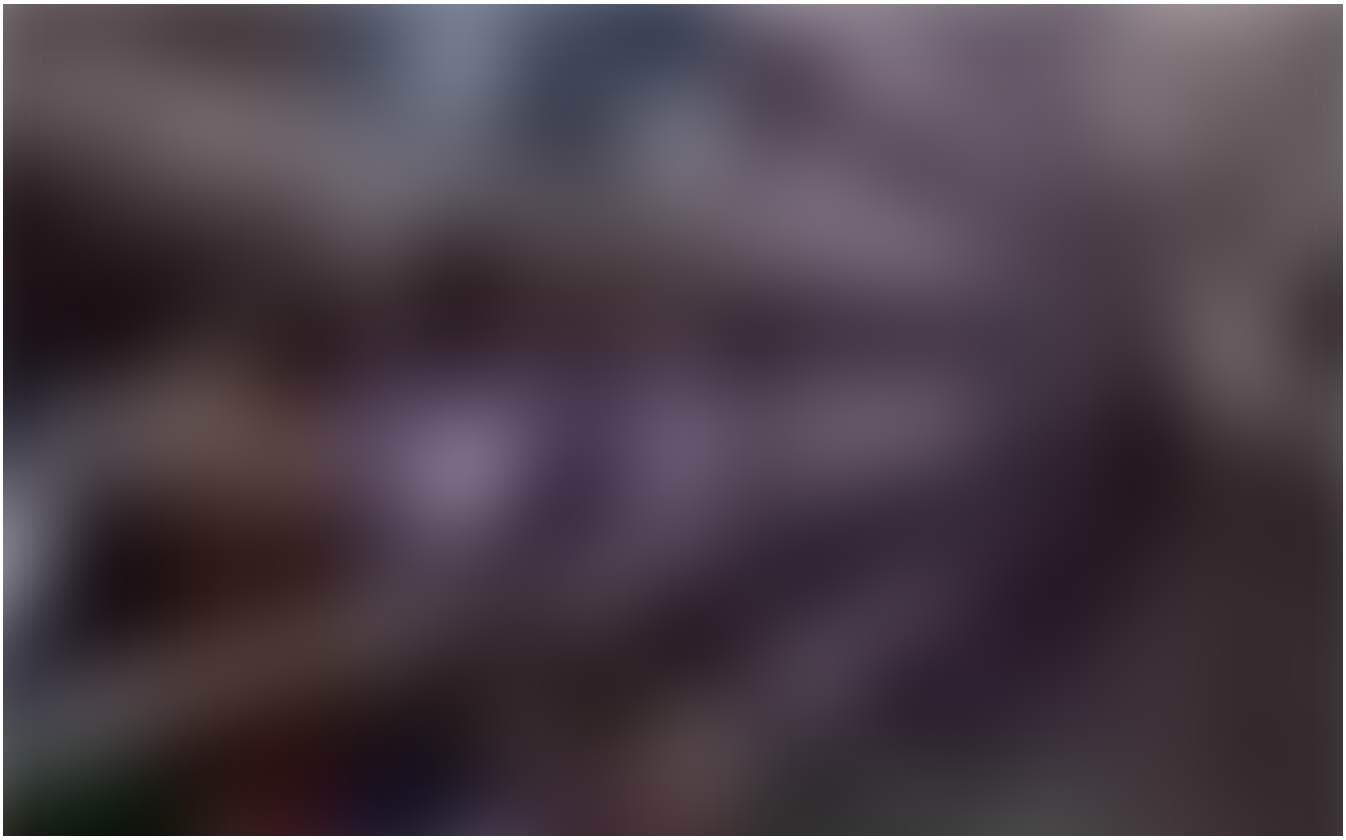


Figure description-

a)Live chickens are raised in the industrial farm and are kept here until they are butchered

b) Poultry meat eviscerated and cut into small parts and ready for further treatment and packaging

c) Poultry processing line- Here the outer skin is removed and mechanically the edible pieces are cut further

Distribution-

Distribution means transporting the product in either in bulk or packaged form to the desired stakeholders. The storage requirements and other shelf parameters for the product distributed are properly taken in mind by the food technologists.

Marketing-

It involves the promotion, selling of the produced goods in different places of consumer involvement. Marketing includes the extensive use of e-commerce nowadays.

Along with the four main steps as mentioned above, the main challenge in front of the food technologists in applying the core applications of food technology is estimating

and balancing the relative value of the different operations that are to be performed in the sequence of the food industry.

For example:

In the animal meat industry, the high cost is in the farm production for the animals that are raised for the meat, in their caring, etc., and in contrast, the lowest cost incurred is in its processing and packaging.

However, if we talk about the Canned tomatoes manufacturing sequence steps, the highest cost incurred is in the processing and packaging because the canning process itself has a lot of steps.

Canning involves steps like selecting the adequate tomatoes, sorting/grading, washing, peeling, bleaching, can filling, brining, lidding (clinching), exhausting, sealing, washing cooling, and finally labeling and cooling. So, this number of steps will automatically take a lot of time, effort, money, etc. in its completion.

Contrastingly, in the farm production of the tomatoes, the cost is minimal, as compared to animal meat production.

So, we can assume the contrasting differences in the value obtained by different sequences of manufacturing products in the food industry.

Hence, it is a challenging task for the food technologists in applying the food technology principles here, and to regulate the pricing differences with the help of another team, but not the toughest job to perform.

So, overall, we can say that there is a lot of strategic planning that is involved in operating the food industry.

The food technologists, along with the other technical supports, really have a responsible task to make the things working in a place and rectify the errors as soon as possible, to smoothly run the production line or sequence of operations in the food industry.

The main constituents of food

Food Technology involves utilizing help form almost every field and then combining to obtain our desired result.

We will now talk about the various constituents of foods in which the food technology professionals have to deal about.

The main constituents of food are –

1. Carbohydrates
2. Proteins
3. Fats & Oils
4. Natural Emulsifiers

5. Replacers and new Ingredients
6. Organic Acids
7. Flavors
8. Vitamins and minerals
9. Natural Toxicants
10. Water
11. Oxidants and Antioxidants
12. Enzymes
13. Pigments and colors

These constituents are available naturally in the foods. But if people or manufacturers fell that some constituents are missing, so deliberate addition is also done by them.

For example, the wheat flour nowadays is also fortified with iron, folic acid or vitamin B12, etc. for the prevention of anemia and enhancing the blood formation.

Now we will discuss one by one each of the constituents of food.

The food technology professionals must have sound knowledge in these constituents, then only they can make decisions regarding the change in compositions for their new product that is to be launched, choosing analog or replica constituents over the already used constituents in the newly made food, etc.

Food technologists consume this knowledge and apply it to obtain the desired results related to the field of food technology.

(1) Carbohydrates-

We eat them every day, in the form of rice, wheat, beans, potatoes, spaghetti, maize or even soft drinks, etc.

We can break the word 'carbohydrates' into (carbon+ hydrates), i.e., carbohydrates are the hydrates of carbon. Or we can say that carbohydrates are those compounds in which the water molecules are added to the carbon atoms.

We also know that carbohydrates can also be written as Cx(H20)y. Here y number of H2O molecules are attached to the x number of carbon C atoms.

Simple carbohydrates are roughly called Sugar in broader terms.

One of the most widely used carbohydrates may be Sugar. Be it ice-cream, soda juice, cookies, pastries, ketchup, breakfast cereals, sweetened yogurts, sweetened milk, honey, fruit juices, and even in the processed meats.

Some of the simple carbohydrates are Glucose, mannose, etc.

Glucose, as we all know, is a six-carbon sugar, and it forms a ring structure. These simple carbohydrates are also called Monosaccharides.

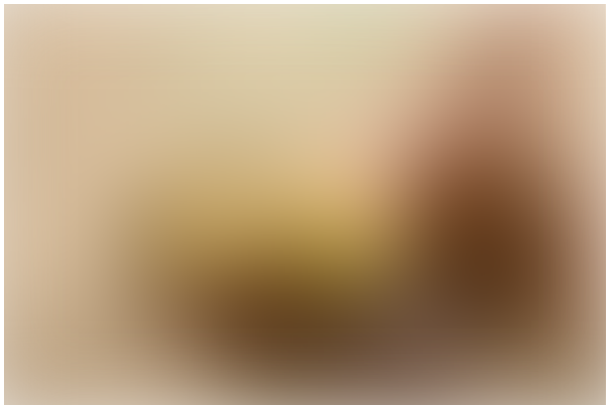
Disaccharides and Polysaccharides

If we talk about Disaccharides, these are formed when two glucose or other monosaccharide units are chemically joined together by the expulsion of water molecules.

The disaccharides are made up by combining the simple sugars. Similarly, these simple sugars are the building block of the more complex carbohydrates like the trisaccharides or even the polysaccharides.

In turn, we can also say that the polysaccharides can also be hydrolyzed into simpler sugars like dextrin, Glucose, etc.

Beet sugars and cane sugars are very common examples of disaccharides and are formed by the reaction between Glucose and fructose.



The food technology professionals frequently use the term, Reducing sugars.

What are Reducing Sugars?

We know the structure of Glucose or other carbohydrates can be shown by line diagram in which horizontal or vertical lines draw the Carbon, hydrogen, and other functionals groups.

There we show the cyclic structure also, in which the CHO (aldehyde) group is either free or not free.

Suppose the structure of Sucrose, which is made by combining two other monosaccharides i.e., Glucose and fructose.

So, these two monosaccharides join through their aldehyde or ketone groups only. Thus, these functional groups are now busy and occupied; hence the aldehyde or ketone functional groups are not free, and they cannot reduce other compounds. So, in turn, they are called non- reducing sugars.

In contrast, if the functional group is free, i.e., if the aldehyde or ketone group is free in a carbohydrate structure, then that carbohydrate is called Reducing sugar.

Additional info about Carbohydrates

Carbohydrates have wide applications and presence in the food science and technology research along with the growing interests among the food technologists.

They are produced by the photosynthesis process in the green plants, and it is the natural way to store the energy from the sunlight.

We well know that carbohydrates store energy in plants in the form of starch and animals store in the form of glycogen.

Plants and animals can use this stored energy from their reserves, i.e., from starch or glycogen, respectively, during their need or in any emergency situation.

Properties(P) of Sugars

We know the famous examples of sugars as Glucose, maltose, fructose, sucrose, and maltose, etc.

Let us see the exciting properties of Sugars below-

P1- Sweet in nature

They are mostly used for their sweetness property, so added in cakes, pastries, juices, dairy products, baguettes, desserts, sweets, etc.

P2- They form crystals

They have a very interesting property of forming crystals when any sugar solution is evaporated by providing heat or by using natural sunlight.

This same evaporation principle of the sugar crystals is used in the sugarcane industries to get sugar crystals. The sugar or sucrose crystals that we use daily.

P3- Good Solubility

Due to the soluble nature of the sugars, they are commonly used to prepare sugar syrups. Very less effort is required to mix the sugars into any liquids.

P4- Provide energy

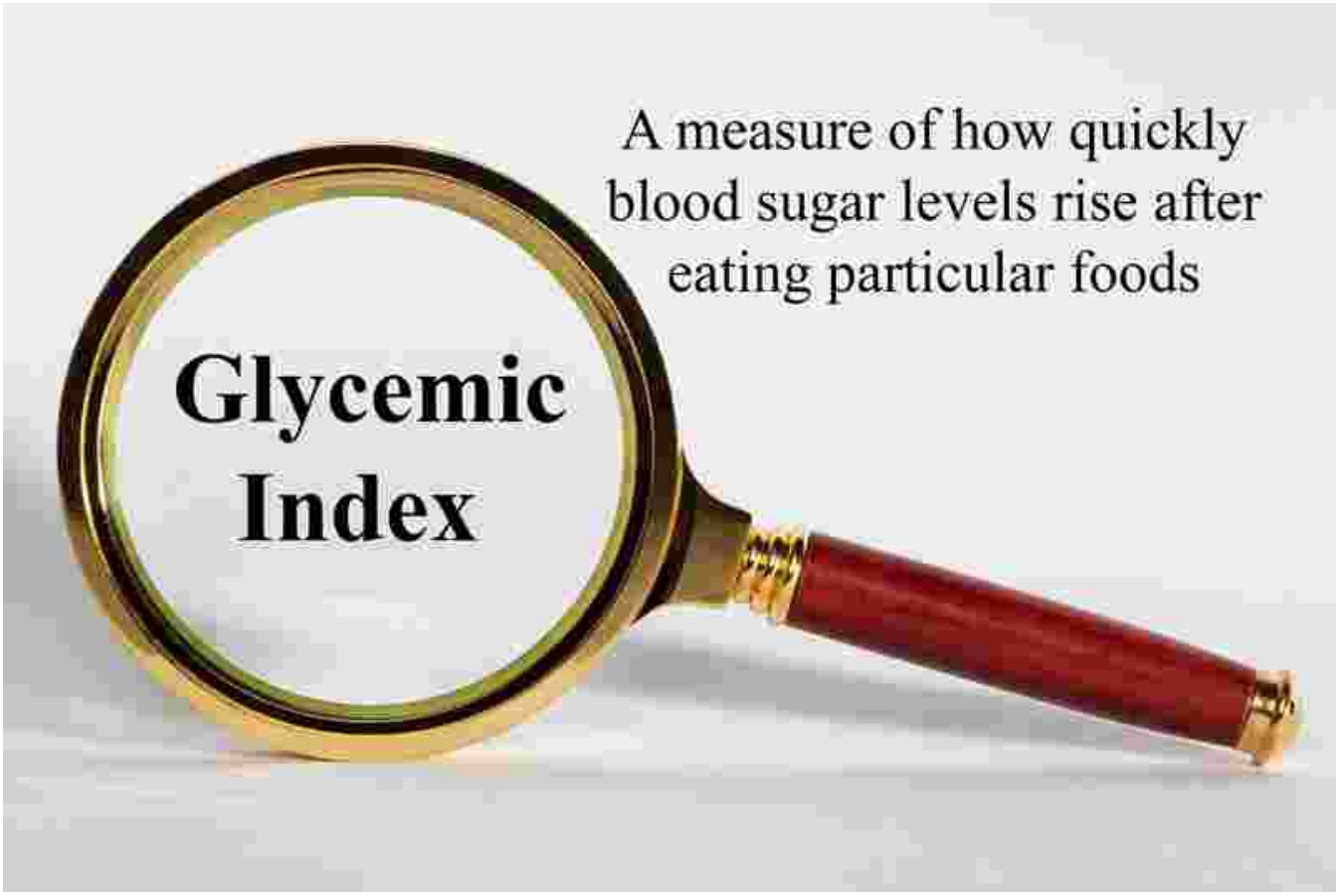
They provide energy too. For example, we use Glucose powders, which are basically Glucose monosaccharides.

Instant energy by glucose-

Glucose provides instant energy when consumed and hence readily and quickly absorbed by the walls of the small intestines. So, after reaching the small intestines and absorbed from it, they enter into the blood and may change the sugar level in the blood.

One of the main challenges in front of the food technology professionals is to maintain the sugar amount in their designed food products.

That too in such a way, so that minimum side effect is seen in the consumers. The food technologists have to develop food products with such food constituents' proportions that maintain the sugar release in the blood at a desired quantity and pace.



If the sugar release in the blood is instant, i.e., suppose I consumed a sweetened pastry, it was very easily digested in my body and quickly assimilated into the small intestine.

Hence rapidly absorbed via small intestine into the bloodstream, thus raising the blood sugar level abruptly so that I may face some health risk at that time.

In that case, I have to take insulin in order to minimize the effect of the increased blood sugar level.

Low sugar release in blood

Similarly, sometimes low sugar is released in the blood than required. That is also a chance for an emerged problem.

So, these cases create a sense of responsibility in front of the Food technology professionals to accurately observe the demands of specific people who have certain restrictions in their diet or prohibitions as per their health.

Food technologists are nowadays finding new innovative ways to formulate new diets to curb the problems of immediate or slow release of sugars in the blood.

P6- Caramelization

Food technology and food science professionals, along with other allied sectors' people like chefs, etc. take advantage of caramelization to a very greater extent to improve the appearance and texture of the food.

Caramelization is simply the occurrence of browning on the food surface, and the chemical reaction is mainly the removal of water & breakdown of the sugar.

During the reactions, volatile chemicals are released, producing the characteristic caramel flavor, which creates the brown color.

As we all know, Caramel is also a very famous food colorant that is widely used in the world of food beverages.

For example, in North America, Caramel is the most used food colorant used in the Coke and other coke type drinks. It gives Coke a unique brown flavor and color, which is widely accepted by people across the world.

According to the website, https://www.scienceofcooking.com/caramelization.htm, the caramelization temperature of Sucrose, Glucose, and galactose is around 160C, while for the fructose, it is 110C.

P7- Sugar & its hygroscopic nature

Sugars can prevent the growth of microorganisms as the sugars are a well-known moisture absorber just like salts.

Since most of the microorganisms are require a particular water activity to survive, the presence of sugar limits the availability of water or the moisture content present in the food.

Similarly, we have widely seen that salt is applied on the butchered surface of the meats, which are kept for sale in the open market.

The main reason why salt is applied in the food surfaces is to preserve the meat pieces to last long in the open. Salt decreases the water activity on the surface of the meat product, and hence microorganisms can't survive under this situation.

P8- Maillard reaction

The food technology professionals also utilize the reaction between the amino acids present in the food proteins and the reducing sugar in many applications in new product development and other modifications in the foods. This reaction is very popularly called Maillard Reaction.

P9- Provide texture

The sugars can also be used by the food technology professionals to make the body of the food and to look solid in terms of texture.

For example, if the newly developed semi-solid food has become more fluid and its viscosity has decreased, then to reverse it and to attain the desired flowability and rheology, some food of specific property is added in the product.

P10- Evolution

The food technology field has certainly evolved much greater in the last decades.

P11- Enzymatic reactions

One of the best examples of using the food technology principles by the food technologists is the preparation and development of an enzymatic process to obtain fructose from its isomer, Glucose.

We already know that fructose is sweeter than Sucrose or Glucose. So, it is better to convert the obtained fructose in large amounts from Sucrose or Glucose.

Thus, the primary reaction involved in this conversion of Glucose to fructose or Sucrose is Isomerization. Glucose has the isomers like fructose and Sucrose, and the isomerization of Glucose obtains them.

Nowadays, the dependence on fructose as a direct raw material has been reduced to a certain extent due to this production method.

In this specific method, the food technologists and other allied professionals are trying to obtain fructose from starch directly. We know starch is of two types, amylose and amylopectin.

Amylose is made up of simple glucose units in a straight chain, whereas amylopectin is a branched-chain of glucose molecules. So, starch is taken and hydrolyzed (broken down into smaller glucose molecules) in order to get Glucose, and then those glucose molecules are converted to fructose or Sucrose.

Properties(P) of Starch

P1- Components of Starch

Starch may be divided into amylose and amylopectin. Since starches are made up of Glucose subunits, yet, they are not sweet in nature.

P2- Good Solubility

If we dissolve the starch powder into hot water, they are soluble easily, and they form a gel-like solution, which is partially opaque. However, in contrast, starch molecules are not readily soluble in cold water.

P3- Gelatinization and Retrogradation

The food technology professionals experiment a lot with some of the properties of starch like Gelatinization and Retrogradation. These two terms are related to starch granules.

When the starch granules are allowed in contact with water, they absorb water and start swelling until they burst. On bursting, their stored content gets mixed and thus make a viscous semi-solid gel-like substance.

This process is called Gelatinization. However, a specific temperature of the water is required to attain Gelatinization.

The obtained gels have a high viscosity, and because of this reason, these gels are widely used to make thickener to increase the rheological properties of foods like the viscosity, as discussed before.

If the gels are frozen, they can revert to the original insoluble form, and this is called Retrogradation.

P4-Altering rheology of Starch gels

If the food technologists want to decrease the viscosity of the thickened gel, they can break the glycosidic linkages between the glucose molecules that are the fundamental constituents of the starch molecule.

Or if the OH (hydroxyl groups) is oxidized (i.e., oxygen is added to the OH group by removing the oxygen), then also, the desired goal can be achieved.

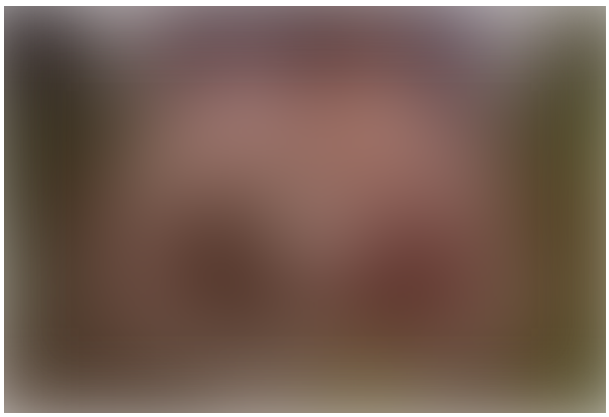
(2) Proteins

Proteins, as we know, are made up of amino acid monomers, and these monomers join in different sequences to form different proteins having different specific proteins.

There are many sources of proteins in food like meat products, cheese, milk, peanuts, soybean, pulses, etc. Proteins are a must in our daily diet.

There are instances of diseases linked with the deficiency of proteins such as kwashiorkor or Marasmus etc.

Food technologists and other food science experts have already developed many protein-rich mixture diets toward the elimination of such diseases among people and especially malnourished kids.



Plumpy'Nut example

Plumpy'Nut is a peanut-based mixture that is used to treat severe acute malnourished children. A French Nutrition company manufactures *Nutriset*.

Plumpy'Nut is recognized as a Ready to Use Therapeutic Food (RUTF), which means it is specifically made for a therapeutic purpose and health supplementation like eliminating malnourishment by emerging feeding.

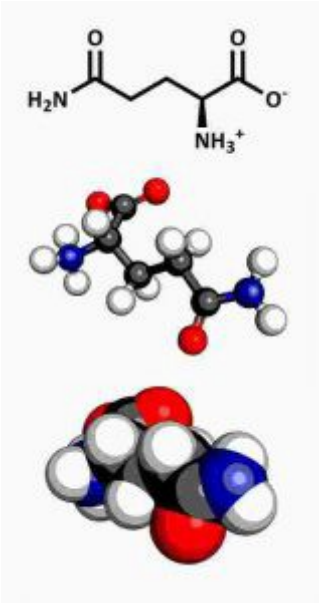
Source — Source

Details about Amino acids

We know that amino acids have an NH2 group (amino group) and a carboxylic acid i.e., COOH group.

The amino acid group is, in general, basic in nature, so it can accept the hydrogen ion or the hydronium ion. The carboxylic acid (COOH) are acidic in nature, so they can readily lose the hydronium ion or the hydrogen ion.

Hence the amino group of one amino acid can easily combine with a carboxylic acid of the other amino acid so as to proceed with the favorable chemical reactions. And when this reaction happens, there is a formation of a peptide bond.



The food technology professionals continuously try to improve the shelf life of animal foods. The main reason for giving extra care for the preservation of animal foods like beef, chicken, etc. is PUTREFACTION.

Putrefaction-

Putrefaction is the degradation of the protein in the foods. The organic matter present in the menus is degraded by either bacteria or fungus infestation, which in turn causes the release of gases making the tissues or organs inflate with gases.

So, in the putrefaction process, the peptide bonds are broken, and then the above-stated degradation occurs.

If two amino acids react with each other, then dipeptides are formed. Similarly, tripeptides are formed when three amino acids react and form the three amino acid products.

There are mainly 20 primary amino acids that make the enzymes, blood proteins, human tissues, etc.

Eight of the 20 amino acids are essential amino acids. These are called essential amino acids because of their non-availability in the body, and we have to provide these essential amino acids externally with the help of food containing these acids. So, these are not synthesized by humans.

Examples of Essential Amino acids-

- Methionine,
- Leucine,
- Phenylalanine,
- Threonine,
- Isoleucine,
- Lysine,
- Tryptophan

Examples of Non- Essential Amino acids-

- Alanine,
- Arginine,
- Cysteine,
- Cystine,
- Aspartic acid,
- Glycine,
- Serine,
- Hydroxyproline,
- Glutamic acid,
- Proline,

(3) Fats

Fats we know are insoluble in water. The structure of a fat molecule is very simple. It is simply a glycerol molecule in which three fatty acids are attached.

The molecular formula of Glycerol is CH2OH**(CHOH)**CH2OH, whereas, the formula for fatty acid is HOOC-CH2-CH2-CH3.

There are around 20 fatty acids that are commonly attached to the glycerol backbone. Some of the examples of fatty acids are-

Formic acid (HCOOH)

Acetic Acid (CH3COOH)

Propionic Acid (CH3CH2COOH)

These three are fatty acids, which are the shortest among all the fatty acids. One of the longest chain fatty acids is Stearic Acid (C17H35COOH).

If we talk of the degree of unsaturation, i.e., the number of unsaturated bonds, either double or single bonds, Oleic acid, and linoleic acids are unsaturated.

Intriguing properties(P) of Fats in Food Technology perspective-

P1- Fats soften on heating

Fats slowly get softened when heated. The softening is slow, which means they are not that much affected by heat, or we can also say that the boiling point of fats is higher than that of the water i.e., 100°C.

So, more heat is required to melt the fat, or if the heat provided is constant, then it will take more time to melt.

So, fats melt slowly on heating. As a result, they can form some brownish shades on the surfaces of the foods during cooking.

P2- Some definitions-

According to the food technology professionals, heat treatment to fats can be described by three main terms, like the Smoke point, flash point, or the fire point.

These three properties of fats/ oils are observed only when these fats/ oils are heated further, as discussed in the above *point no.(a)*

Smoke point-

It is defined as that temperature when the fat substances begin to create a bluish smoke.

Flashpoint-

The flashpoint is a point at which flames start coming at the surface of the fat or the fat/oil-rich food or substance.

Fire point-

According to www.encyclopedia.com, the temperature at which the fat or oil sustains combustion for at least 5 seconds in an open flame, is called Fire point.

P3- Rancidity

Suppose any enzyme attacks on the glycerol backbone in which already three fatty acids chains are attached, so the fatty acids are released and detached from the glycerol

backbone.

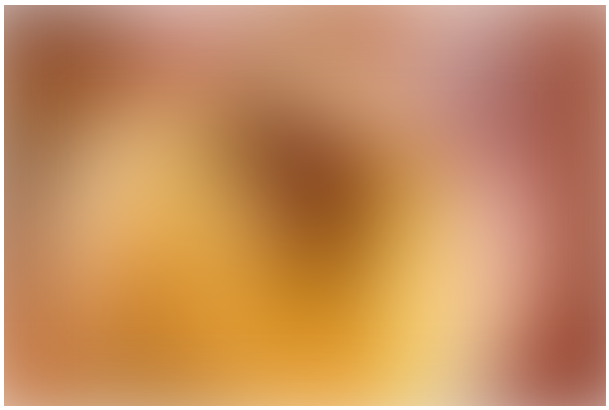
Due to the randomness of the fatty acids, they are much prone to be attacked by the oxygen present in the atmosphere and elsewhere.

So, when the fats/ oils react with oxygen (O2), they become rancid, and they start smelling foul. This process is called Rancidity.

P4- Emulsions

You may have heard very well about emulsions. Emulsions have two mediums, like dispersion medium and dispersing substrate.

The food technology professionals very well manipulate the composition of these two components, to stabilize that emulsion.



Similar is the case in fats. Fats are not soluble in water, and when these fats are mixed in water, both of them separate in layers.

So, to make them mix into each other and stabilize that emulsion, emulsifiers are needed. We take the example of fat droplets suspended into large amounts of liquid like water or milk or even cream.

In butter, some water droplets are suspended in large amounts of fat globules, so the fat droplets in butter are said to be in dispersion medium while the water droplets here are in the dispersed phase. Also, we can note that butter is water-in-oil (W/O) emulsion.

So, finally, we can say that emulsifiers are of great help to the food technologists in stabilizing the tough emulsions like in butter, egg-related foods, etc.

P5- Butter as a Lubricant

The lubricating power of the fats is excellent. Fats help easy swallowing of other foods along with other foods, in addition, thus making the easiness in the passage of food along the gastrointestinal tract. This due to the oily nature of fats/ oils.

P6- Fat delays the hunger

Fats are famous for producing a feeling of satiety or fullness in the body. If we eat fat-rich food in our diets, then we will feel the hunger in more time after taking that first meal.

So, in another way, we can say that after consuming fatty foods, appetite is lost at that moment or for some time. In India, ***Chhole Bhature*** is a very famous food, which is widely eaten. Bhature is made up of white flour (Maida in Hindi). Firstly, a plane circular bread is made from the white flour and then fried in oil. This fried bread is served hot with spicy gram and its curry.

Chole bhature is very famous among Indian politicians, who are planning for a hunger strike. So, before their hunger strike, they eat Chole Bhature very well till their full satiety. Thus, their hunger is suppressed for almost 6–7 hours or even more.

This suppression of hunger is mainly due to the fats because the food which is rich in fats last longer in the stomach and intestines, thus suppressing the arrival of hunger.

P7- Fats as Shortening agents

Food technology professionals use fats as shortening agents in an extensive manner in the industry.

Meats are very elastic in nature, and sometimes much effort is to be made for chewing or stretching the meat. This seems very irritative to people who consume meat products. So, the professionals in food technology or food science mostly use meat tenderizers to soften the meat pieces.

Hence, people eat them without putting much effort into chewing or stretching the pieces. The fats have the power of shortening the pieces of food, be it the pieces of meat or other.

The primary function of shortening is tearing apart the protein and the starch structures and hence shorten the structures.

(4) Natural Emulsifiers

As per the Food technology professionals or the food scientists, emulsifiers are simply defined as those materials that keep the globules of fat dispersed into the water, i.e., stabilize the oil in water emulsion, or to keep the water droplets submerged or stabilized into the fat medium.

If the emulsifiers are not present into a Mayonnaise, there would-be two-part separation of the fat and the water layers.

And it seems very unpleasing in texture and even to the taste buds also.

In Mayonnaise, the name of the emulsifier present is a type of phospholipid known as Lecithin, which is present actually in the egg yolk.

(5) Substitute Foods

Many foods are delicious but rich in their caloric content. So, food technology professionals and other food technologists are trying to prepare substitute products that mimic the desired foods in all properties like the mouthfeel, texture, flavor, appearance, but only the caloric content is reduced in them.

This is an excellent approach to obtain the same tasty foods with the same texture, flavor, appearance, etc. but with reduced caloric content, that only is required for the healthy body.

Mimicking foods

Similarly, the food technology professionals have relentlessly tried to mimic the protein-rich no- animal foods that look similar in texture to the meat.

They use soy protein isolates and other emulsifiers in composition to mimic the texture of real animal meat.

The food technologists aim to make the stretching or the elastic property similar to that of the meat, and we well know that meat like chicken or beef is tender and elastic in texture, which most meat lovers like to eat.

Fat replacers in Ice-cream

Another example of using substitutes in the food products by the food technology professionals is the use of fat replacers in the ice creams. The fats present in the ice cream is to increase the smoothness, creaminess and desired flavor of the ice creams.

So, to replace the fats present in the ice creams, food technologists are trying to use proteins from milk or egg proteins, which are tiny tiny spheres. Replacing the fat spheres with tiny protein droplets will cause minor or no difference in the weight ratio, but there will be a significant difference in the calorie present in them.

The calorie in the protein spheres is less than the fat droplets which are present in the ice creams. Hence this seems to be a successful attempt of the applications of the food technologists.

But there always comes some challenges which need to be overcome. The food technologists are continuously trying to find solutions for some after tastes, that very rarely arise in the specific foods after consuming such foods.

Sometimes some vitamins or flavors which are naturally present in the natural fats are absent in the fat replacers.

So, these topics are also specifically reconsidered by the food technology professionals.

(6) Organic Acids

Natural Organic Acids play a vital role in the preservation process of foods and also in imparting the tart flavor to the foods.

Few examples of natural organic acids are- Malic acid, which is present in apples, Citric Acid, which is present in oranges and lemons, whereas grapes contain tartaric acid.

Citric acid is found naturally in citrus fruits, especially lemons and limes. It's what gives them their tart, sour taste. A manufactured form of *citric acid* is commonly used as an additive in food, cleaning agents, and nutritional supplements. (Source-healthline.com)

Due to the presence of these acids in fruits, the fruits become tart in nature. Due to the tartness, their rate of bacterial spoilage is mostly decreased.

But not all the foods that we eat naturally contain these acids in them. So, in order to include similar property and behavior as of the above natural organic acids in these foods, the food technology professionals try to produce acids artificially by fermenting separately.

Some examples

Sauerkraut

Sauerkraut is a food prepared by firstly crushing the cabbage petals and fermenting it or hours to yield Lactic acid, which is finally prepared to get the popular food called

Sauerkraut.

Apple Fermentation

Similarly, the food technologists study the fermentation of apples for the production of Alcohol.

The Alcohol is then utilized to produce the Acetic acid, which if finally used to make Vinegar.

Fermentation uses

Also, in cheese manufacturing, there is the use of starter cultures, which is prepared by fermentation only, and then it is used to further processing steps in cheese production.

The organic acids have other properties also despite providing the desired flavors and in preservation.

According to the researches conducted in food technology and other allied fields, the importance of organic acids has been widely extended in other applications like to alter textural properties by allowing reactions of organic acids wit starches, pectin, gums, proteins, etc.

(7) Antioxidants and Oxidants

The food technologists have always been challenged by the activity of the oxygen that results in the rancidity and early deterioration of foods.

Oxygen is present everywhere. Foods rich in oils or fats are much prone to the attack by oxygen, which is present in the air, and Oxidation happens, and hence bad smell starts coming from such foods.

The food technology professionals are utilizing the application of Antioxidants to tackle this problem for a very long time.
Besides rancidity, oxygen also decreases the carotene (vitamin A), ascorbic acid (Vitamin C) content by Oxidation.

Earlier Copper and iron were also used for storing food items in the past. But later, it was found that these metals like Iron and Copper were excellent promoters of Oxidation, so stainless-steel materials were then used for the storage and refrigeration purpose of foods.

So, Antioxidants are used widely by the food technologists in food formulation, storage, and preservation. BHA (Butylated Hydroxy Anisole) and BHT (Butylated Hydroxy Toluene) are some examples of antioxidants.

These BHA and BHT are synthetic antioxidants. However, lecithin is an antioxidant and an emulsifier too. Other examples of antioxidants are Vitamin A and C and also some Sulphur containing amino acids.

(8) Enzymes

Enzymes are simply proteins, and they catalyze the reactions without utilizing themselves into the reaction.

So, the speed of the reactions increases manifolds, and, in this way, the enzymes help in completing the desired biochemical reactions.

Enzyme in Saliva

When we chew some food in our mouth, the saliva is released from our salivary glands, which help in mixing the food well.

The saliva contains an enzyme called Amylase. Amylase breaks the starch present in the food, and hence glucose is formed, which reaches the small intestine and finally gets absorbed into the blood via the inner lining of the small intestines.

Pepsin enzyme

Pepsin is an enzyme that is used to digest the protein present in the foods. The pepsin is present in the gastric juice that is secreted in the gastrointestinal tract during food consumption.

Lipase enzyme

The enzyme Lipase is present in the liver, and it helps in the fat breakdown. Enzymes are required in very small amounts, and yet they are very effective.

(9) Colors and pigments

We see many colorful and beautiful foods around us. The colors present in the foods impart a sense of psychological feeling among the people, may it be in terms of liking or disliking.

Food technology has a significant role to play in imparting and deciding appropriate colors for specific foods so that it fits in the consumer's mind both physically and psychologically.

Consumers also majorly buy foods based on colors. One of the best examples of purchasing foods based on color is Pepsi Blue.

PEPSI BLUE

The story of Pepsi Blue failure in India is a great example. Indians are one of the greatest fans of cricket in the world. Also, the cricket jersey of the Indian cricket players is blue.

Pepsi tried to get the attraction of the cricket enthusiasts around India by launching the Pepsi blue, which was blue in color, just like the blue jersey.

But the Indian people didn't like that Pepsi, and they rejected it only on the basis of its color because it resembled like kerosene.

Finally, Pepsi stopped Pepsi blue production due to the massive decrement in sales.

So, we can assess how much the color factor of food rules in the minds and hearts of food consumers in terms of purchase.

Food technology professionals pay more heed to the colors of the foods relatively in comparison.

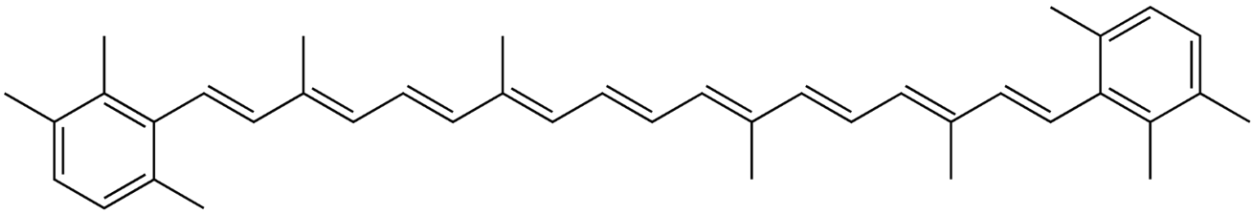
Few interesting points(P) about the food colorants and pigments-

P1- Chlorophyll presence

Peas and Lettuce, as we can see, are green in color due to the pigment Chlorophyll.

P2- Carotenoids

We have seen carrots. They are orange in color, mainly due to the presence of Carotenoids. The structure of carotenoids has many double bonds.



As we know, the double bonds or triple bonds act as a chromophore, and they absorb the radiations of specific wavelengths in them, and the wavelengths that are not absorbed and reflected give the orange color to us.

P3- Anthocyanins

Blueberries and grapes are purple due to the presence of Anthocyanins in them.

P4- Oxymyoglobin

Meats are red in color due to the oxymyoglobin's presence.

P5- Lycopene

Lycopene imparts the red color to the watermelons and tomatoes.

P6- Cochineal Red

Cochineal red is a natural food colorant used widely in many drinks like Cola, pink strawberry flavored drinks, etc.

P7- Colors due to cooking

The above colors arise mainly due to the natural segments. Another source of food color appears during cooking also.

Caramelization example-

Caramelization is a process in which sugars present in the food turn brown on cooking. The sugars get heated and become dark.

Similarly, when the breads are toasted, brown color appears.

Have a look at this caramel toffee, Alpen Liebe. It is in a pleasant caramel color.

The main reason for this dark color is because of the reaction between Proteins and the reducing sugars, and this reaction is called the Maillard reaction or the browning reaction.

We know proteins made up of repeating numbers of a large number of amino acids. These amino acids have two reacting ends, the COOH (carboxylic acid group) and the amino group (NH2).

So, the amino group reacts with an aldehyde or ketonic group of the reducing sugar present in the food, and hence the browning appears due to the resulting compound formed.

This is the primary reaction that is involved in the Maillard reaction.

Sometimes, we can observe that dried milk powders generally turn brown during long term storage.

(10) Flavors

Food flavors are also as complex to study as the food colors for the food technology professionals, because of the reaction chemistry involved in them.

Example-1

If we take the example of the world-famous beverage coffee, there are almost 800 elements that constitute the aroma and the desired flavor.

However, the major challenge in front of food technology professionals is to maintain the same flavor and aroma after processing also, because processing alters some changes in the composition of the food.

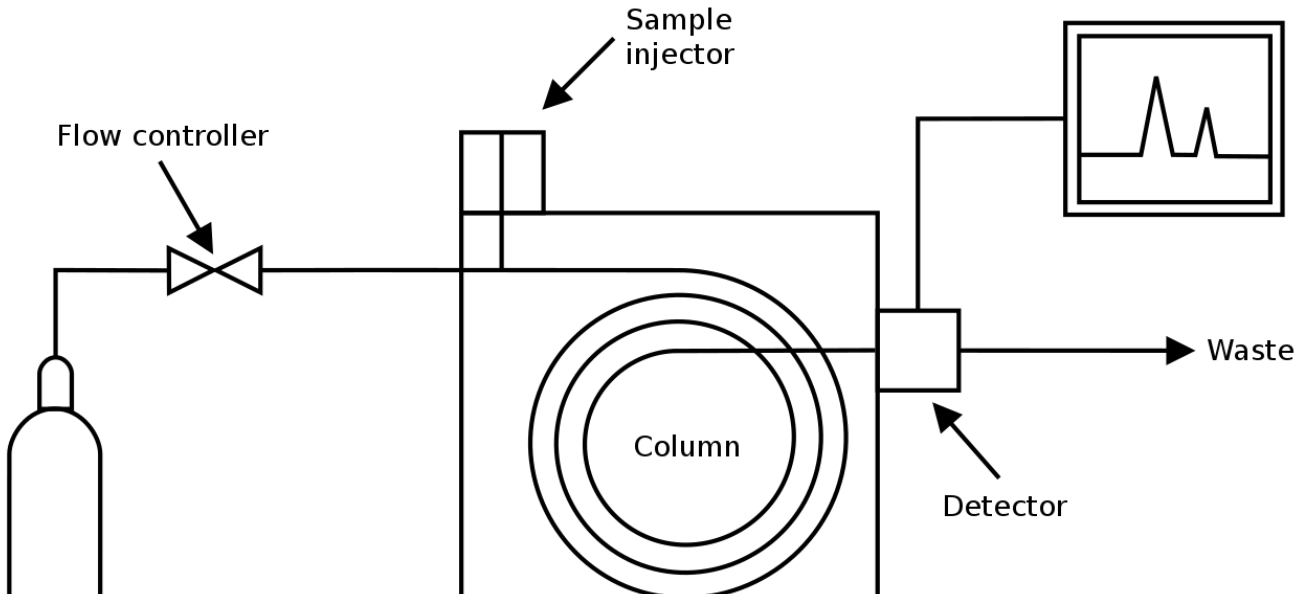
In the modern lifestyle, it has been frequently observed about the decreasing preference of people towards flavors and aroma due to the rapidly changing food culture.

Example-2

Due to the increased processing steps in foods like milk, coffee, cooked meats, or other foods, their flavor and aroma are somewhat lost, but still, people love to eat them. Many analytical methods are used by the food technologists to measure the presence and also the amount of the flavor compounds.

Example-3

Gas chromatography is a chemical analysis instrument in which there are two phases, the mobile phase, and the stationary phase.
The mobile phase is gas in the case of gas chromatography. In contrast, the stationary phase is mainly something like silica or other substances that is applied to the inner lining of the columns.



Carrier gas

Column oven

So, when gas, as a mobile phase, is passed through the coiled tubes, different flavor molecules have different affinity towards the stationary phase.

Hence, those flavor compounds which are less attracted toward the stationary phase would come out of the column at a fast rate, while the molecules having higher affinity with the stationary phase would stick and thus come at the last.

After coming out of the column, the compounds hit a detector screen, and then different peaks are formed on it. The peak height shows the relation between the volatility of the flavor compounds.

(11) Toxicants

Plants also form compounds that are toxic in nature, to protect them from external predators and adverse biochemical reactions.

Not only plants, water, and soil also contain some potentially harmful metals like cadmium, mercury, lead, arsenic, selenium, and zinc.

Since the food we eat has a direct relationship between the soil and the water for sowing and irrigation purposes, so these trace metals from the soil or water directly get transferred to the crops that are harvested.

However, the crops harvested contain some amount of trace elements only, and so in our food we eat.

These trace elements in foods are harmless at a situation, and also, in contrast, selenium, arsenic, etc. are essential nutrients too.

Some other uses of toxicants other than natural toxicants are those produced by the microorganisms, those additives which are consumed at a level which is far more exceeded than the safe level advised, etc.

Examples of common toxicants in food-

a) Potatoes contain a low level of Solanine which is an alkaloid

b) Lima beans contain some cyanide generating compounds

c) Spices contain safrole

d) Almonds contain Prussic acid

e) Soybeans contain some hemagglutinins and enzyme inhibitors

f) Rhubarb and spinach in oxalic acid

g) Cottonseed oils contain gossypol

h) Cheese contains Tyramine

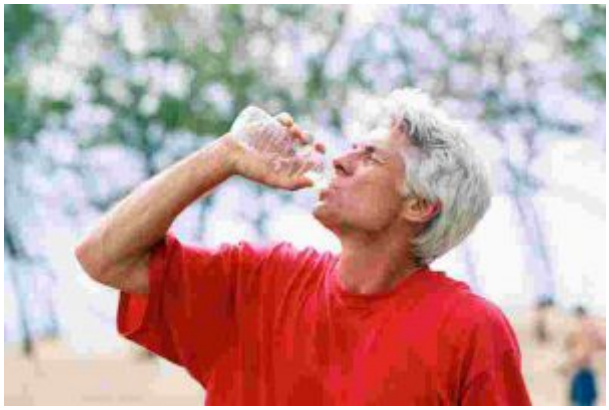
i) Vitamin B1 is destroyed by Thiaminase, which is present in fish

j) Egg white contains Avidin

k) Some vitamins like A and D, along with methionine, which is an essential amino acid, also produce toxic effects when consumed in excessive amounts.

So, the food technology professionals pay special heed to the toxic levels in the foods so as to remain ensured about the adequate daily intake.

(12) Water



Water is one of the components in foods that is in a larger composition in foods. The composition of water in most of the fruits and vegetables accounts for around 90% or even 95%.

The water in cooked meat is around 59–60%, that too after some water is drained after the cooking procedure.

The water content in food substances directly affects the texture of the foods. For example, grapes contain a high amount of water, but when the grapes are dried to obtain the raisins, the decreased water content drastically affects its texture.

The raisins are shrunk at their minimum level with very less amount of water.
Food technology professionals are also focusing mainly on the dehydrating the specific foods, so as to remove the water content from the foods by evaporation and then concentration.

Evaporation as a food technology application–

Evaporation is undoubtedly the oldest drying method that is used for decades.
It is used before the onset of other drying methods involving new food technology principles like hot air oven drying, tray drying, vacuum tray drying, spray drying, freeze-drying, etc.

The main reason for the removal of water from the foods is to decrease the microbial activity because the microorganism's growth is more in higher water activity.

The second most crucial valid reason for the removal of the water content from the foods is to decrease the transportation cost because of the volume decrement. For example, nowadays, milk is transported all over the world in the form of milk powders.

Reconstitution of Milk powders–

Milk powders are later reconstituted with water as per convenience.
So, by converting the liquid milk into milk powders either by spray drying evaporation or by other drying methods, the cost of transportation is much reduced drastically, because the bulk volume occupied by the milk powder is much much lower than that of the liquid milk.

So, the food technology professionals have to deal with detailed research and the manipulation of the water content in foods like removal of water, its stabilization with emulsifiers, reconstituting the dehydrated foods.

Water may exist in different forms like free water, bound water, etc.
Tomatoes have free water, and they can easily be extracted by crushing the tomatoes. In contrast, chemically bound water in the sugar crystals is the most difficult to remove by evaporation or other drying methods, which ultimately reduces the shelf life of these foods.

So, the food technologists have a significant role to play in manipulating the water composition in foods, to improve the shelf life of foods.

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