

Why we need food?

Approximately 96% of our body weight is composed of the chemical elements carbon, hydrogen, oxygen and nitrogen in the form of protein, fat, water and a small amount of carbohydrate. The rest 4% of body weight is made up of mineral elements mainly including calcium and phosphorus.

The approximate composition of an adult is as follows;

1. Water 61.6%
2. Proteins 17.0%
3. Fat 13.8%
4. Carbohydrates 1.5%
5. Minerals 6.1%

Foods are complex and nutritious substances that contain more than about 50 chemical compounds required to nourish the body. Foods are taken into animals including humans to maintain the life and growth. Nutritional value of foods varies from one source of food material to another and also

Food processing industry has its own characteristics specific to cultural and religious beliefs, social status, family income and other similar factors predominant to any given country. Knowledge in food science widens and the relevant technologies advance. Our lifestyle has remarkably changed due to increased ownership of electrical appliances like refrigerators, deep-freezers, microwave ovens, deep fryers etc. With change of the life style, manufacture of a wide range of 'ready to eat' meals, snack foods and convenience foods became necessary. In this context, major challenges of the present food technologists are many and the following are of primary importance;

1. To increase the shelf life by using improved preservation techniques. These techniques should satisfactorily inhibit microbial spoilage or suppress biochemical changes which would otherwise take place in the food itself. But we should not forget that the consumer does not like to buy a product remaining on the shelf for months and months.
2. To improve sensory characteristics or organoleptic qualities; textures, flavours, colour, aromas and taste. Sensory characteristics are the most important attributes the consumer expects in a food. Therefore aim of the food manufacturer should be to find out ways of preserving and creating desirable sensory qualities in the final food product.
3. To preserve nutritional value in the food or to improve its nutritional qualities.
4. To provide nutrients required for consumers who have physiological and health disorders
5. Sustain the food industry as income generating livelihood projects.

Food Science and Food Technology

Simply speaking, **Food Science** studies about the nature and composition of food materials and their behaviour under the various condition to which they may be subject during harvesting, post-harvest handling, and food processing. Its application to the practical treatment of food material in order to convert them into food product having nutritional and sensory qualities, and to get the foods packaged and distributed in satisfying the needs of consumer for safe, wholesome, nutritious and attractive foods.

Modern food technology is integrated with many other technologies such as engineering, instrumentation, electronics, agriculture, biotechnology and information technology and sciences like management sciences.

What are the sensory characteristics?

Texture

Texture of a food is mainly determined by water and fat content, quality and quantity of structural carbohydrates and proteins. We do textural changes that can take place due to loss of moisture or fat, molecular changes of carbohydrates or proteins within the food due to their breakdown, polymerization, hydrolysis or coagulation. So we thereby change or improve characteristics like brittleness, chewiness, gumminess, crispiness and oiliness.

Taste

There are four major attributes determining the taste of a food; saltiness, sweetness, bitterness and acidity. Although food processing techniques or unit operations usually do not affect the taste of the food, respiratory changes taken place in the food can contribute to the taste especially by changing acidity or sweetness.

Foods produced are required to analyse as a part of food quality management. Usually chemical composition and physical properties of the food are used to determine the nutritional value, functional characteristics and acceptability of the final food product. There is a wide range of analytical methods used in food analysis. However the method of analysis selected should ensure that they meet the legal requirement established by Government or accepted International Agencies. It is also worth noticing that many Sri Lankan food industries have not yet given due consideration to incorporate an analytical part into the manufacturing procedure as a part of food quality management. Chemical analysis of foods is an important component in the quality management programme. Analysis can be done at different stages on different samples; from ingredients and raw materials, intermediate products or finished products. In addition, as a food manufacturer, one may analyse competitors' sample and samples rejected by consumers. Irrespective of the type of analyses, the food analyst should follow three major steps viz.

1. Selection and preparation of sample
2. Conduction of the assay

3. Calculation and interpretation of results

What do we understand by food processing operation?

Each food processing operation called unit operation has very specific effect on the food material. Many unit operations used in the food industry involve heat transfer whereas other unit operations include mechanical operations like mixing, sorting, dehydration and fermentation. The natural laws concerned with conversion of mass or energy are also applicable to the food as any other material.

Importance of heat treatment in food processing technology

As far as heat treatment is concerned, there are three ways in which heat is transferred in food materials; radiation, conduction and convection. In electric grills, heat is transferred to food in form of radiation or through electro magnetic waves.

Heating a solid food material in a saucepan is an example for conduction. Thermal conductivity of food and vessel material in which foods are heated are different. For example aluminium and copper containers have higher thermal conductivity than stainless steel. In other words, the former conducts heat transfer better. The thermal conductivity of a food is determined by its cell structure, air and moisture content within the food. Reduction of moisture in the food reduces thermal conductivity remarkably. Suitable packing materials should have less thermal conductivity to prevent heat transfer inwards or outwards.

When string hopper or flour is steamed in a steamer, heat transfer occurs in the form of convection. Heat transfer from a hot fluid to the surface of a food is a classical example of convection. Usually there is a resistance to heat flow from the source of heat to the food. This phenomenon is better understood by the term Surface Heat Transfer Coefficient (SHTC). For example SHTC of moving air is far less than that of liquids. In other words, heat transfer through air is lower than through liquids. SHTC also depends on the property of the heating medium (e.g. liquid) like viscosity, specific heat and density.

Unit Operations

When a modern food technologist is concerned, he is required to produce a food having all the requirements satisfied in the food itself which would attract the consumer for the attributes developed. The food also should not lose its nutritional value due to processing operations.

If foods are not eaten raw, it has to be either stored or processed before it is placed on the dining table. Hence, processing operations or unit operations can be employed singly or in batches in the processing procedure.

Cleaning

One of very initial unit operations in food processing is *cleaning*. Cleaning allows us to remove unnecessary edible or non edible particles from the food. This operation also permits to prolong the shelf life of the product by removing unwanted particles which otherwise would harbour microorganisms

Today, food industry possesses different equipment utilized for cleaning purposes. In addition, the entire food manufacturing plant should be kept clean and free from unnecessary debris or by products in order to maintain a satisfactory sanitation level. It is also very important to utilize raw materials, water and other ingredients without any possible contamination.

Cleaning can be divided into two major operations; *wet cleaning* and *dry cleaning*.

Wet cleaning is more effective than dry cleaning and is capable of moving unwanted particles and residues of pesticides and other chemical applications. Dry cleaning involves simpler techniques. For example, destoning of rice is an example for dry cleaning.

Sorting

Sorting is meant for separating foods according to their physical measurable properties; size, shape, weight, colour. Sorting is an important unit operation because, for example one can sort out heterogeneous raw material stuff according to the size or shape which could be a primary requirement for mechanized food industry.

Sorting can also help to grade food material according to their degree of *maturity index* which enables the consumer to give an idea about the ripening status of a given commodity.

Peeling

In the preparation of raw material for major manufacturing operations, some food commodities need to be peeled. This unit operation helps to remove unwanted and edible material from the major counterpart thereby improving the appearance and other sensory attributes in the final product.

Peeling can be classified into five main methods;

1. Flash steam peeling:
Foods like root crops are subjected to high pressure steaming in order to cause a rapid heating of only the surface layer easing to peel.
2. Knife peeling:
This method can be manual or mechanized and suitable for citrus fruits because their skin is easily removed without damaging the fruit.

3. Abrasion peeling :
Using abrasion surfaces this method can be used to peel foods having irregular surfaces peels food
4. Caustic peeling:
A dilute, heated NaOH solution are softened and they can be removed by washing.
5. Flame peeling:
Food raw material are subjected to a flame for a short period and then outer layer of the material are removed by high pressure water sprays. Onions are peeled by using this unit operation.

Size reduction

Size reduction is an important unit operation in the food industry. It enhances the surface to volume ratio of the food particles. When the surface to volume ratio is increased interaction of the food particles with the environment factors is promoted. Size reduction can also affect the nutritional value. This promotion facilitates unit operations like drying and cooling osmotic dehydration reactions, heat transfer, etc.

Methods of the unit operation size reduction can be classified according to the particle size resultant.

1. Chopping, cutting, slicing and dicing:
These operation reduce the particle size of the raw material but particles are a bit larger. Above operations are applied mainly for fruits, vegetables, fish and meat.
2. Milling:
This operation converts the product into very small particles. Milling can be applied in making flour,spices,starch etc.
3. Emulsification and homogenization:
In this method particles are broken into minute droplets or particles and dispersed evenly throughout the medium. This method is employed in the manufacture of mayonnaise, essential oils, ice-cream, margarine etc.
Emulsification is the formation of a stable emulsion of two or more dispersed phases within each other. Homogenization is the reduction in size and increase in the number of particles of the dispersed phase. In homogenization an intense shearing force is applied. Although both emulsification and homogenisation change eating quality of foods, they hardly affect the nutritional value or shelf life of the foods. Emulsification can be achieved by using emulsifying agents which form micelles around each droplets of the dispersed phase. Forming of micelles needed to reduce the inter-facial tension between the phase. Emulsifying agents used in food processing are *sodium stearyl-2-lactylates*, *glyceryl monostearates* and *sorbitol* esters of fatty acids.

In the size reduction of solid food, different equipment are used. All these equipment are designed to use three types of forces.

1. Compression forces
2. Impact force
3. Shearing

Different equipment use these forces in different proportions depending on the purpose. Equipment are grouped as follows.

1. Slicers
2. Choppers
3. Millers
4. Dicers
5. Shredders
6. Pulpers
7. Pre-crushers
8. Flaking equipment

Mixing (blending)

Mixing is a unit operation used to obtain a uniform mixture of two or more components dispersed within each other. Mixing can change the eating quality of food. This unit operation can be applied to combine ingredients to achieve different functional properties or sensory characteristics. However, mixing has no ability to improve the preservative effect of the food.

Forming

Forming is a unit operation which enables the food manufacturer to mould high viscosity or dough like food materials into certain shapes and sizes. Usually forming is followed immediately after mixing operations. Forming is frequently applied in bakery and confectionery technologies. This unit operation has no direct effect on the shelf life and nutritional value of the food. But it can enable to produce the food items with a high uniformity. However care should be taken to control the size of the food as it determines the rate of heat transfer to the center of the food.

For example, in the manufacture of candies, ingredients including fondants, chocolates and jellies are placed into appropriate mould where they are then allowed to cool and harden.

Extrusion

Extrusion is a combination of several unit operations including mixing, cooking, kneading, shearing and forming. The main objective of extrusion is to produce a variety of food with different shapes, textures, colors and flavors by having the same basic ingredients. Extrusion thus allows having a product with different colors, different textures, different flavours and with several combinations. Extrusion is being populated due to this reason .It also minimizes production cost and affluence.

Dehydration

Food commodities are susceptible to microbial spoilage as they provide microorganisms with necessary nutrients for them to grow. They are also very often susceptible to biochemical dehydration due to enzymatic activities taken place in the commodities themselves. Among the factors positively affecting the microbial spoilage and biochemical degradation, water available in the commodities is of primary importance. The more the water freely available in the food, the faster the microbial spoilage and the shorter the shelf life of the food. Therefore dehydration (drying) is one of the solutions to remove water from foods. However dehydration should be done in such a manner that drying should not cause deterioration of eating quality and nutritional value of the food, thus dehydration equipment should be designed to serve this purpose.

Dehydration operations can involve simultaneous application of heat and removal of moisture from foods. Drying rate or removal of moisture content from the food depends on several factors; Water content in the food, relative humidity, temperature of the food commodity etc. Therefore dehydration operations should be designed by taking these factors into consideration. Drying can be done by several ways.

1. Sun drying
2. Oven drying
3. By an air flow
4. By a hot air flow

Accordingly dryers can vary by designs, capacity, source of energy etc. If the commodity is exposed to solar heat or flow is blown over the food and heat is transferred to its surface, latent heat of vaporization results in water evaporation.

Water vapour diffuses through a boundary film of air. Water vapour can be carried away in case of an air current provided. If the commodity is exposed merely to solar heat, there will be a chance of retaining moisture on the surface of the commodity leading to an incomplete dehydration. Water films remaining on the surface can promote microorganisms' growth and alter physiological changes. Thus drying of commodity by using a heated air flow is more advantageous in several ways. There is a wide range of hot air dryers used in food industry.

Most of the dryers are capable of recirculating a uniform hot air current in order to dry the contents in the oven evenly. They are well insulated to save energy. Depending on the requirements like the nature of the final food product and raw material type of dryers vary.

1. Deep bed drier (bin drier)
2. Cabinet drier
3. Belt drier
4. Fluidized bed drier
5. Pneumatic drier

6. Rotary drier
7. Spray drier
8. Tunnel drier
9. Drum drier
10. Vacuum shelf drier

Filtration

Filtration is a unit operation used to clarify liquids by the removal of small amount of solid particles or separate liquids from the solid part commodities like wine, beer and oil are clarified by removing solid particles through filtration. Whereas commodities like fruit juices are separated from solid part by cake filtration. For filtration, different filters with different mechanism can be used: pressure filters and vacuum filters.

Concentration

Concentration is a unit operation which promotes preservation of some foods. This unit operation reduces water thereby weight and volume of the food are reduced. This also increases the viscosity. This unit operation can produce very important food commodities of jelly, butter, frozen unit juice concentration, condensed milk, sugar syrup, jams, tomato paste purees.

Removal of water by the above unit operation may increase the food acid-levels in food. However concentrated foods still can undergo microbial spoilage.

Concentration can be done by several methods;

1. Solar concentration (e.g. salt methods).
2. By using steam (jellies, jams and some soups).
3. Flash evaporation (High temperature short-term treatment).
4. Thin evaporation.
5. Vacuum evaporation (Low temperature, Low pressure evaporation)

Membrane concentration

Membrane concentration is done by reverse osmosis and ultra filtration. During this process water and some solutes in the solution are selectively removed through a semi-permeable membrane.

Food Quality Management

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Food standards

Food standards are very essential criteria being guidelines to be followed in food manufacturing. The main purpose of the food standards is to ensure the health and safety to the consumer. They assure the customer a sound wholesome food free from adulteration and quality with definite substances. Food standards are generally set up by appointed committees consisting of relevant authorities including Government representatives, food scientists, food inspectors, medical and veterinary personnel, food manufacturers, traders and consumers. The standards build up an understanding among the members of this sequence thereby promoting the trade. The standards also should assure the customer that foods are labeled and presented correctly. According to the standards require a correct description of the food with the net weight or volume of the contents, drained weight, ingredients as per weight or importance limits for contaminants etc. Sometimes the standards may require specific processing requirements. In addition to standards set by the [Sri Lanka Standards Institution](#) ,there are standards and codes of practices established by a joint body of [WHO](#) and [FAO](#) called Codex Alimentarius Commission.