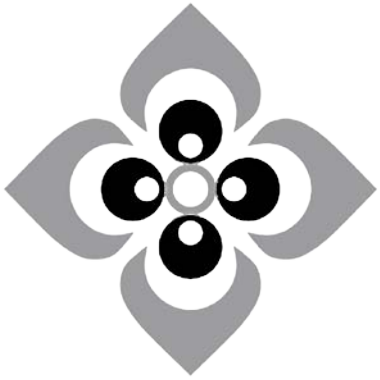


Consortium for Educational Communication

Module
on
Constituents Of Food

By
SAJAD AHMAD MIR
Ph.D. scholar
Deptt. Food Science & Technology
Cell no. 9797050619 & 9796315556

TEXT

Introduction

Constituents of Food

The food groups are divided based on the nutritional properties they offer. Foods that we eat can be classified based on the amount of nutrients and the type of nutrients they provide for subsistence and survival. It is highly recommended to eat portions of food from the different groups in order to live a healthy lifestyle. These nutrient classes can be classified either into macronutrients or nutrients that are needed in large quantities and micronutrients or nutrients that are needed in small amount. Macronutrients include the carbohydrates, proteins, fats, fibre, and water while the micronutrients include vitamins and minerals. The quantity of these constituents depends on the type of food and varies from one food to another. The main constituents of the food are described below.

1. Carbohydrates:

Carbohydrates may be defined as polyhydroxy aldehydes or ketones. They contain carbon, hydrogen and oxygen as their main constituents. Oxygen and hydrogen are present in the same proportion as in water. They are the main sources of energy for human body. Carbohydrates are mainly distributed among plant food; except glycogen, lactose and ribose which are present in muscles or in liver, human milk and animal cells respectively. The recommended daily amount (RDA) of carbohydrates for adults is 135 grams, according to the National Institutes of Health (NIH); however, the NIH also recommends that everyone should have his or her own carbohydrate goal. Carbohydrate intake for most people should be between 45 and 65 percent of

total calories. However, people with diabetes should not eat more than 200 grams of carbohydrates per day, while pregnant women need at least 175 grams

Classification of Carbohydrates:

Carbohydrates are classified as:

(a) Monosaccharides — (Single sugar unit)

(b) Disaccharide — (Two sugar units)

(c) Polysaccharide — (Many molecules of simple sugar units)

(a) Monosaccharides:

Monosaccharides are simple carbohydrates which cannot be hydrolyzed to simpler compounds. Based on the number of carbon atoms present in them, monosaccharide's are grouped into triose (3-carbon), tetrose (4-carbon), pentose (5-carbon) and hexoses (6-carbon). Biose, triose and tetrose are not nutritionally significant. Pentose like ribose, xylose and arabinose are widely distributed in many roots and vegetables. Ribose is a part of riboflavin and DNA and RNA, body can synthesize it and it is not a dietary essential. Xylose and arabinose are not present in free state. Both of them are present in gums of various origins like wood gum, cherry gum, etc. In human nutrition only hexoses are of importance. Commonly found hexoses are aldose and ketose (containing aldehydes and ketones group).

(i) Glucose:

It is also known as dextrose. Glucose is an aldose sugar. It is white, crystalline and easily soluble in water with sweet taste. Glucose is readily absorbed from the stomach. Glucose is also present in fruits and honey.

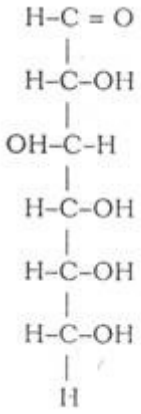


Fig.1. Structure of Glucose

(ii) Fructose:

Fructose is known as fruit sugar or levulose and is a keto sugar. It is sweeter than glucose. It is also obtained by the hydrolysis of sucrose.

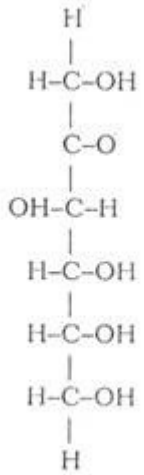


Fig.1. Structure of Fructose

(iii) Galactose:

It is not found free in nature. Its only source is the hydrolysis of lactose. It also occurs in cerebrosides of brain and nervous tissue. Hence, it is nutritionally important.

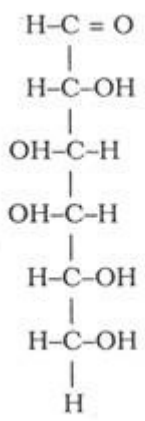


Fig.3. Structure of galactose

(iv) Mannose:

This does not occur free in nature. Mannose is a constituent of prosthetic polysaccharides of albumin, globulin and mucoids. Mannose on reduction gives mannitol.

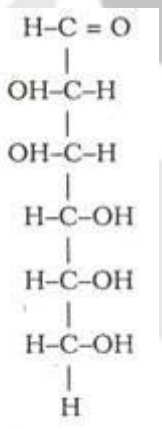


Fig.4. Structure of mannose

(v) Sugar Alcohols:

The important sugar alcohols are sorbitol, mannitol and dulcitol. D-sorbitol is an alcohol made commercially from glucose by hydrogenation, where in aldehyde (CHO) group is reduced to an alcohol group (OH). The rate of sorbitol absorption from the gut is slow as compared with glucose and does not increase the blood sugars. Hence, it is preferred for diabetics.

(b) Disaccharides:

The disaccharides are formed by the condensation of two monosaccharide's with the elimination of one molecule of water.

The disaccharides of nutritional importance are:

i. Sucrose

ii. Maltose

iii. Lactose

(i) Sucrose:

Sucrose occurs in sugarcane and beet root. It is manufactured on a large scale from sugarcane or beet root. Sucrose is formed by the condensation of one molecule of glucose and one molecule of fructose. Sucrose is easily hydrolyzed to glucose and fructose either by dilute mineral acids or by the enzyme sucrase present in intestinal Juice.

(ii) Maltose:

Maltose is mainly present in malt. It is formed in cereal grains during germination by

the hydrolysis of starch.

Starch (amylase) Maltose

It is formed when starch present in the food is digested by salivary and pancreatic amylase. Maltose is also formed by the condensation of 2 glucose molecules. It is hydrolyzed to glucose by the enzyme maltase.

Maltose (maltase) Glucose + Glucose

(iii) Lactose:

It is the type of sugar present in milk of all mammals. Lactose is formed by condensation of one molecule of glucose and one molecule of galactose. Lactose is hydrolyzed to glucose and galactose by the enzyme lactase present in intestinal juice.

Lactose (lactase) Glucose + Galactose

(c) Polysaccharides:

(i) Starch:

These are complex compounds with relatively high molecular weight. Starch occurs widely in plant kingdom. Starch occurs in the form of granules which have characteristic shape when seen under microscope. Starch is a polysaccharide formed in nature by condensation of a large number of (4000-15,000) glucose molecules. There are two types of glucose chains present:

(1) Amylose consisting of long straight chains of glucose,

(2) Amylopectin consists of short branched chain of glucose unit.

(ii) Dextrins:

These are intermediate products in the hydrolysis of starch and consist of shorter chain of glucose units. Some dextrins are produced when flour is browned or bread is toasted.

(iii) Glycogen:

The so called “animal starch” is similar in structure to the amylopectin of starch but contains many more branched chains of glucose. It is rapidly synthesized from glucose in the liver and muscle.

(iv) Indigestible Polysaccharides:

Indigestible polysaccharides include cellulose, hemicellulos, pectin, gum and mucilages. These types of polysaccharides are mostly present in the plant foods. They play a significant role in the different parts of the food.

Sources of Carbohydrates:

The main sources of the carbohydrates are bread, potatoes, cookies, soft drinks, corn, whole grains, legumes, fruits, starchy vegetables, milk and yoghurt etc.

(2) Proteins:

The word protein is derived from the Greek word “proteios” which means principal components of all living cells and are important in practically all aspects of cell structure and functions. Proteins contain carbon, hydrogen, nitrogen and sulphur and some also contain phosphorus. Proteins are large molecules formed from the combination of large number of simpler substances known as amino acids.

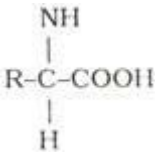


Fig.5. Structure of amino acid

Different amino acids can be formed by varying the group that is attached to carbon containing the amino group. The R-group might contain straight or branched chain, an aromatic or heterocyclic ring structure or a sulphur group. There are 2 amino acids widely distributed in proteins. Proteins consist of chains of amino acids joined to each other by the peptide linkage of 21 amino acids. There are 8 essential and 13 non-essential AA. Essential AA are those that cannot be synthesized in the body e.g histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Thus they can be attained from food alone. Nonessential amino acids are those that body can synthesize from an available source of nitrogen and carbon skeleton.

Classification of Proteins:

a. Simple proteins

b. Conjugated proteins

c. Derived proteins

(a) Simple Proteins:

These proteins on hydrolysis by acid, alkali or enzymes yield only amino acids or their derivatives. Examples of this group are albumin and globulins found within all body

cells, blood serum, keratin, collagen and elastin in supportive tissues of body, in hair and nails, globin in haemoglobin and myoglobin, zein of corns, gliadin and glutenin in wheat, legumin in peas and lacto-albumin and lactoglobulin in milk.

(b) Conjugated Proteins:

Simple proteins combined with a non-proteinaceous substance constitute conjugated proteins. This group includes lipo-proteins, the carrier needed for the transport of fats in blood; nucleoprotein, the protein of cell nuclei; phosphoproteins, such as casein milk and ovovitellin in eggs; metalloproteins, such as the enzymes that contain mineral elements, mucoproteins found in connective tissues. Mucin and gonadotropic hormones; chromoprotein such as haemoglobin and visual purple and flavoproteins which are enzymes that contain the vitamin D.

(c) Derived Proteins:

These proteins result from the decomposition of simple and conjugated proteins. This include rearrangement within the molecules without breaking the peptide bond such as that occurring with coagulation and also substances formed by hydrolysis of proteins of smaller fraction.

Functions of Proteins:

(a) Building Block:

Proteins form the main solid matter of muscles, organs and endocrine glands. They are major constituents of matrix of bones and teeth, skin, nails and hair and blood cells and serum. The first need for amino acids is to supply the materials for the building and continuous replacement of cell proteins throughout life.

(b) Regulatory functions:

The body proteins have highly specialized functions in the regulation of body processes, e.g., haemoglobin, which is chief constituent of RBC carries oxygen to tissues; contractile proteins regulate muscle contraction.

(c) Formation of enzymes, hormones and other secretions:

Proteins supply raw materials for the body to synthesize enzymes like trypsin and pepsins. Hormones like insulin and thyroxine are protein in nature. Antibodies which give resistance power to the body are also protein in nature. They are known as immune proteins (immunoglobulin's).

(d) Source of energy:

Protein is generally considered as building material of our body. But when diet contains insufficient amount of carbohydrates and fats, body uses up proteins for the energy purposes. Each gram of protein yields 4 Kcal of energy.

(e) As binding factor:

Proteins like lipoproteins, transferrin, phosphoproteins are essential to our body for transporting many chemical substances.

Sources:

Plant sources: pulses, Legumes, nuts, Cereal Grains, etc.

Animal sources: Meat, fish, poultry eggs, milk and milk products.

Table1. Protein content of some food stuffs

Food stuff	mg/100g

Bengal gram dal	20.8
Black gram daal	24
Cow pea	24.1
Green gram	24.5
Horse gram	22
Khesari dal	28.2
Soya bean	43.2
Ground nut	25
Cashew nut	21.2
Almond	20.8
Pistachio	19.8
Walnut	15.6
Milk	3.2-4.3
Meat	18-26
Egg	13
Fish	15-23
Paneer	18

(3) Fats:

Fats are the most concentrated source of energy and supply 9 Kcals of energy per gram of fat. They provide the body's main reserve of energy and are essential for various functions. Like carbohydrates, fats are organic compounds composed of carbon, hydrogen and oxygen, but they differ from carbohydrates in that they contain much less oxygen and much greater proportions of carbon. Fat has one molecule of organic ester of glycerol and three molecules of fatty acids. Fats are insoluble in water and soluble in organic solvents like ether, benzene or chloroform. Their cooking property depends on the kind of fatty acid present in them. Lipids are heterogeneous group of compounds with same properties. Fat is the common household name given to lipids.

Classification of lipids/Fats:

Lipids are classified into:

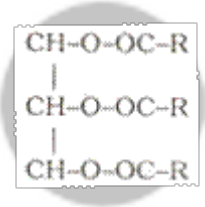
a. Simple lipids

b. Compound lipids

c. Derived lipids

(a) Simple lipids:

These are esters of glycerol and fatty acid; glycerol is a 3-carbon alcohol with three hydroxyl groups each of which can combine with fatty acid.



Fatty acids are broadly divided into two main groups:

a. Saturated acids

b. Unsaturated fatty acids (containing one or two double bond).

(a) Saturated fatty acids:

A saturated fat is a type of fat in which the fatty acids have single bonds. The common saturated fatty acids are palmatic, stearic, myristric and lauric acids.

(b) Unsaturated fatty acids:

An unsaturated fatty acid is one in which a hydrogen atom is missing from each of the 2 adjoining carbon atoms thus necessitating a double bond between the 2 carbon atoms. A mono unsaturated fatty acid has one double bond; oleic acid is widely distributed in food and body fats. A poly unsaturated fatty acid (PUFA) contains two or more double bonds; linoleic, linolenic and arachidonic acids are nutritionally important examples of this group.

(b) Compound lipids:

These are esters of glycerol and fatty acids, with substitution of other components such as carbohydrate, phosphate and/or nitrogen groups. Phospholipids such as lecithin and cephalin contain a phosphate and nitrogen, group replacing one of the fatty acids.

(c) Derived lipids:

These include fatty acids, alcohols (glycerol's and sterols) carotenoids and the fat soluble vitamins A, D, E and K.

Functions:

a. The primary function of fat is to supply energy. 1 gram of fat provides 9 Kcal of energy which is twice than that of carbohydrates and proteins.

b. They provide taste to the food.

c. The fats reduce gastric motility and remain in the stomach much longer and the onset of hunger is delayed, thus giving a good satiety value.

d. Fats are the carriers of fat soluble vitamins, i.e. A. D, E and K. Fats are needed for the absorption of vitamin A and its precursor carotene.

e. The subcutaneous layer of fat acts as an effective insulator thus reducing the heat

loss from the body in cold weather.

f. It provides the diet with essential fatty acids as these cannot be synthesized in the body.

Sources: Plant sources: Ground nut oil, Coconut oil, Gingelly oil, Mustard oil.

Animal sources: Lard, Butter, Ghee, Cream

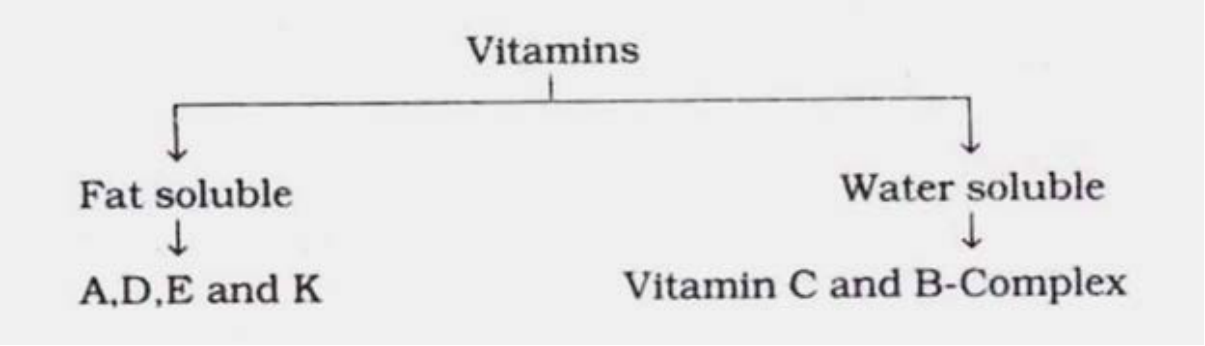
Most of the foodstuff contains some amount of fats in them which are termed as invisible fats. The above listed fats are visible fats. The invisible fats are believed to contribute significantly to the total fat and essential fatty acid content of the diet depending upon foodstuff present in diet. Diet containing nuts, oil seeds, soya bean, avocado pear (butter fruit) and animal foods have higher amount of invisible fat.

(4). Vitamins:

Vitamins are the discovery of the 20th century. Vitamins are defined as

organic compounds which are necessary for good health and vitality. Vitamins are required in minute quantities and their deficiency results in structural and functional disorders of various organs.

Vitamins can be classified as:



A. Fat soluble vitamins:

Fat soluble vitamins are generally associated with fatty foods such as butter, ghee, cream, oils and fats of meat and fish. Fat soluble vitamins are stable to heat and are less likely to be lost during cooking and processing of foods. They are absorbed from the Intestine along with

fats and lipids.

(i) Vitamin A:

Vitamin A is found in the form of retinol and carotene. Vitamin A in its pure form is a pale yellow substance soluble in fat. It is unsaturated alcohol which is stored in the body as ester. Vitamin A is found in milk, meat, fish, etc. The vitamin is found in highest quantity in the liver. Plants do not contain vitamin A, but contain its precursor, the carotenoids which are converted to vitamin A after absorption by the ingesting animal. Carotenoids are orange and yellow pigments of fruits and vegetables. Vitamin A is expressed in terms of international units (IU).

1 I U = 0.3 µg of retinol

1 I U = 0.6 µg of carotene

Sources:

(a) Animal sources: Important sources are liver, egg yolk, butter, cheese, whole milk and fish.

(b) Plant sources: Contain Vitamin A in the form of their precursors which are present in fresh dark green leafy vegetables such as spinach, amaranth, fenugreek, etc. It is also present in orange and yellow colored fruits and vegetables such as carrot,

papaya, pumpkin, mango, etc.

(c) Fish liver oil: The richest natural source of vitamin A is fish liver oil. One teaspoon of cod or shark liver oil supplies about 6000 IU of vitamin A.

(ii) Vitamin D:

Vitamin D is known as the sunlight vitamin as it is synthesized with the help of sunlight. From nutritional point of view it occurs in two major forms.

a. Vitamin D2—Ergocalciferol b. Vitamin D3—Cholecalciferol

Vitamin D2 is formed when ergosterol found in plants is exposed to ultraviolet light. Vitamin D3 is the chief form occurring in animals and develops to 7-Dehydrocholecalciferol on exposure to ultraviolet light from sun. Vitamin D is measured in terms of international units.

1 IU = 0.025 µg of pure crystalline vitamin D.

Sources: Sunlight — This is an important natural source of Vitamin D. 7-dehydro cholesterol which is normally present in the skin is converted to vitamin D3 by the action of ultraviolet rays of sunlight. Food rich in vitamin D are egg yolk, liver, fish and fish oils. Fish liver oils are the richest source of vitamin D. Vitamin D is not found in foods of vegetable origin.

(iii) Vitamin E:

This vitamin is also known as tocopherol, the most common and active type being alpha-tocopherol. The vitamin prevents the oxidation of the unsaturated fatty acid and acts as an antioxidant. High temperatures and

acids do not affect the stability of vitamin E. Decomposition of vitamin E occurs in the

ultraviolet light. It is expressed in terms of international units. Vitamin E requires the presence of fats and bile salts for absorption into the intestinal wall.

Sources: The principle sources of vitamin E in the diet are vegetable oils, hydrogenated fats from vegetable oils, whole grains and dark green leafy vegetables, nuts and legumes. Foods of animal origin are low in vitamin E.

(iv) Vitamin K:

Vitamin K consists of a number of related compounds known as quinones.

The important ones being:

1. Vitamin K1-Phylloquinone

2. Vitamin K2-Manaquinone

This Vitamin requires bile for its absorption as it is a fat soluble vitamin. The two forms of vitamin K occur naturally. Vitamin K1 [phylloquinone] is in green plants and K2 [Menaquinone] which is formed as a result of bacterial action in the intestinal tract.

Sources: Green leafy vegetables like cabbage, cauliflower and pork liver. Cereals, fruits and other vegetables are poor sources of this vitamin.

(B) Water Soluble Vitamins:

(i) B-Complex Vitamins:

Vitamin: B1-Thiamine, B2-Riboflavin, B6-Pyridoxine, B12- cyanocobalamine, niacin, folic acid, pantothenic acid, biotin, choline.

(a) Vitamin B1 (Thiamine):

This vitamin is widely distributed throughout the plant and animal kingdom. It is stable

in its dry form. Cooking food in neutral or alkaline media causes destruction of this vitamin. The vitamin is present in good amount in pulses and nuts, liver, meat, chicken, egg yolk and fish. Thiamine is readily soluble in water and soluble in fat solvents. Extensive losses occur in cereals and pulses as a result of cooking or baking. It is also lost during processing of fruits, vegetables and meats.

(b) Vitamin B2 (Riboflavin):

It is a yellow colored pigment widely distributed in plant food and in small amounts in animal foods. Dried yeast is a rich source of this vitamin. It was named riboflavin because of the similarity of part of its structure to that of ribose sugar. This vitamin is stable in heat and to oxidizing agents and acids.

(c) Niacin or Nicotinic Acid:

Niacin is also known as nicotinic acid or nicotinamide. It is a white crystalline compound soluble in water, stable to heat, light, acids and alkalies. In body niacin is converted into niacin-amide. Whole cereals, dried yeast, liver, ground nuts, legumes and fish are good sources. Milk, eggs and vegetables are fair sources of the vitamin.

(d) Vitamin B6 (Pyridoxine):

Vitamin B6 is otherwise known as pyridoxine, pyrodoxal and pyridoxamine. This vitamin is widely distributed throughout the plant and animal kingdom. Vitamin B6 is soluble in water and distributed throughout plant and animal kingdom. The best sources are meat, especially liver, some vegetables and grains with bran.

(e) Pantothenic acid:

Pantothenic acid is widely distributed in all foods particularly abundant in that of

animal origin, whole grains and legumes. It occurs in small quantities in milk, fruits and vegetables. It gets decomposed by alkali or

rise in temperature.

(f) Folic acid:

Folic acid is also known as folacin. Pure folic acid occurs as a bright yellow crystalline compound, slightly soluble in water. It is easily oxidised in an acid medium and is sensitive to light.

Sources: Folic acid is widely distributed in foods, liver, kidney, yeast and green leafy vegetables which are excellent sources. Vegetables, legumes, eggs, whole grain cereals and fruits are good sources.

(g) Vitamin B12 (Cyanocobalamin):

This is the most complex of the B-Vitamins. It has been named as cobalamin as it is found as a co-ordination complex with cobalt. It occurs in several forms known as cobalamin. Cyanocobalamln is the most stable form. There is little loss of Vitamin B12 in food by regular cooking procedures.

Sources: It is found in animal foods only, like organ meats, muscle meats, fish, poultry, milk and eggs.

(h) Biotin:

Biotin is a relatively simple compound, a cyclic urea derivative which contains a sulphur group. It is very stable to heat, light and acids. In tissues and in foods, it is usually combined with proteins.

Sources: Dried yeast, organ meats, rice polishings, soyabean are good sources of

Biotin.

(i) Choline:

All living cells contain choline, principally in phospholipids which is essential for the structure and function of cell membranes and serum lipoproteins. Egg yolk is rich in choline but legumes, organ meats, milk,

muscle meats and whole grain cereals are also good sources. Choline enhances the oxidation of fatty acids and cholesterol in blood and from the liver deposition and removal in adipose tissues. It is essential for the

transfer of nerve Impulses.

(C) Vitamin C:

Ascorbic acid is an essential nutrient for man as he lacks the capacity to synthesise it like any other animal species, vitamin C is a water soluble vitamin. It is the most unstable of all vitamins, being rapidly destroyed by high temperature, oxidation, drying and storage. Ascorbic acid is a white crystalline substance readily soluble in water.

Sources: Fruits – All fresh fruits contain vitamin C. Amla, the Indian gooseberry (Nellikayi) is one of the richest sources. Guava is another cheap source of vitamin C. Vegetables especially green leafy vegetables are rich in vitamin C. Roots and tubers are poor sources of vitamin C. Sprouts also contain small amounts of vitamin C.

Animal food – Meat and milk contain very small amounts of vitamin C.

(5) Water:

Water is the largest constituent of the body. The body's need for water is second only to that for oxygen. One can live without food for weeks but death is likely to follow,

deprivation of water for more than a few days. A 10% loss of body water is a serious hazard and, death is likely to follow a 20% loss. Water makes up 50% to 70% of the weight of the human body, lean individuals have a higher percentage of body water than do obese individuals. Water is present inside the cells of tissues (intracellular) and outside the tissue cell (extracellular). Water and electrolytes are essential constituents of cellular functions and to regulate the excretion through kidney, lungs and skin. The excretion of water through skin and kidneys changes according to the climatic conditions. In dry climate one sweats a lot and in cold weather one passes urine more often. Water is a simple compound containing two parts of hydrogen with one of oxygen. Good drinking water has no odour and is pleasant to taste. Water may contain traces of calcium, sodium, magnesium and iron depending upon the soil from which it is obtained.

Sources: Fruit and vegetables containing high percentage of moisture in them like, cucumber, watermelon, ashgourd, tomatoes, orange, sweet lime, lemon, grapes, pomegranate, pineapple, cashew fruit, khol-khol, chocho, marrow, bottle gourd, brinjal, bitter gourd, etc.