Chapter 13: Healthy Diets for All

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Chapter 13: Healthy Diets for All

Food is necessary for survival. All organisms consume food for the energy and nutrients it provides. However, the basic biology underlying food intake is also closely linked to pleasure. Hence, we continue to eat food even when satiated knowing well that most of the highly palatable foods may not be the most wholesome. Our desire to eat these foods is also dependent on several influences in our modern food environment, like cost, availability, convenience and social influences.

It is known that even though food is essential for survival, not all foods are created equal. An appropriate knowledge related to food and its constituent nutrients is necessary to ensure good health. Nutrients are those constituents of food that give nourishment essential for the maintenance of life, growth and development. Most foods contain nearly all nutrients, some being in higher proportions and some lesser. Some nutrients are needed in larger amounts by the body and are hence called macronutrients; while some, though being essential, are needed in smaller amounts, these are called micronutrients. It is important to obtain the right proportion of nutrients from the foods consumed. The following discussion will highlight the different nutrients and their role in health and well-being. This chapter will also help in understanding different concepts that could be used to enrich our diets.

Basic concept of food and nutrition

It is well known that for survival, the human organism needs to take in oxygen, water, and food. We can survive only about three minutes without air, three days without water, and three weeks without food (Towell, 2011). Food is the source of nutrients which are essential for growth, reproduction and good health.

Nutrients, Food groups and Balanced diets

Nutrients are the constituents of food that is required by the body in appropriate amounts. Broadly, nutrients can be classified as:

- Macronutrients – These are required by our body in large quantities (measured in grams) and include proteins, carbohydrates, fats and water.
- Micronutrients – These include vitamins and minerals and are required by our bodies in relatively smaller quantities (measured in milli or micrograms) but are essential for various body processes.

The requirement of these nutrients varies throughout the lifecycle depending on the need and nutritional status of an individual. Nutritional status is the condition of health which is influenced by the utilization of nutrients. The key to achieve a good nutritional status is to consume a balanced diet. A balanced diet is one that contains all types of food in such quantity and proportion that meets all needs of the body adequately. The quantities of foods needed to meet the nutrient requirements vary with age, gender, physiological status and physical activity. A balanced diet should provide around 55-60% of total calories from

carbohydrates, preferably from complex carbohydrates, about 10-15% from proteins and 20-30% from fat.

In addition, a balanced diet should provide other non-nutrients such as dietary fibre, antioxidants and phytochemicals which bestow positive health benefits. Antioxidants such as vitamins C and E, beta-carotene, riboflavin and selenium protect the human body from free radical damage. Other phytochemicals such as polyphenols, flavones, etc., also afford protection against oxidative damage. Spices like turmeric, ginger, garlic, cumin and cloves are rich in antioxidants. Foods are conventionally grouped as:

1. Cereals and Millets
2. Pulses
3. Milk and milk products, Egg, Meat and Fish
4. Vegetables and Fruits
5. Oils and Fats, Nuts and Oilseeds, and Sugars

However, foods may also be classified according to their functions - energy giving, body building and protective foods. Energy giving foods mainly include cereals, fats and sugars; body building food groups are pulses, milk and milk products, meat, fish, poultry and eggs; and, protective foods include mostly fruits and vegetables, though other food groups also contribute vitamins and minerals to the diet.

The relationship between food and health is complex. Everyone needs food to live, but too little food, too much food, or the wrong type of food has negative consequences for health. Improving eating habits is not just for an individual but for the whole population. ICMR-NIN has introduced the concept of 'My Plate for the Day' (figure 1) to fight hidden hunger. The plate is half filled with fruits and vegetables. A major portion of the remaining half is cereals, millets and pulses. Small amounts of fats, oils, nuts and oilseeds are also included along with one glass/cup of milk/curd.

Figure 13. 1: My Plate for the Day

Source: NIN, ICMR 2018.

While planning a diet the dietary goal should focus on maintenance of a state of positive health and optimal performance. It should ensure adequate nutritional status by achieving adequacy in all nutrients, prevention of deficiency diseases, prevention of chronic diet-related disorders and increasing the life expectancy.

Food Based Dietary Guidelines

Right nutritional behaviour and dietary choices are needed to achieve dietary goals. The following 15 dietary guidelines provide a broad framework for appropriate action (ICMR/NIN 2011):

1. Eat variety of foods to ensure a balanced diet.
2. Ensure provision of extra food and healthcare to pregnant and lactating women.
3. Promote exclusive breastfeeding for six months and encourage breastfeeding till two years or as long as one can.
4. Feed home based semi-solid foods to the infant after six months.
5. Ensure adequate and appropriate diets for children and adolescents, both in health and sickness.

6. Eat plenty of vegetables and fruits.
7. Ensure moderate use of edible oils and animal foods and very less use of *ghee*/ butter/ *vanaspati*.
8. Avoid overeating to prevent overweight and obesity.
9. Exercise regularly and be physically active to maintain ideal body weight.
10. Restrict salt intake to minimum.
11. Ensure the use of safe and clean foods.
12. Adopt right pre-cooking processes and appropriate cooking methods.
13. Drink plenty of water and take beverages in moderation.
14. Minimize the use of processed foods rich in salt, sugar and fats.
15. Include micronutrient-rich foods in the diets of elderly people to enable them to be fit and active.

Nutrient Requirements

Requirements are the quantities of nutrients that healthy individuals must obtain from food to meet their physiological needs. These have been defined at different levels - the Estimated Average Requirements (EAR), the Recommended Dietary Allowances (RDAs) and the Tolerable Upper Intake Levels (TUL).

Terms used in the framework of nutrient requirements (ICMR-NIN, 2020)

Estimated Average Requirement (EAR) refers to the average daily nutrient intake level estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group.
Recommended Dietary Allowances (**RDAs**) refer to the daily dietary nutrient intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and gender group.

Tolerable Upper Level (TUL) refers to the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the TUL, the risk of adverse effects will increase.

Macronutrients

The macronutrients needed by our body in larger quantities and these include carbohydrates, protein and fats. In addition, water is also considered to be an important nutrient.

Water

Water is the largest component of the human body making up 50 to 70 % of body weight, depending on age and body composition. Water is the medium in which all metabolic processes of our body take place. Water itself participates in several metabolic reactions. It serves as a solvent for vitamins, minerals, amino acids, glucose and many other substances so that they can participate in reactions. It is the medium of all cell fluids, digestive juices, lymph, blood, urine and perspiration, and hence important for the process of digestion, absorption, transport and excretion of nutrients and waste products. Water helps in the regulation of normal body temperature.

Besides plain water, beverages like fruit and vegetable juices, milk, soft drinks and soups also contribute to the total water intake. Water is also present in fruits and vegetables making up most of their weight. Fruits which are juicy have higher water content like watermelon, muskmelon, oranges, etc. Vegetables with a high percentage of water by weight include cucumber, bottle gourd (*ghia*), green leafy vegetables, etc. Water needs vary with factors such as body size, physical activity and environmental conditions. Adults need at least 2 to 3 litres (8-12 glasses) of fluids per day to replace daily losses. This amount includes pure water and water present in foods and beverages.

Carbohydrates

Carbohydrates are essential for the body as they are a source of readily available energy for the body. These are organic compounds that consist of carbon, hydrogen and oxygen.

Classification

Carbohydrates are of two types - simple and complex. **Simple carbohydrates** are sugars, such as the ones found in candy, fruits and baked goods. They are called simple sugars because they are made up of one (mono) or two (di) units of sugars (saccharides).

Monosaccharides (simple sugar): These contain one sugar molecule. Glucose – which is needed by the body for immediate energy is a simple sugar. It is also known as dextrose, grape sugar, and corn sugar. It is about half as sweet as table sugar. Other examples for monosaccharides are fructose (found in fruits and honey) and galactose.

Disaccharides (simple sugar): Disaccharides contain two sugar molecules. Table sugar, or sucrose is a disaccharide, as it consists of glucose and fructose. Other examples are lactose or milk sugar, composed of galactose and glucose; and Maltose made of two glucose molecules.

Cane sugar or sugar and other sweeteners like honey and jaggery are 95 per cent to 100 per cent carbohydrate. Although both honey and sugar provide the same amount of calories, unlike table sugar, honey contains a small amount of vitamins and minerals.

Complex Carbohydrates are the ones found in fruits and vegetables, whole grains and pulses. They are basically long chains of several (poly) sugar (saccharide) molecules attached together. Hence, they are called polysaccharides. Examples of complex carbohydrates are starch, glycogen and dietary fibre (pectin, gums, mucilages, cellulose, hemicellulose). **Starch** is a complex carbohydrate and is the storage form of carbohydrate found in plants. It is an important source of energy for animals and humans. Cereal and cereal products, pulses and legumes, roots and tubers are the main source of carbohydrate for Indians. It acts as an excellent source of fuel (energy) for the body. **Glycogen** is the form of carbohydrate stored in the body in animals.

Dietary fibres are complex carbohydrates that cannot be digested by human enzymes. Cellulose is the main structural component of plant cell walls and is referred to as insoluble dietary fibre. Pectin is also a complex carbohydrate found in ripe fruit and vegetables and is referred to as soluble dietary fibre. It helps to set jams and jellies. Both soluble and insoluble dietary fibre help in regulating many body processes, including body weight, bowel movement, blood sugar, blood pressure and blood cholesterol.

So, it can be said that carbohydrates are important components of the diet. While simple sugars and many refined foods like flour provide readily available energy/calories, many of these foods lack vitamins, minerals, and fibre. These "empty calories" and can lead to weight gain. In 2015, the World Health Organization (WHO) set upper limits by recommending that the intake of free sugars be less than 10% of the total energy intake (strong recommendation) and a further reduction to less than 5% of total energy intake (conditional recommendation) throughout the lifespan for preventing both dental caries and obesity. Thus, it is healthiest to get carbohydrates from as natural a form as possible -- for example, from fruit instead of table sugar, or from whole wheat flour instead of maida.

Functions

Some of the important functions of carbohydrates are listed below:

- The main function of the carbohydrate is to provide energy. One gram of carbohydrate yields 4 kcal (17 kJ) of energy. Some amount of carbohydrate is stored as glycogen in the liver and muscles for immediate conversion to glucose/energy. Brain and the central nervous system use only glucose as their source of energy.
- Fibre, or complex carbohydrates, can absorb water, prevent constipation and other bowel disorders, provide a feeling of fullness and control hunger. Fibre plays a role in prevention of diseases like cancer of colon i.e. the large intestine, diabetes (by

lowering blood glucose levels) and heart disease (by lowering blood triglyceride and cholesterol levels).

- If taken in sufficient quantity, carbohydrates are preferentially used as a source of energy thus sparing proteins for their function of growth and maintenance.

Food sources

Milk, yogurt, and other milk products are a source of lactose; fruits, some vegetables and their juices are a source of fructose, glucose and sucrose; bread, rice, wheat and other cereals, legumes and pulses, starchy vegetables are a source of starch and fibre; processed food items like sweets, cookies, sweetened beverages and other desserts are a rich source of sucrose.

Carbohydrates are thus an important component of our diet and we must ensure that 55 to 60% of our daily calories are provided from an intake of healthy carbohydrates.

Proteins

The English word protein originated from the Greek word "proteios", meaning prime or primary. This term is very appropriate in nutrition, because proteins are the primary structural and functional component of every living cell. Like carbohydrates, they are organic compounds, but are distinct from carbohydrates as they have nitrogen along with carbon, hydrogen and oxygen in their structure. A protein molecule is made up of tiny units called amino acids. Amino acids are linked together in chains by linkages called peptide linkages. All proteins are built up of just 20 kinds of amino acids.

The biological value of proteins is dependent upon combinations of amino acids that build up any particular protein. There are nine amino acids that are essential to human health and nutrition. They are essential because they cannot be synthesised in the body and must be supplied by the protein in the diet. The nine essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Thus, the content, digestibility coefficients, and relative proportions of amino acids in dietary protein are the determinants of its nutritional value.

Classification

The proteins can be classified on the basis of their amino acid content as:

Complete protein: Any food that has all the essential amino acids in the right proportions is called a complete protein food. These are high quality proteins which promote growth and maintain life. Animal proteins, such as eggs, cheese, milk, meat, and fish, are considered high-quality, or complete proteins because they provide sufficient amounts of the essential amino acids and hence are superior to plant protein foods. The protein content of soybean is exceptionally high.

Partially complete protein: Plant proteins are of lower-quality, or partially complete proteins because many plant proteins lack one or more of the essential amino acids. Partially complete proteins can, however, be combined with other foods to provide all the essential amino acids. For example, cereals and pulses are deficient in lysine and methionine, respectively. Rice and pulse when taken together improves the quality of protein by supplying these two amino acids and making up for the deficiency. This is called **mutual supplementation.**

Incomplete protein: They are completely lacking in one or more of essential amino acids and can neither promote growth nor maintain life, e.g. gelatin (found in bones, cartilage and collagen) and zein (found in corn). Nitrogen liberated by the breakdown of these proteins can be utilized for synthesis of other amino acids in the body.

Functions

- Proteins are vital to basic cellular and body functions, including cell regeneration and repair, tissue maintenance and regulation.
- Hormone and enzymes, which are vital for the regulation of metabolism, are protein in nature.
- Even antibodies which protect the body from illness are also proteins.
- Proteins like hemoglobin, lipoproteins perform important body functions.
- Protein can also provide energy if sufficient carbohydrate and fat are not supplied by the diet. Each gram of protein yields about 4 Kcal.

Deficiency of proteins leads to serious illnesses such as impaired mental health, oedema, shrinkage of muscle tissues, as well as weak immune system. Deficiency of both energy and proteins results in protein-energy malnutrition (PEM). It is characterized by a group of related disorders that include marasmus, kwashiorkor and intermediate states of marasmic-kwashiorkor.

Children with kwashiorkor have nutritional oedema, skin and hair changes, metabolic disturbances, including hypoalbuminemia (low protein in the blood) whereas marasmus is characterized by severe wasting.

Food sources

Protein is found in foods from both animal and plant sources. Good sources of protein include meat, poultry, fish, milk, egg, and cheese, as well as legumes and pulses. Protein content of some foods is given in Table1.

Table 13. 1: Protein content of some foods (g/100 g of foodstuff)

Food from animal sources	Protein (g)	Food from plant sources	Protein (g)
Chicken, leg	19.44	Peas (dry)	20.43
Goat chops	20.39	Lentils	24.35
Fish (Hilsa)	21.8	Cowpea	21.25
Eggs	13.28	Cashew Nut	18.78
Paneer	18.86	Groundnuts	23.65
Milk	3.26	Soybean	37.8

Sources: IFCT. 2017 http://www.ifct2017.com/frame.php?page=home

Fats or Lipids

Fats are organic compounds that are made up of carbon, hydrogen, and oxygen. A typical fat molecule is made of one molecule of glycerol and three molecules of fatty acids. It is also called triglyceride or triacylglycerol.

Classification

Fats or the fatty acids they are made of can be classified as:

- Essential and non- essential fatty acids
- Saturated and unsaturated fats
- Visible and invisible fats

Some fatty acids are called **essential** as they cannot be synthesised in our body and must be an essential part of our diet. Examples are linoleic acid (omega 6) and linolenic acid (omega 3); whereas fatty acids which can be synthesised in the body are termed as **non-essential** fatty acids like stearic acid, palmitic acid, etc.

Saturated fats have single bonds between their molecules and are "saturated" with hydrogen molecules. They tend to be solids at room temperature, such as ghee, butter, coconut oil.

Unsaturated fat: Unsaturated fats contain one or more double or triple bonds between the molecules. Most of these are found in vegetable oils. These fats are liquid at room temperature. They are also found in certain foods. This group is further classified into two

categories called monounsaturated fats (having one double bond) and polyunsaturated fats (having two or more double bonds).

Fat naturally present in foods and our body exists as the cis isomer. During the process of hydrogenation **trans fats** are formed. Hence partially hydrogenated oil (e.g. vanaspati, margarine, bakery fat) would have some trans fats. Some meats and dairy products contain small amounts of trans fats which have been formed due to microbial conversion, but mostly they are usually found in processed foods. Examples of food products that may contain trans fats include bakery products like cookies, doughnuts, and fried foods like namkeens, samosas etc. Trans fats should be completely avoided in the diet as they are harmful for health.

Fat is also present in almost all food stuffs. Cereals, pulses, nuts and oilseeds, meat, fish, poultry have fat in them. They are called **invisible** fats as we cannot see the fat. **Visible** fats are fats which are added to foods like butter, cooking oil, ghee, etc. and can be seen.

Functions

- Fat is a concentrated source of energy. Each gram of fat provides approximately 9 kcal.
- Fats provide satiety and palatability to the diet.
- Fat serves as a carrier of fat-soluble vitamins in the body and also helps in their absorption.
- Fat is stored under the skin and thus it checks the loss of heat from the body and keeps the body warm.
- It is also present around the vital organs of the body such as kidney and the heart and thus protects them from external injury.
- Fat serves as a source of essential fatty acids which have important functions in our body.

It is recommended that not more than 30% of a person's daily calories should come from fat; and less than 10% from saturated fats. Dietary cholesterol comes exclusively from animal sources. It is an important component of cell membranes and a precursor of bile acids, steroid hormones and vitamin D. A mix of different vegetable oils should be consumed to attain a good fatty acid profile. High fat diets lead to obesity and associated non-communicable diseases like cardiovascular diseases, diabetes and certain cancer.

Food Sources

Rich Sources of different types of fats are given in Table 2:

Table 13. 2: Food Sources of Different Types of Fats

Type of Fat	Food Sources
Saturated fat	Animal sources include meat and dairy products, such as: cheese, butter, cream, high-fat cuts of meat. Plant sources include coconut oil, palm oil.
Monounsaturated fat	Red palm, palmolein, groundnut, sesame, olive, ricebran and cottonseed oil
Polyunsaturated fat	All vegetable oils except for coconut oil, especially corn oil, safflower and sunflower oils, fish oil
Omega 3 fatty acids	Fatty cold water fish (salmon, tuna, sardines, mackerel) and fish oils, invisible fat of legumes like rajmah, cowpea, soyabean, black gram, cereals like wheat and bajra, mustard and fenugreek leaves and seeds, green leafy vegetables, canola, mustard and soyabean oils, flaxseed, walnuts.
Trans fat	Hydrogenated or partially hydrogenated vegetable oil, *vanaspati*, margarine, bakery shortening/fat
Cholesterol	Egg yolk, organ meats (liver, kidney, brain, etc), milk fat, red meat, shrimp, prawn

Source: Ross et al, 2014; Mudambi and Rajagopal, 2012; Chadha and Mathur, 2015; Roday, 2018

Micronutrients

Nutrients which are required by the body in relatively lesser amounts are called micronutrients. Vitamins and minerals fall under this category. The requirements in terms of amounts may be small, but most vitamins and minerals have very important roles to play in health and well-being.

Vitamins

Vitamins are organic nutrients that are essential for carrying out several regulatory functions in the body. Vitamins are classified as water soluble and fat – soluble vitamins, based on their solubility in water and fats respectively.

Fat soluble vitamins: Vitamins which are soluble in fats are called fat soluble vitamins. There are four fat soluble vitamins – vitamin A, vitamin D, vitamin E and vitamin K. These vitamins can be stored in the body, hence excessive intake could be toxic. Table 3 gives in brief the main functions of each of these fat-soluble vitamins along with some examples of their food sources and deficiency signs and symptoms.

Table 13. 3: Fat soluble vitamins: Function, Sources, Deficiency symptoms

Nutrient	**Function**	**Sources**	**Deficiency**
Vitamin A	- Normal vision in dim light. - Maintains a healthy epithelium, especially the membranes that line the eyes, mouth, the gastrointestinal, respiratory and genitourinary tracts. This resists bacterial invasion and thus vitamin A gives protection against infection. - Essential for normal skeletal and tooth development. -Keeps the skin healthy. -Essential for the normal development of foetus.	Retinol (animal sources: fortified milk, cheese, cream, butter, eggs, liver, fish oil Beta-carotene (plant sources): Dark green leafy vegetables; yellow-orange fruits (apricots, papaya, mango) and vegetables (carrots, sweet potatoes, pumpkin)	-Xerophthalmia: Night blindness Conjunctival xerosis (dryness of the conjunctiva), Bitots spots (foamy spots on the conjunctiva) and keratomalacia which may lead to blindness. -Keratomalacia: degeneration and keratinization of the epithelium. -Follicular Hyperkeratosis: Skin changes, skin becomes rough, dry and scaly.
Vitamin D	-Regulates the absorption and utilization of calcium and phosphorus from the intestinal tract. -Along with calcium and phosphorus forms bones and teeth makes them healthy and strong. -It regulates the amount of calcium and phosphorus in blood and promotes reabsorption of calcium and phosphorus in kidney.	Egg yolks, liver, fatty fish, fortified milk, fortified margarine. When exposed to sunlight, the skin can make vitamin D.	Rickets in Children: a condition in which the level of calcium and phosphorus is low causing knock knees, bow shaped legs and rachitic rosary (swelling or expansion of ends of ribs). Softening of the skull, and delayed closing of the fontanelles. Tetany: Low serum calcium level, causes trembling in hands and sometimes cramps and convulsions in children. Osteomalacia, in adults: bones become soft, fragile and susceptible to fracture. There is bone pain and difficulty in walking and climbing stairs.

Vitamin E	-Antioxidant: it combines with free oxygen radicals, protects the integrity of the cell membranes. - It reduces the risk of cancer, heart disease by protecting cells, DNA, lipids from oxidative damage. -It has an important role to play in maintaining reproductive health _ -Vitamin E also maintains health of muscles	Polyunsaturated plant oils (soybean, corn, cottonseed, safflower); leafy green vegetables; wheat germ; who le-grain products; liver; egg yolks; nuts, legumes and seeds	Vitamin E deficiency is very rare. -Increased haemolysis (break down) of the red blood cells leading to anemia. -Repetitive abortions or premature births. -Weakening of muscles due to the excessive oxidation of fats.
Vitamin K	Needed for proper blood clotting It is also called an Anti- Haemorrhage vitamin.	Leafy green vegetables such as spinach; green vegetables such as broccoli, brussels sprouts, and asparagus; also produced in intestinal tract by bacteria	Usually seen in premature infants, but otherwise rare. May lead to excessive bleeding due to non-formation of blood clot

Source: Ross et al, 2014; Mudambi and Rajagopal, 2012; Chadha and Mathur, 2015; Roday, 2018

Water soluble vitamins: These vitamins are soluble in water. They cannot be stored in the body and excess are excreted mainly in urine. Vitamin B –complex and Vitamin C are examples of water-soluble vitamins.

Vitamins of B complex group include Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Folic acid, Cobalamin (B_{12}). Table 4 gives, in brief, the main functions of important water-soluble vitamins along with some examples of their food sources and deficiency signs and symptoms.

Table 13. 4: Water-soluble Vitamins- Functions, Sources and Deficiency

Nutrient	Function	Sources	Deficiency
Thiamine also known as the 'anti beri beri' or 'anti – neuritic vitamin	-Acts as a co-enzyme for an enzyme carboxylase, needed for energy metabolism; -important for nerve function	Found in all foods in moderate amounts: whole-grain legumes, nuts and seeds, dried yeast, pork, liver.	Beriberi (dry beriberi mainly the nervous and muscular systems are affected and wet beriberi affects the neurological and the cardiovascular systems and it is characterised by oedema)
Riboflavin	-Part of an enzyme needed for energy metabolism; -important for vitamin and mineral metabolism as well - Some riboflavin dependent enzymes have an antioxidant role in the body	Dried yeast, milk, liver, meat eggs, kidney and green leafy vegetables.	Ariboflavinosis (inflammation of the tongue, scaling and cracks at the corners of the mouth, scaly lesions on the skin)
Niacin	-Part of an enzyme needed for energy (carbohydrate and fat) metabolism - essential for protein metabolism	Yeast, poultry, meat, liver, fish, peanuts, whole grains, legumes and some green leafy vegetable -Milk is deficient in niacin but rich in Tryptophan which is a precursor of niacin.	Pellagra characterized by diarrhoea, dementia, dermatitis and ultimately death if condition is left untreated. The dermatitis is bilateral and worsens on exposure to sunlight.
Pantothenic acid	-Part of an enzyme needed for energy metabolism -It participates in several reactions of synthesis of lipids, neurotransmitters, steroid hormones	Widespread in foods - Common sources include milk, meat and vegetables, peanuts, egg yolk, mushroom, potatoes, tomatoes, broccoli, yeast.	Irritability, anorexia, postural hypotension (low blood pressure in standing position), impaired muscle co-ordination, numbness and tingling of hands and feet
Biotin	-Part of an enzyme needed for energy metabolism -role in regulating gene expression	Widespread in foods like egg, liver, green leafy vegetables and nuts; also produced in intestinal tract by bacteria	Hair loss, dermatitis (redness and soreness of skin), conjunctivitis, lethargy, depression, hallucinations, prickling or tingling sensation of extremities in adults and decreases tone of muscles.

Nutrient	Function	Sources	Deficiency
Pyridoxine (vitamin B6)	-Part of an enzyme needed for amino acid metabolism; - Works with vitamin B12 and folic acid to lower homocysteine -Essential for the synthesis of heme, white blood cells and neurotransmitters.	Meat, fish, poultry, nuts, pulses and whole grains, some vegetables, fruits	Inflammation of nerves, anaemia, neurological disorders
Folic acid	-essential for maturation of RBCs -formation of neurotransmitters. -required for the synthesis of DNA. -metabolism of amino acids	Organ meat (liver, kidney), deep green leafy vegetables, yeast, eggs, muscle meats and fish are good sources of this vitamin. Wheat and cereals provide a fair amount.	-megaloblastic anaemia (large, immature RBCs) -Deficiency during pregnancy may cause neural tube defects in infants
Cobalamin (vitamin B12) Absorbed in the body only in the presence of an intrinsic factor which is secreted in the stomach	-It helps in metabolizing fats. -essential for the maturation of red blood cells in bone marrow. -important for nerve health	Present only in the foods of animal origin. Liver, organ meat, muscle meat, fish, poultry, and milk and its products are good sources. It is not found in the foods of plant origin.	pernicious anaemia -is associated with nerve degeneration that can result in eventual paralysis and death, megaloblastic anaemia (large, immature RBCs)
Ascorbic acid (vitamin C)	-Formation and maintenance of collagen the cementing material that holds the cells of the body together. -Healing of wounds -Absorption of iron by the reduction of ferric iron to ferrous ion which is assimilated easily in the body. -Acts as an antioxidant -Provides Immunity -Formation of RBC's in bone marrow. -It is helpful in the formation of hormones	Citrus fruits (oranges, grapes, fruits, lemons and limes) berries, melons, pineapples, guavas, pears, banana, apple, leafy vegetables, capsicum, gooseberry, tomatoes are good source of ascorbic acid. Germination enhances the Vitamin C content of legumes.	Fleeting joint pains, irritability, retardation of growth in infants and children, anaemia, poor healing of wounds and increased susceptibility to infections Gross deficiency results in Scurvy (spongy bleeding gums)

Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Bamji et al, 2009; Srilakshmi, 2007; Roday, 2018

Minerals

Minerals are inorganic substances required by the body in small amounts and perform a variety of functions. Mainly, minerals are essential components of enzyme systems needed for several body functions. Some minerals are called **macrominerals** as they are needed in larger amounts than others, e.g. calcium, phosphorus, magnesium, sodium, potassium and chloride. Others are required in smaller quantities and are sometimes called **trace minerals**, e.g. iron, zinc, iodine, fluoride, selenium and copper. Despite being required in smaller amounts, trace minerals are no less important than other minerals. These minerals may be needed in very small quantities but having too much or too little can upset a delicate balance in the body. Table 5 and 6 list the functions and sources of important minerals in the body.

Table 13. 5: Macrominerals: Function and sources

Mineral	Function	Sources
Sodium	Maintains proper fluid balance, nerve transmission, and muscle contraction	Table salt, sauces, pickles, papads, chutneys, processed foods; small amounts in milk, breads, vegetables
Chloride	Maintains proper fluid balance	Table salt, sauces, pickles, papads, chutneys, processed foods; small amounts in milk, breads, vegetables
Potassium	Maintains fluid balance, muscle contractions and nerve signals, help reduce blood pressure and water retention	Bananas, oranges, grapefruit, prunes, raisins, and dates, broccoli, spinach, Potatoes, Sweet potatoes, Mushrooms, Peas, Cucumbers.
Calcium	Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation. Deficiency causes osteoporosis	Milk and milk products; green leafy vegetables, legumes, sesame seeds
Phosphorus	Important for healthy bones and teeth; phospholipids help in the transport of fat and are part of the cell membrane, constituent of nucleic acids, involved in energy production	Meat, fish, poultry, eggs, milk, beans, lentil, nuts, whole grains
Magnesium	It is a cofactor in more than 300 enzyme systems, regulates protein synthesis, energy production, muscle and nerve function, blood glucose control, and blood pressure regulation, good for bone health, immunity	Nuts and seeds; legumes; leafy green vegetables; seafood; bananas, apricots, cashew

Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Nix, 2009; Wardlaw et al, 2004

Table 13. 6: Trace minerals- functions and sources

Mineral	**Function**	**Source**
Iron	Haemoglobin (iron containing compound) transports oxygen and carbon dioxide; myoglobin (iron containing compound in muscle) provides oxygen for muscle contraction; vital component of certain enzymes involved in metabolism of carbohydrates, fats and protein; helps in preventing infections, improves cognitive ability. Deficiency causes anaemia	Organ meats; red meats; fish; poultry; egg yolks; legumes; dried fruits; dark, leafy greens; and fortified cereals
Zinc	It is a constituent of many enzymes present in the body; is a cofactor in the synthesis of DNA and RNA, and thus proteins; immune reactions, insulin synthesis, taste perception, wound healing, the making of sperm, and the normal development of the fetus. Deficiency leads to delayed growth and sexual development	Meats, fish, poultry, nuts, whole grains, legumes
Iodine	Found in thyroid hormone, which helps regulate growth, development, and metabolism; needed for foetal brain development Deficiency leads to goitre (swelling of thyroid gland), cretinism in infants born to deficient mothers, poor cognitive development in children	Seafood, foods grown in iodine-rich soil, iodized salt
Selenium	Proper functioning of thyroid gland, as an antioxidant, improves immunity	Meats, organ meats, seafood, grains
Copper	Part of many enzymes for energy metabolism, regulation of neurotransmitters and connective tissue formation; needed for iron metabolism	Legumes, nuts and seeds, whole grains, organ meats, seafoods, drinking water (where pipes are made of copper)
Manganese	Part of many enzymes especially in carbohydrate and lipid metabolism, formation of connective and skeletal tissues, part of the antioxidant defence system	Widespread in foods, especially plant foods - whole grain cereals (wheat, barley, rice bran), legumes, green leafy vegetables, nuts and tea, fruits and vegetables
Fluoride	Involved in formation of bones and teeth; helps prevent tooth decay Excess can lead to fluorosis with mottling of teeth, joint pains, arthritis, stiffness of spine	Drinking water (either fluoridated or naturally containing fluoride), seafood, and most teas

Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Nix, 2009; Wardlaw et al, 2004

Other Bioactive Substances

Besides nutrients, there are a few other constituents of food which one should be familiar with. These substances with are bioactive are referred to as **phytochemicals** (plant chemicals) or **zoochemicals** (chemical substances obtained from animal sources e.g. omega-3 fatty acids obtained from fatty fish, probiotics obtained from fermented dairy products). They have numerous health benefits. There are several ways in which these chemicals exert their beneficial effect in the body. Some act as antioxidants and help to neutralize the damage-causing free radicals in the body. Others exert their influence by modulating the activity of enzymes which control metabolic processes. They may activate, deactivate, block or suppress certain enzymes or hormones. Some others work by reducing the inflammation levels in the body. An inflammatory condition has been linked to increased risk of cardiovascular diseases. Some phytochemicals work by improving immunity. They may have antibacterial and antiviral properties. Certain others may help to maintain DNA stability and ensure repair. Alteration of lipid and lipoprotein metabolism, regulation of blood sugar levels and blood pressure are some of the beneficial effects attributable to other phytochemicals. Fruits, vegetables, spices and condiments are a storehouse of different types of phytochemicals.

Antioxidants: They are natural compounds found in some foods that help in neutralising free radicals in our body. Fruits and vegetables are good source of antioxidants. Besides vitamins like β carotene, E, C and minerals like selenium, other phytochemicals like lycopene (present in tomatoes and watermelon), carotenoids (present in Green/yellow/orange fruits and vegetables), catechins (in tea), allium sulphur compounds (present in garlic, onion), anthocyanins (present in berries, beetroot), etc. act as antioxidants.

Anti-inflammatory: Some foods are rich in phytochemicals which reduce inflammation in the body. Curcumin present in turmeric is a powerful anti-inflammatory substance. Fatty fish are rich in omega 3 fatty acids which also reduce inflammation. Berries, broccoli, green tea, peppers, mushrooms, dark chocolate, cherries, tomatoes, etc. are considered as anti-inflammatory foods.

The role of antioxidants and other phytochemicals in health is increasingly becoming important, owing to our immense exposure to toxins, pollutants, pesticides and other harmful substances.

Pre and Probiotics. In recent years probiotic bacteria have increasingly been incorporated into foods and are 'live microorganisms which when administered in adequate amounts confer a health benefit on the host' (FAO/WHO 2002). In today's fast pace life there are factors that negatively influence the interaction between intestinal microorganisms such as stress and diet, which lead to detrimental effects on health. Increasing evidence indicates that consumption of 'probiotic' microorganisms can help maintain a favourable microbiome which results in several therapeutic benefits. Commonly used bacterial probiotics include various species of *Lactobacillus, Bifidobacterium* and *Streptococcus* as well as *Lactococcus lactis* and some *Enterococcus* species. Currently, the only probiotic yeast used is the non-pathogenic *Saccharomyces boulardii*.

The term prebiotic was coined by Gibson and Roberfroid in 1995. Dietary fibres which resist digestion by the human enzymes but are digestible by the gut microbes are referred to as prebiotics. These encourage the growth of good bacteria in our gut.

Oligosaccharides, which are relatively short chain carbohydrates, have now been acknowledged to have prebiotic properties. Various type of oligosaccharides are found in natural foods available abundantly in the Indian diets like fruits(watermelon, pomegranate, dates, figs), vegetables (onion, beetroot, green peas, sweet corn, garlic), legumes (chickpea, lentils, soyabeans) cereals (wheat, bran), milk and honey.

It can thus be concluded that almost all the nutrients and other substances which we derive from the diet have some essential role to play in the body. The lack or excess of any may prove to be harmful to the body. Eating a diversified, balanced diet with wholesome meals would meet the requirements of most of the nutrients. Awareness regarding the correct proportions of food and nutrients required, based on the physiologic needs, would help in promoting health.

Enriching the quality of our diet

'Hidden Hunger' or micronutrient deficiencies are majorly impacting the nutritional status of the Indian population. According to the CNNS Survey, nearly 80% of the adolescent population suffers from at least one micronutrient deficiency in India. Poor diet quality and faulty dietary patterns coupled with lack of nutrition awareness is the main cause of malnutrition. Enriching the diets of at-risk population through micronutrient fortification, supplementation and encouraging dietary diversification is the most cost-effective and sustainable method to tackle deficiencies. Strategies to combat malnutrition at a national level need to be cost-effective and feasible enough to reach remote areas. Enriching diets of masses with specific micronutrients and not focusing simply on caloric intake is a solution adopted by several nations around the globe. In India, various policies and programs have been implemented to ensure adequate supply of micronutrients. These include increasing content of protein and micronutrients contained in the Midday Meal Scheme and Integrated Child Development Scheme, development of efficient public distribution schemes and food fortification. It is not enough to just provide adequate amounts and quality of food, but also to improve awareness about nutrition and eating right.

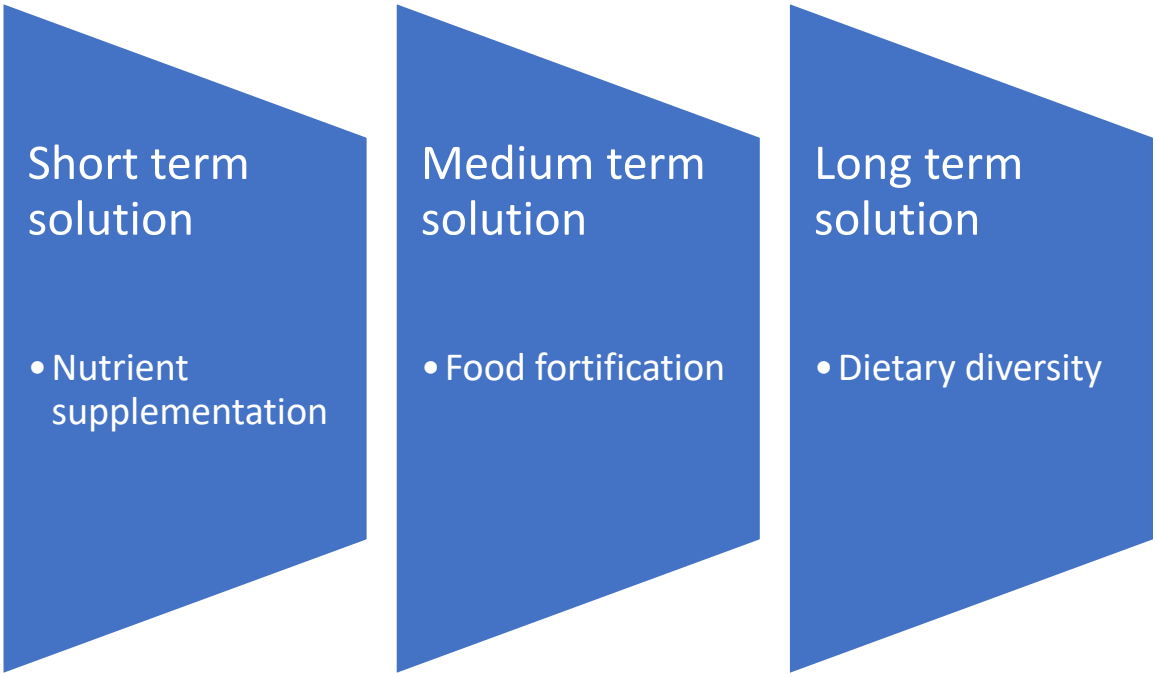

Figure 13. 2: Three main interventions to prevent and tackle malnutrition

Figure 1 depicts the short, medium and long term solutions to the problem of micronutrient malnutrition. These can be used either individually or in combination. These interventions are complementary rather than mutually exclusive and a multi-sectoral approach involving health, food security and agriculture is, therefore, of prime importance. Micronutrient supplementation provides the fastest improvement in the micronutrient status of targeted population, fortification has lesser but a wider and sustainable impact; increasing dietary diversity and utilizing local food resources takes the longest to create an impact, however, it is the most desirable and sustainable solution. The choice would depend on (1) level of nutritional deficiency (2) public health issues (3) existing government policies (4) availability of resources (5) awareness amongst populations and (6) cost-effectiveness.

Short term intervention: Supplementation

What is supplementation?

Supplementation is the term used to describe the provision of relatively large doses of micronutrients, usually in the form of pills, capsules or syrups.

What is the need for supplementation?

Timely supplementation of micronutrients in the correct doses can be lifesaving. Ensuring that women of reproductive age, pregnant women and children have sufficient essential micronutrients improves the health of expectant mothers, the growth and development of unborn children, and the survival and physical and mental development of children up to five years old.

- Micronutrient insufficiency is a direct cause of child mortality. Even very small doses of micronutrients such as iron, vitamin A, iodine and folic acid can be life saving for young children and pregnant women.
- The intake of foods rich in vitamin A, iron and zinc is low in India.
- In cases of severe deficiency, food-based approaches alone are not as effective, and supplementation is required to be implemented.
- The bioavailability of many micronutrients is low and require an ideal environment for absorption. For example, the rate of conversion of carotene to retinol is less than desired, limiting the use of dietary diversification as a strategy to combat vitamin A deficiency. (Retinol is the active form of vitamin A. Vegetarian sources such as yellow-orange fruits and green vegetables contain a precursor of retinol i.e. β carotene). Additionally, the absorption of iron from vegetarian food sources (also known as non-heme iron) is lower as compared to iron from meat, poultry and fish (also known as heme iron) due to the presence of anti-nutrient factors such as oxalates and phytates. This makes it difficult to raise levels through diet alone even after increasing food intake in case of a public health crisis.
- Certain medical conditions such as severe diarrhea in children and acute respiratory illness, pneumonia can prove to be life-threatening. Micronutrients such as zinc play a vital role in reducing the morbidity associated with the same.
- The requirements of micronutrients are altered throughout the life cycle. For example, demands of micronutrients such as iron, folic acid, vitamin B6 and vitamin B12 is increased during pregnancy. Supplementation of these during pregnancy has proven to reduce postnatal complications such as neural tube defects, low birth weight babies and anemia during pregnancy.

<u>Who is the target group for supplementation?</u>

- Women in reproductive age
- Pregnant women
- Lactating women
- Children under the age of 5

<u>How is it done?</u>

Supplementation is often done through government intervention programs.

<u>For how long is it done?</u>

Periodic supplementation should be combined with programs focussing on food fortification and dietary diversification. Supplementation should only be used as a short-term intervention in order to avoid risks of high dosages.

Which micronutrients are targeted?

Micronutrients that are identified to pose a public health challenge through intervention studies in a target population are often used for supplementation in at-risk population. These include vitamin A, iron, folic acid

What are the current programs in India?

National Vitamin A prophylaxis program

Deficiency of vitamin A is recognised as a public health problem. Dietary surveys indicate that intake of vitamin A is lower than Recommended Daily Allowance in young children, adolescent girls and pregnant women. Clinical and subclinical deficiency is highest in India. In the fifties and sixties many states reported blindness in children below five years of age due to vitamin A deficiency. A five-year long trial by National Institute of Nutrition indicated that mega doses of vitamin A once in six months in children aged one to three years can prevent xerophthalmia. These results suggested the need to administer massive doses of vitamin A in at-risk population groups.

The National Prophylaxis Program Against Nutritional Blindness was started in 1970, for children up to 3 years of age. In 2006, the age group was changed to children from 6 months to 5 years after reconsidering recommendations of the WHO, UNICEF and Ministry of Women and Child Development. The prophylaxis program has long term as well as short term strategies. The short-term strategy focuses on administration of mega doses on periodic bases, the long-term strategy focuses on the improvement of dietary quality.

National Iron Plus Initiative

Anaemia is one of the most challenging public health problems with more than 50% prevalence among the vulnerable groups such as pregnant women, infants, young children and adolescents. The most common causes of anaemia are nutritional with Iron Deficiency Anaemia (IDA) being the most prevalent nutritional cause of anaemia. Anaemia is known to have serious health outcomes and affects physical and cognitive health during all life stages. It is thus important that measures must be taken to prevent the onset of anaemia in vulnerable population groups

The National Iron Plus Initiative (NIPI) is an attempt to look at the Iron Deficiency Anaemia comprehensively across all life stages including adolescents and women in reproductive age group who are not pregnant or lactating. The National Iron+ Initiative guidelines have been developed by the Adolescent Division of the Ministry of Health and Family Welfare (MoHFW), Government of India. The guidelines build on past and continuing work on the prevention and control of anaemia in India and have been developed in the context of the existing policies and strategies of the health, nutrition and population sectors. Under an Intensified NIPI, the Anemia Mukt Bharat Campaign has been launched in 2018 to reduce the prevalence of anemia.

Calcium Supplementation during pregnancy and lactation

Eclampsia and pre-eclampsia during pregnancy is highly preventable with timely care and healthcare provision. WHO recommendations and global evidence suggests that provision of calcium supplementation during pregnancy and lactation, can prevent the onset of hypertensive disorders. This program has now been included in the Government of India's ante-natal care (ANC) and post-natal care (PNC) package. For prevention of pre-eclampsia, WHO 2013 guidelines recommend inclusion of routine prenatal calcium supplementation in high doses (>1 gm/day), especially in areas where dietary calcium intake is low.

Protocol: Oral swallow able calcium tablets to be taken twice a day (total 1g calcium/day) starting from 14 weeks of pregnancy up to six months post-partum. It is not advisable to take both calcium tablets together as more than 800 mg calcium interferes with iron absorption. Calcium tablets should not be taken empty stomach since it causes gastritis. Calcium and Iron Folic Acid (IFA) tablets should not be taken together since calcium inhibits iron absorption. IFA tablets should be taken preferably two hours after a meal. Along with this, women are also counselled with regards to supplementation and calcium intake.

What are some challenges for supplementation programs?

A lack of supplies and poor compliance are consistently reported by many Supplementation programme managers as being the main barriers to success. Iron supplements are not well tolerated by some as they produce symptoms of gastric distress.

Anemia Mukt Bharat

Anemia affects a large part of our population, all age groups and income categories. It affects physical growth, mental development and work capacity. Anemia Mukt Bharat campaign by the Ministry of Health and Family Welfare targets to reduce the prevalence of anemia by 3 percentage points per annum. It has a 6x6x6 strategy – 6 types of beneficiaries, 6 interventions and 6 institutional mechanisms. It specifically targets iron deficiency and folic acid deficiency related anemia by prophylactic supplementation. In addition, there is provision for biannual deworming as intestinal worm infestation has been identified as one of the causes of anemia. Besides testing and treating people for anemia, the important component of behaviour change communication has also been incorporated in the strategy for demand generation of supplements, to improve intake of iron rich foods as well as other measures.

Read more about it at: https://anemiamuktbharat.info/

Medium Term Intervention: Food Fortification

What is food fortification?

Food Fortification is the practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health. Food fortification can take several forms. It can either be for the general population or for a targeted population group; it can be mandated by the Government or can be a voluntary decision of manufacturers.

What is the need for fortification?

As mentioned earlier, the problem of hidden hunger is a serious concern in India which needs to be addressed in order to improve the health status of the nation. Often, there is considerable loss of nutrients during the processing of food as well. One of the food-based strategies to address this problem is fortification of food. This method complements other ways to improve nutrition such as diversification of diet and supplementation of food.

When did food fortification start in India?

Food fortification has been practiced in India since the 1950s and continues to be a part of policy programs to prevent several micronutrient deficiencies till date.

What are some key considerations for fortification?

The fortified food must be consumed in adequate amounts by a large proportion of the targeted population. It is also important that the targeted population has access to the foods which are going to be fortified. The form in which the nutrient (fortificant) is to be added, should be absorbed well by the body. The fortificant should not affect the sensory properties (taste, colour, appearance, texture) of the food to which it is added.

The general principles underlying the conditions for any fortification program given by the Food Safety and Standards Authority of India (Fortification of Food) Regulations, 2016 include the following:

Essential nutrients may be added to food for the purpose of contributing to any of the following:

I. Prevention or reduction of demonstrated deficiency of one or more micronutrients.
II. Reduction of the risk or correction of inadequate nutrition status of one or more essential nutrients
III. Meeting daily requirements of one or more essential nutrients
IV. Maintaining or improving health
V. Maintaining or improving nutritional quality of foods.

What are the health benefits seen with fortification?

The nutrients used in fortification of staple foods can prevent deficiencies, and hence improve immunity, productivity and cognitive development. Fortifying food with iodine, iron, vitamin A, and vitamin D has reduced the cases of iron deficiency anemia, night blindness and goiter. Evidence pertaining to fortifying staple foods with essential micronutrients is vast and thus the Government of India and FSSAI have set standards and regulations for fortification.

Which foods are used as staple vehicles for fortification in India and which micronutrients are targeted?

Single micronutrient or a combination may be used in order to fortify foods. Some processed foods are fortified. The Food Authority has drafted the standards for fortification of processed foods. The standards include fortification of cereal and cereal products like breakfast cereals, pasta and noodles, and bakery wares like bread, biscuits, rusks, buns with added iron, folic acid, and vitamin B 12 (in addition they may be fortified with zinc, vitamin A, riboflavin, niacin, and pyridoxine). In addition to these fruit juices shall be fortified with vitamin C. Fortification of processed foods will help in increasing the nutritional quality of these products as well as help in improving the nutritional status of the population at large.

How are allowances for fortification decided?

Generally, the extent of food fortification depends on the level of public health issues and those nutritional deficiencies that are most seen must be given priority. The level of micronutrient/s recommended for fortification of staple foods is country specific. It largely depends on the habitual diet of the population in a region. A database of micronutrient compositions of various foods and information on bioavailability are powerful tools to facilitate the process of arriving at the quantity of micronutrients required for fortification. It is also necessary to keep in mind the nutrient requirements and recommended dietary allowances of micronutrients for Indians.

How can a fortified food product be identified?

A logo (+F logo) has been notified for fortified food products as shown in figure 2.

Figure 13. 3: The Logo to indicate whether the food is fortified

Food fortification provides a medium-term food-based intervention and its benefits outweigh the limitations. Fortification must be encouraged, and nutrition awareness must be created regarding the use of fortified staples.

The intent of Food Fortification rests on micronutrient deficiencies which are a public health concern. Today we have iron deficiency, iodine deficiency and vitamin A and vitamin D deficiencies which are causing a serious concern in the population. The amount of the nutrient fortified is country and population specific and thus it is based on scientific recommendations made by expert bodies at national level. The quantities of nutrients fortified are safeguarded towards any toxicity as the dosages are in line with the normal recommendations needed by the population. The foods which are selected for fortification are the vehicles which are used by major section of the population on daily basis like wheat, rice, salt, oil. This is to cover the adequacy of these specific nutrients due to lack of diet diversity especially in the lower and middle socio-economic strata.

Long term intervention: Dietary Diversification

Increasing dietary diversity means increasing both the quantity and the variety of foods consumed (including a variety of food groups and a range of micronutrient-rich foods from each of the food groups). In practice, this requires the implementation of programs that improve the availability and consumption of, and access to, different types of micronutrient-rich foods (such as animal products, fruits and vegetables) in adequate quantities, especially among those who are at risk for, or vulnerable to micronutrient deficiencies. Increasing dietary diversity is the preferred way of improving the nutrition of a population because it has the potential to improve the intake of many food constituents – not just micronutrients – simultaneously. Micronutrient-rich foods also provide a range of antioxidants and prebiotic substances that are important for protection against non-communicable diseases and for enhancing immune function.

However, as a strategy for combating micronutrient malnutrition, increasing dietary diversity is not without its limitations, the main one being the need for behaviour change and for education about how certain foods provide essential micronutrients and other nutritive substances. A lack of resources for producing and purchasing higher quality foods can sometimes present a barrier to achieving greater dietary diversity, especially in the case of poorer populations. The importance of foods from animal sources for increasingly dietary quality is being recognized, and innovative approaches to increase their production and consumption in poorer regions of the world are currently being explored. Efforts are also underway to help poorer communities identify, domesticate and cultivate traditional and wild micronutrient-rich foods as a simple and affordable means of satisfying requirements. For infants, ensuring a diet of breast milk is an effective way of preventing micronutrient deficiencies. In much of the developing world, breast milk is the main source of micronutrients during the first year of life (with the exception of iron). Exclusive breastfeeding for the first 6 months of life and continuation into the second year should thus be promoted. Moreover, all lactating women should be encouraged to consume a healthful and varied diet so that adequate levels of micronutrients are secreted in their milk. After the age of 6 months, it is important that the complementary foods provided to breast-fed infants are as diverse and as rich in micronutrients as possible.

Others

Some of the other techniques that could be used easily at home scale are fermentation, germination and biofortification**. Fermented foods** are those foods that have been subjected to the action of microorganisms. Fermented foods have many advantages, besides enhancing the nutritional quality of food by increasing the bioavailability of certain vitamins and minerals; it also acts as nutraceutical agents to impart beneficial health effects. **Germination** refers to the process by which grains are sprouted. This is an effective processing method for improving nutritional quality, reducing anti-nutritive compounds, boosting the level and digestibility of free amino acids and available carbohydrates, increasing mineral bioavailability, increasing vitamins and improving the functional properties of cereal and pulses.

A very important aspect in enriching diet is communication and awareness. This is one of the most important issues if the message of nutrition has to spread to all sections of the society including, policy makers and planners, bureaucrats, professionals from the fields of agriculture, health and medicine, social sciences, education and others besides the community. For health and nutrition security there has to be awareness, and access to balanced diet at an affordable cost. Knowledge of right feeding practices, clean environment and safe drinking water, and health care outreach- primary and curative is important. Education, particularly of women is important for optimum utilisation of the available services and creating demand.

It is ironical that both ends of the spectrum of malnutrition have inherent hidden hunger which is related to the quality of food intake by the population. High intake of HFSS foods across all socioeconomic strata of Indian population adds to the baggage of malnutrition. In addition, a low diet diversity is an added aspect contributing to micronutrient malnutrition. Thus, a judicious combination of strategies- Food Fortification, Diet Diversification and Supplementation is the way forward to enrich the diets of the Indian population.

Summary

- Nutrients are those constituents of food that are essential for the maintenance of life, growth and development.
- Nutrients can be classified as macronutrients and micronutrients based on the requirement. They can also be classified as energy giving, body building and protective foods based on their functions.
- Macronutrients are nutrients required in larger quantities and include proteins, carbohydrates, lipids and also water.
- Micronutrients are nutrients required in small quantities and include all the vitamins and minerals.
- All nutrients have important functions to perform in our body. A deficiency of any of the nutrients results in clinical signs and symptoms.

- Phytochemicals and zoochemicals are bioactive substances present in plant and animal foods respectively. They confer us with health benefits.
- My plate of the day given by ICMR/NIN (2018) gives a good example of a balanced meal providing 2000kcal a day.
- The quantities of foods needed to meet the nutrient requirements vary with age, gender, physiological status and physical activity.
- To overcome malnutrition various simple techniques could be used to enrich our diet such as diet diversification, food fortification, food supplementation, fermentation and germination.

Key Words

Hidden hunger – another term for micronutrient deficiencies

Macronutrients – These are required in large quantities (in grams) and include proteins, carbohydrates, fats and water.

Micronutrients – These include vitamins and minerals – are required in relatively smaller quantities, but are essential for various body processes.

Prebiotics – substances (like oligosaccharides, fibre) which encourage the growth of good bacteria in our gut

Probiotics- live microorganisms which when administered in adequate amounts confer a health benefit on the host

Exercises

1. List the dietary guidelines for the Indian adult.
2. Why is water important for our body?
3. What are the different types of carbohydrates? Explain by giving examples.
4. What are the different types of fats found in our diet? Give at least two food sources for each.
5. Define the following terms briefly (2-3lines):
    a. Pellagra
    b. Balanced Diet
    c. Essential Amino acids
6. Describe the functions of the following nutrients:
    a. Lipids
    b. Vitamin C

c. Calcium

d. Proteins

7. Explain the different methods which can be used at the household level for enriching our diet. Supplement your answer with suitable examples.
8. Discuss the merits and limitations of food fortification as a strategy to address micronutrient malnutrition.

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