**Food Science**

**Lecture 2 Food constituents and their functions**

Some of the sub disciplines of food science are described below.

**Food chemistry**

Food chemistry is the study of [chemical](https://en.wikipedia.org/wiki/Chemical) processes and interactions of all biological and non-biological components of foods. The biological substances include such items as [meat](https://en.wikipedia.org/wiki/Meat), [poultry](https://en.wikipedia.org/wiki/Poultry), [lettuce](https://en.wikipedia.org/wiki/Lettuce), [beer](https://en.wikipedia.org/wiki/Beer), and [milk](https://en.wikipedia.org/wiki/Milk) as examples. It is similar to [biochemistry](https://en.wikipedia.org/wiki/Biochemistry) in its main components such as [carbohydrates](https://en.wikipedia.org/wiki/Carbohydrate), [lipids](https://en.wikipedia.org/wiki/Lipid), and [protein](https://en.wikipedia.org/wiki/Protein), but it also includes areas such as water, [vitamins](https://en.wikipedia.org/wiki/Vitamin), [minerals](https://en.wikipedia.org/wiki/Dietary_mineral), [enzymes](https://en.wikipedia.org/wiki/Enzyme), [food additives](https://en.wikipedia.org/wiki/Food_additive), [flavors](https://en.wikipedia.org/wiki/Flavor), and [colors](https://en.wikipedia.org/wiki/Food_coloring). This discipline also encompasses how products change under certain [food processing](https://en.wikipedia.org/wiki/Food_processing) techniques and ways either to enhance or to prevent them from happening.

An example of enhancing a process would be to encourage fermentation of [dairy](https://en.wikipedia.org/wiki/Dairy) products with [microorganisms](https://en.wikipedia.org/wiki/Microorganism) that convert [lactose](https://en.wikipedia.org/wiki/Lactose) to [lactic acid](https://en.wikipedia.org/wiki/Lactic_acid); an example of preventing a process would be stopping the [browning](https://en.wikipedia.org/wiki/Browning_(chemical_process)) on the surface of freshly cut [Red Delicious](https://en.wikipedia.org/wiki/Red_Delicious) [apples](https://en.wikipedia.org/wiki/Apple) using [lemon](https://en.wikipedia.org/wiki/Lemon#Culinary_uses) juice or other [acidulated water](https://en.wikipedia.org/wiki/Acidulated_water).

**Food Composition**

Chemical substances found in the largest amounts in food:

1-Water 2-Carbohydrates 3-Fats 4-Proteins 5-Minirals .

**Water-1**

## Water in food systems

-A major component of food is water, which can encompass anywhere from 50% in [meat](https://en.wikipedia.org/wiki/Meat) products to 95% in [lettuce](https://en.wikipedia.org/wiki/Lettuce), [cabbage](https://en.wikipedia.org/wiki/Cabbage), and [tomato](https://en.wikipedia.org/wiki/Tomato) products.

-It is also an excellent place for [bacterial](https://en.wikipedia.org/wiki/Bacterial) growth and food spoilage if it is not properly processed. One way this is measured in food is by [water activity](https://en.wikipedia.org/wiki/Water_activity) which is very important in the shelf life of many foods during processing.

- One of the keys to [food preservation](https://en.wikipedia.org/wiki/Food_preservation) in most instances is reduce the amount of water or alter the water's characteristics to enhance shelf-life. Such methods include [dehydration](https://en.wikipedia.org/wiki/Food_dehydration), [freezing](https://en.wikipedia.org/wiki/Frozen_food), and [refrigeration](https://en.wikipedia.org/wiki/Refrigeration). This field encompasses the *"physiochemical principles of the reactions and conversions that occur during the manufacture, handling, and storage of foods"* .



## Types of Water:-

**1-Free water :**

* Held inside cell **.**
* Maintains properties of free water **.**
* May be removed by pressure.
* Not bound and acts as bulk water.
* Available for microbial growth, enzymatic and chemical reactions .

**2-Bound Water :**

* Is part of molecule structure .
* Reduced mobility .
* Dose not retain properties of free water .
* Tightly bound .

**3- Water Activity :**

* More bound water, than less water activity .
* **Water Activity** **(aw)**:Ratio of vapor pressure of sample/ vapor pressure of water at same temp.( Ratio of vapor pressure of water in a food at a specified temperature to the vapor pressure of pure water at same temperature) .
* Foods more perishable if higher water activity (The measure of the amount of water available for microbial growth, enzymatic activity and chemical reactions) .
* Microorganisms need water activity .
* To reduce water activity ( Dry , Freeze, Add sugar or salt ) .

**Uses of Water in Food preparation:-**

1-Universal solvent 2-Heat transfer 3-Freezing4-Cleansingagent5-Promotion of chemical changes 6-Ionization of salt 7- Baking powder 8-Water and Ph 9-Hydrolysis reactions .

**Water Hardness**

**Types of hard Water: 1-Temporary . 2-Permanent .**

**Hard Water and Food preparation:-**

1-Rehydration and softening of dried beans slowed .

2-Alkalinity may affect color of vegetables .

3-Promote cloudiness in tea .

**Properties of Water in Foods**

**1- Bulk water(Monolayer water):-** Bulk water is free from any other constituents, so that each water molecule is surrounded only by other water molecules. It therefore has physicochemical properties that are the same as those of pure water, *e.g.,*melting point, boiling point, density, compressibility, heat of vaporization .

**2-Capillary or trapped water***:-*Capillary water is held in narrow channels between certain food components because of capillary forces. Trapped water is held within spaces within a food that are surrounded by a physical barrier that prevents the water molecules from easily escaping, *e.g.,*an emulsion droplet or a biological cell. The majority of this type of water is involved in normal water-water bonding and so it has physicochemical properties similar to that of bulk water.

**3-Physically bound water** :-A significant fraction of the water molecules in many foods are not completely surrounded by other water molecules, but are in molecular contact with other food constituents, *e.g.*proteins, carbohydrates or minerals. The bonds between water molecules and these constituents are often significantly different from normal water-water bonds and so this type of water has different physicochemical properties than bulk water*e.g.,*melting point, boiling point, density, compressibility, heat of vaporization, electromagnetic absorption spectra.

**4-Chemically bound water:-** Some of the water molecules present in a food may be chemically bonded to other molecules as water of crystallization or as hydrates, *e.g.*NaSO4.10H20. These bonds are much stronger than the normal water-water bond and therefore chemically bound water has very different physicochemical properties to bulk water, *e.g.,*lower melting point, higher boiling point, higher density, lower compressibility, higher heat of vaporization, different electromagnetic absorption spectra .

**ASH and MINERAL CONTENTS OF FOODSAsh:** The inorganic residue remaining after either ignition(burning) or complete oxidation of organic carbonaceous matter(total mineral content).

**Inorganic elements occur in foods :**

**1.**As natural constituents coming from the soil, certain regions and plants, mineral contents are specific.

**2.**As additives to prepared foods. NaCl adding prepared foods. It is also in the ash.

**3.**As contaminants migrating to foods during processing i.e. From machinery →metal migration, when preparing the food. Migration can come from metallic materials like pipes or silos.

Ratio of ash in foods is very much related with the moisture contents of foods. H2O↓Ash↑.

**Metals/minerals in food chain**

**1.of Nutritional interest= Ca, P, Na, K, Mg, Zn.....**

**2.of toxicological concerns, also called "contaminant" Hg, Cd, Pb, As**

**3. Both: Co, Cr, Cu, Sn**

**Concentrations:**

•**macro minerals Requirements>100mg/day**

**[Ca, P, Na, K, Mg, Cl, S,]**

•**micro (trace) minerals:requirements~1mg/day(in foods mg/100 g**

**[I, Fe, Cu, Zn, Cu, Cr, F, Se]**

**Densities:**

•**Light metals (d<5 g/cm3) Ca (1.5), I (4,6), P (1.8),**

•**Heavy metals (d>5 g/cm3) Pb (11.3), Fe(7.8)**

Both nutritional and toxicological : Fe (7.8) and Cu (8.9) Fe when higher than a certain concentration, will be of toxicological concern. Below a certain concentration, it will be of nutritional concern. Two ways of expressing:

**1. MAC in food : Maximum Allowed Concentration**(mg/100g food

**2. AWI in diet= Allowed Weekly Intake** for metals of toxicological concern

i.e. AWI cd= 0.0067-0.0083 mg/kg b. w. of humans

**Properties of Ash:**

**1-**Acid-insoluble ash= (~%10 HCl) .insoluble soil metal contaminants like silicates( index of dirt, sand, soil).

**2-**Salt-free ash= Index of added NaCl, Total ash is dissolved in dilute HNO3 and titrated with AgNO3 solution for NaCl determination.

**3-**Alkalinity of ash\*: Titration with 0.1NHCl.Shows acid-base balance of food. Index of fruit contents of jams :Organic acids in fruits are transformed to carbonates and oxides, resulting in alkalinity. Also detects adulterations with minerals.

**4-**Water-soluble ash: Also an Index of fruit contents. Since metal oxides are water-insoluble, lower ash in water soluble fraction means extra fruit was added and indicate higher amount of fruits.

•**\*Ash of fruits is alkaline(Ca, Mg, K, Na)**

•**\*Ash of meats+ cereals is acidic(P, S, Cl)**