

1. Details of Module and its structure

Module Detail	
Subject Name	Food, Nutrition for Healthy Living
Course Name	Food, Nutrition for Healthy Living
Module Name/Title	Conserving and enhancing nutritive value of Food
Module Id	FNHL_10109
Pre-requisites	General knowledge about Conserving and Enhancing Nutritive Value of Food
Objectives	After going through this lesson, the learners will be able to understand the following : <ol style="list-style-type: none">1. Appreciate the need and importance of conserving nutrients in food.2. Learn to minimize loss of nutrients during pre preparation and cooking of foods.3. Practise germination, supplementation and combination to enhance the nutritive value of foods.4. Selecting fortified foods and differentiating between enrichment and restoration.
Keywords	Concept, Conserving Food nutrients, Germination and fermentation, Supplementation and combination, Fortification

2. Development Team

Role	Name	Affiliation
National MOOC Coordinator (NMC)	Prof. Amarendra P. Behera	CIET, NCERT, New Delhi
Program Coordinator	Dr. Mohd. Mamur Ali	CIET, NCERT, New Delhi
Course Coordinator (CC) / PI	Prof. Poonam Aggarwal Dr. Suniti Sanwal	DGS, NCERT New Delhi DEE, NCERT New Delhi
Course Co-Coordinator / Co-PI	Dr. Yash Paul Sharma	CIET, NCERT, New Delhi
Subject Matter Expert (SME)	Dr. Erram Rao	Bhaskaracharya College of Applied Sciences, New Delhi
Review Team	Mrs Sunetra Roday	Former Principal, MSIHMCT, Pune

Table of Contents:

- 1.0. Objectives
 - 1.1 Introduction
- 2.0. Conserving Nutrients
 - 2.1 Conserving Nutrients during Food Preparation
 - 2.2 Conserving Nutrients during cooking
 - 2.2.1 Moist heat methods
 - 2.2.2 Dry heat methods
- 3.0. Traditional Methods of Enhancing Nutritive Value
 - 3.1 Sprouting or Germination
 - 3.2 Fermentation
 - 3.3. Supplementation and combination
- 4.0. Fortification

1.0. Objectives:

After reading this unit you should be able to;

1. Appreciate the need and importance of conserving nutrients in food.
2. Learn to minimize loss of nutrients during pre preparation and cooking of foods.
3. Practise sprouting/ germination, supplementation and combination to enhance the nutritive value of foods.
4. Select fortified foods and differentiate between enrichment and restoration.

1.1. Introduction

Foods are perishable in nature. Several changes take place in foods from the time they are harvested in case of plants or slaughtered as in animal foods. The storage and transportation conditions further influence the overall quality of these foods. For instance, if the temperature and humidity are not controlled or modified according to the requirements of the plant or animal foods, 20- 30% of food wastage will take place by the time it reaches the *mandi* or market place. This amounts to losing huge amounts of money as well as nutritious food in terms of crores of rupees which would have fed so many people. We all know that the perishable foods are

abundant in precious nutrients like vitamins and minerals which are also lost. Therefore, all possible precautions must be taken to prevent post harvest losses and thereby conserve nutrients. Let us understand how this can be achieved by all people who handle food from the farm to the table, including consumers.

2.0. Conserving Nutrients

We know that the foods are exposed to a wide range of environmental conditions after harvest such as temperature, humidity, oxygen, light etc which play a crucial role in accelerating food spoilage. You must have noticed that a fruit or a vegetable vendor is constantly protecting his foods from the harsh sunlight and moisture loss by keeping it covered with a wet jute bag. This helps in keeping the fruits and vegetable hydrated and prevents them from wilting and drying out. This will also provide some protection from loss of nutrients and subsequent loss of quality. Let us examine some of factors affecting the quality of foods after they are harvested, stored and transported.

(i) Physical Changes

(ii) Chemical Changes

1. **Physical Changes:** are caused by mishandling of foods during harvesting, processing and distribution. These changes lead to reduced shelf life or keeping quality of foods. Physical changes could occur either by the farm implements during harvesting or by the birds or insects, while still on the plant. These physical defects do not just undermine the quality of the food but also are susceptible to infection or microbial growth resulting in food spoilage and leading to undesirable sensory attributes such as visual defects, unpleasant colour or flavour, and tissue softening. At times, the food may become unsafe for human consumption too.

Similarly, animals before they are slaughtered, should be inspected by a veterinarian doctor for any disease or disability, and will only permit healthy animal to be slaughtered. Other sources of animal foods such as meat, milk, fish and poultry are also immediately frozen or chilled as the case may be. Otherwise their quality will also be affected by the microorganism's proliferation, if low temperatures are not maintained. That is why you must have seen that milk is transported in refrigerated trucks and this cold chain is maintained till it reaches the consumer. Fish is also

kept on ice as soon as it is caught and till it is sold to the consumer. Meat and poultry too is stored under chilled temperatures to ensure complete safety and quality of the food.

Moreover, non perishable commodities such as cereals, pulses, nuts and oilseeds are stored in airtight containers, or else they will pick up moisture and become damp and lose their premium quality. In case of peanuts, if they are damaged or stored in humid conditions, they get mould growth (mycotoxin) which is highly toxic when ingested by human beings.

2. **Chemical Changes:** Have you noticed that some fruits and vegetables turn brown when cut and exposed to air. Can you name some of them? These are apples, bananas, pears, potato and brinjal. These fruits and vegetables are susceptible to chemical changes because of the presence of an enzyme, which initiates oxidative reactions in cut or bruised fruits in the presence of oxygen. Warm temperature hastens the reaction. The name of the enzyme is *phenolase*. It is responsible for this type of chemical browning which is termed as enzymatic browning. However, it does not affect the nutritive value of the food adversely.

Enzymatic browning can also be prevented by :

1. Cutting off oxygen supply by immersing cut potatoes and brinjals in water or brine.
2. Immersing cut fruits in sugar syrup.
3. Sprinkling lime juice or orange juice in fruits salad.

However, these enzymes are heat sensitive and can be easily inactivated by blanching, boiling and cooking; which is why boiled potatoes do not turn brown, or adding salt, sugar etc to cut fruits and storing in the refrigerator prevents them from turning brown. Salad dressing is usually made up of a salad oil, vinegar or lime juice with some flavouring agents such as sugar or salt which helps in masking the cut fruit surface and subsequently prevents the oxidation. This is how the brown colour development can be prevented which spoils the appearance and in turn palatability of the food.

Similarly, fried foods, nuts, vegetable oils and oilseeds on storage for long periods undergo deteriorative changes due to the presence of enzymes (lipase and lipoxygenase) which bring about changes in their flavour and colour. This is termed as rancidity. These chemical changes in the oils generate free radicals as a result of auto oxidation reactions off odour, which lead to nutrient losses such as vitamins, alteration of colour and degradation of proteins. This can be very easily prevented

by the use of antioxidants (Vitamin E) and use of opaque, airtight packaging materials which cuts off the air and light responsible for lipid oxidation.

2.1 Conserving Nutrients during Food Preparation

In order to maintain good health, ingesting a diet containing the nutrients in correct amounts is essential. Food preparation is an important step in meeting the nutritional needs. Understanding food behaviour in scientific terms helps in choosing the most suitable methods of pre preparation and cooking to conserve or maximize the utilization of nutrients present in foods.

Preliminary preparation of food includes washing, cleaning, peeling, cutting, soaking etc.

Washing and soaking- of foods is necessary as it helps remove visible dirt, microorganisms and chemical pesticides. However, washing cereals like rice causes loss of B complex vitamins especially thiamine. This can be minimised by quick and thorough washing and using the water used for soaking for cooking rice. In case of green leafy vegetables and other fruits and vegetables, it is desirable to first wash and then cut them. This will prevent the loss of water soluble vitamins. Ideally meat should not be washed but wiped with a damp cloth, however from the hygiene point of view it desirable to wash it quickly in water without soaking. This will prevent leaching of B vitamins. Legumes and pulses should be washed thoroughly and soaked in water; the water should be discarded before cooking as it contains some anti nutritional factors like saponins which interfere with the absorption of nutrients in the body like calcium, B-complex vitamins etc.

Peeling and stringing- Both these methods involve the removal of inedible fibrous portion of food. Peeling brings about loss of nutrients present under the surface of the food, hence the product should be boiled or blanched and then peeled e.g. potatoes, beetroot etc. The colour of the vegetable such as sweet potato or beetroot is preserved better when it is cooked with the skin. Some of the phyto chemicals, which bestow health benefits, are present in the coloured pigments of the fruits and vegetables. That is why today a lot of salad vegetables are eaten preferably with the skin such as that of turnip, cucumber, gherkins etc. Citrus fruits should be eaten with the segments as it provides Vitamin C; peeling reduces the vitamin C present in whole fruit.

Cutting and grating-This involves division of food into small portions or pieces. However, cutting the perishable foods like meat, fish, fruits or vegetables very finely or mincing them leads to loss of water soluble vitamins. Therefore, it is desirable to cut than to grate or mince.

Sieving- This is usually done for removing insects or coarse fibres from flours. This leads to loss of bran and B complex vitamins. Therefore, unsifted, whole grain flours are considered healthier to refined flours. Multi flour blends are recommended for improved gut health as they provide you with variety of nutrients essential for healthy living.

2.2 Conserving Nutrients during Cooking

Cooking makes the food palatable, improves digestibility and increases the availability of nutrients but at the same time it also destroys heat sensitive nutrients such as water soluble vitamins, C and B-complex.

2.2.1 Moist Heat Methods

Boiling- is the most simple method of cooking foods. This is accomplished by just immersing the foods in water and bringing it to a boil and simmering till the food is cooked or is tender. However, if excess water is used or if the water is discarded after cooking then 30-70% of water soluble nutrients like Vitamin C are lost. There is also considerable loss of minerals especially sodium, potassium and calcium due to leaching. Therefore, to conserve the nutrients it is desirable to use this water in soups, dals, gravies or to knead atta. Loss of water soluble pigments from coloured foods such as beetroot, tomatoes etc also occur. Thus, boiling the vegetables with the skin is advisable to minimize these losses.

Stewing- This is a gentle method of cooking in a pan with a tight fitting lid, using small quantities of liquid to cover only half the food. This is a slow method of cooking taking from 2- 4 hours depending on the nature and volume of foods to be stewed. This method retains the nutrients and prevents the loss of nutrients by leaching since the liquid from the food is not discarded. However, this is a time consuming method. Apples and pears are cooked by this method for making pies.

Steaming- In this method the food does not come in direct contact with water, it is cooked in steam generated by water. Therefore, this is one of the best methods of conserving nutrients as there is practically no leaching of water soluble vitamins. The food which is steamed has attractive colour, texture and pleasant flavour. These foods are not only more nutritious but are also easy to digest and if fermented are also high in B vitamins and minerals. Some examples of fermented and steamed foods which you may be familiar with are *idli*, *dhokla*, *vadis*, etc.

Pressure cooking- This involves controlled cooking of the food for short duration by heating within a lidded pan or container to a very high temperature (above the boiling point). This allows the air pressure and steam to build inside and cooks food faster.

2.2.2 Dry Heat Methods

Baking- Foods are cooked by hot air in a pre- heated oven. In this method the action of dry heat is combined with the steam generated by the food which is being cooked. This is accomplished at temperatures between 120⁰C to 180⁰ C. The foods have improved flavour and texture which is brown from the top and soft and tender from the core. Cakes, bread, and biscuits are prepared by this method. The brown colour development takes place due to the chemical reaction between the sugar (carbohydrate) and amino acids (proteins) which leads to the formation of *melanoidins*, brown colour pigments. This type of browning is also referred to as non- enzymatic browning. Generally, foods which are grilled, roasted or toasted exhibit this type of browning which is considered desirable in the bakery and confectionary products. Non enzymatic browning is responsible for the distinctive colour and flavour of bread, cookies, cakes, meat, chocolate, coffee, popcorn etc. Although, it reduces the nutritional value of a product, as amino acids and carbohydrates may be lost, leading to decrease in bioavailability of these nutrients, the aroma and acceptability increases considerably.

Grilling or Broiling- This is an indirect method of cooking foods on fire. Food is heated by radiation, which improves colour, flavour and texture considerably. Barbecued foods are prepared by grilling, usually without the addition of fat, which is a healthy alternate for cooking especially meat, fish and poultry foods (*tandoori chicken*). However, the brown colour development of the grilled food product reduces the availability of some amino acids and affects their digestibility.

Roasting- This is subjecting the foods to dry heat treatment. Some of the popular examples include toasting of bread, roasting of nuts, puffing of cereals and legumes for improved texture, flavour and digestibility. This is a very healthy way of cooking or processing foods as it is completely fat free. The application of dry heat initiates the process of starch breakdown which in turn enhances its digestibility. It also improves the keeping quality of food products as it removes excess moisture and imparts a characteristic colour, crispness and aroma.

3.0 Traditional Methods of Enhancing Nutritive Value

You are now familiar with all the different types of cooking and processing practices used for food preparation. These include soaking, boiling, steaming, baking, grilling and roasting. All these processes not only enhance the palatability but also improve appearance, texture, cooking quality and reduce the toxic constituents which impair digestibility and nutrient uptake in the body. In addition to these whole grain cereals, legumes are pulses in India from ancient times are germinated or sprouted and fermented to improve its nutritional quality as well as bio availability of nutrients.

Conventionally, whole pulses and legumes are soaked and held at ambient temperatures for few days to facilitate germination. The enzymes activated during germination partially hydrolyze (digest) proteins, starch, and oligosaccharides, inactivate anti nutrients, release minerals, and synthesize many vitamins. These sprouted grains may be consumed directly, or dehulled (skin removed) roasted, and ground for use in blends with other foods.

3.1 Sprouting/ Germination

All whole grains possess the property of germination, and the germinated foods are called sprouts. They can be consumed raw or cooked and are an important source of water soluble vitamins such as B complex and C. The increase in Vitamin C content is around 7-20 mg per 100 g of pulses. Riboflavin, niacin, folic acid, choline and biotin content also increases. The ratio of essential to non essential amino acids increases. Minerals like calcium, zinc and iron are released from bound form. Phytic acid is reduced and the availability of proteins and minerals is enhanced. Besides, enhancing the nutritional value and bioavailability of the nutrients they are also devoid of anti nutritional factors such as Trypsin inhibitors which are present in raw form

The process of sprouting

This involves removal of soil and dirt from the whole pulses and legumes by washing with water, thereafter they are soaked for 12 hours. The excess water after rehydration of the seed is then drained and then it is kept for sprouting at room temperature for 24 – 48 hours.

3.2 Fermentation

Fermented foods are prepared and preserved by the action of microorganisms. Fermentation makes food tasty and nutritious. In India, considerable quantities of cereals and pulses are consumed in the

form of fermented foods such as *idli*, *dosa*, *dhokla*, *badhi* etc. in different regions of the country. Foods prepared from them by fermentation are used either to add flavour to other foods or to serve as sources of increased proteins thus helping in value addition approaches during processing. It also improves the nutritive value, flavour characteristics, reduces the antinutrients and increases the bioavailability of the nutrients of the products. Bread is also one type of fermented cereal product. Other products include bread rolls, Danish pastry, crackers, doughnuts etc. Yeast (*S. cerevisiae*) is used to facilitate the fermentation process to make bread, *naans* and *kulchas*.

During fermentation, the microbial enzymes break down the legume protein and improve palatability and nutritive value of B and C vitamins. Toxic constituents present in pulses can be eliminated by fermentation. In *idli*, *dosa* and *dhokla*, fermentation process improves the availability of essential amino acids and thus the nutritional quality of protein is improved.

Milk is fermented to curds by species of lactic acid bacteria. The sugar lactose present in milk is converted to lactic acid, In an acidic medium, liquid milk sets to form curds or yoghurt. Curds is easy to digest and can be consumed by people who are lactose intolerant. A spoonful of curds is used as starter for setting curds. Buttermilk prepared from cream is another example of fermented milk.

3.2 Supplementation and Combination

Animal proteins are complete proteins containing all essential amino acids in proper proportion and amounts. Indians mainly consume a vegetarian diet with pulses being an important source of proteins. They provide about 20-25% proteins that is double the amount of protein compared to cereals. However, the proteins of pulses are not of good quality as they are deficient in essential amino acids methionine. As per the FAO reference protein, methionine is about 50% below the recommended requirement. This means that we can become protein deficient if we do not take care of this limiting amino acid. You must be wondering how have we achieved our growth potential by being a strict vegetarian. It is simple. Cereals provide more than 50% of protein requirement as they are consumed in large quantities. Among cereals, rice protein is of better quality than others. Cereals are deficient in lysine and rich in methionine. Pulses are rich in lysine. Therefore, when cereals are consumed with pulses, the protein quality improves due to mutual supplementation. A mixture of cereal and pulse combination is superior to that of either one.

As per NIN, 2017 The most effective combination to achieve maximum supplementary effect is 5 parts of cereal proteins and one part of pulse protein. In terms of grains 8 parts of cereals and 1 part of pulses. This combination gives a protein quality equivalent to animal protein. So being a vegetarian has never being a disadvantage.

The Protein quality of a vegetarian diet can be enhanced by adding small quantities of milk, curds or cheese/*paneer* to the diet like serving *raita*, buttermilk or curd rice with lunch in place of a whole glass of milk or bowl of curds. Also, by adding healthy nuts like walnuts, almonds, flax seed, sunflower seeds, ground nut, not only improves the protein quality but also add good quality fats to the meal. Some examples of cereal/pulse combination which are popular in our country are *rajmah*, rice, *khichdi*, *idli*, *dosa*, *thalipeeth*, *chiwda*, *farsan*, *chakli*, *murukku*, *puran poli*, *rawa besan laddoo* etc. Adding gram flour (*besan*) to *chappati* flour or processed soya flour to wheat flour.

Can you add some preparations to this list?

Combining soaked pulses like *channa dal/ moong* or roasted crushed ground nuts or sesame seeds to any vegetable preparation will help improve the protein quality of a packed lunch box of *chappati* and vegetable.

3.2 Food Fortification

In India, the intake of micronutrients in daily diet is far from satisfactory. Over 70% of the Indian population consumes less than 50% of the recommended dietary allowances.

According to the National Survey Data:

1. **70%** preschool children suffer from **Iron Deficiency Anaemia** .(NHFS- 2006-07)
2. **57%** preschoolers have sub clinical **Vitamin A deficiency** (World Bank, 2006)
3. **85%** districts have **Iodine deficiency diseases**
4. Neural Tube Defects- **0.5- 8 /1000 births** (World Bank, 2006)

Some of the common Nutritional deficiencies observed in India are:

1. Protein - calorie malnutrition
2. Vitamin A deficiency
3. Iron deficiency
4. Iodine deficiency
5. Vitamin D deficiency
6. Vitamin B group deficiency

The challenge of nutritional deficiency can be overcome by increasing the availability of nutrients through dietary supplementation, diversification and food fortification. Dietary supplementation is a very effective method but is also expensive. However, food fortification is a simple and inexpensive method of tackling the problem of nutritional deficiency in a region or segment of population.

4.1 Definition of food fortification

The term food fortification, according to WHO is defined as the addition of nutrient(s) to food to improve the quality of the diet of a group, community or a population. This includes the process of adding small quantities of nutrients to a food to improve the nutrient intake of a population. The objective of fortification is:

Nutrients may be added to foods to:

1. Restore nutrients lost during processing of foods so that the nutrient content is restored to a level originally present in the raw food. This is referred to as **Restoration**. e.g. addition of vitamin C to packaged fruit juices.
2. Addition of a nutrient to a staple or other widely consumed primary food deficient in one or more nutrients, to improve, the nutritional quality of the food with a view to ensuring an improvement in the nutrient intake in the population. This is referred to as **Enrichment**. E.g. grains are usually fortified with vitamin A, iron and folic acid.

However, there are some **basic requirements** which should be considered before fortifying foods.

These include:

1. Selection of an appropriate food item which should be consumed by a large section of population which is at risk of deficiency.
2. It should be cost-effective and could be centrally processed.
3. It should be stable during storage and distribution.
4. It should be acceptable by the masses.
5. It should not adversely affect the metabolism of any other nutrient.
6. It should be assimilated well when consumed in a meal.
7. It should not impart any undesirable characteristic such as colour, odour or taste to the food.

Vehicles for fortification with combinations of micronutrients

Vehicles	Micronutrients
Edible common salt	iron and iodine
Whole wheat flour & Maida	iron, folic acid, calcium, zinc
Rice	iron, folic acid, calcium, zinc
Vegetable oils	vitamins A & D
Milk and Dairy products	vitamin D, A iron, folic acid, calcium, Omega-3,6 fatty acids
ICDS supplementary foods	iron, folic acid, calcium, zinc
Sugar	vitamin A

14

4.2 Advantages of Fortification

Food fortification does not require people to change their dietary habits and it does not alter organoleptic or sensory qualities of foods. Therefore, it is socially acceptable. The other benefits of fortification are (i) minimum risk of excess intake of the nutrient, (ii) safe, quick and cheap method of ensuring availability of a nutrient, (iii) introduction through existing marketing and distribution system without any extra effort.

4.3 Limitations of fortification

Food fortification requires knowledge of dietary habits and nutrient intakes of the target group (s). Consumers have to be educated about fortification, particularly if it is causing any change in the sensory qualities of the food or it necessitates any modification in the method of preparation of food at home. Food fortification is a temporary method of improving nutritional status of the people and should ultimately be substituted by the balanced diet based on better food supply and food usage.

4.4 Regulatory status of Fortification in India

A significant milestone in India took place in the year 2016 when the Food Safety Standards Authority of India published standards for food fortification. As per the Household Consumer Expenditure Survey, 2014, people in India consume; cereals- 300g/day, oil - 25g/day, salt- 8-10g/day. It was recommended that these food items, if fortified hold the potential to improve the overall micronutrient status of the Indian population.

The following limits for fortification were prescribed:

1. **Salt fortification**-30 parts per million (ppm) for iodine on dry weight basis and 850-1100ppm in case of iron.
2. **Edible oil**- vitamin A should be 25 IU per gram of oil and vitamin D should be 4.5 IU per gram of oil.
3. **Milk per litre**, the levels of Vitamin A should be 770 IU and Vitamin D 550 IU.
4. **Atta per kg, iron** should be at 20mg, folic acid at 1,300microgram and Vitamin B12 at 10 microgram. Besides, atta can contain other nutrients like zinc, Vitamin A, Vitamins B1, B2, B6, and niacin nicotinamide.
5. **Rice per kg**- the level for fortification includes iron at 20mg, folic acid at 1,300microgram and Vitamin B12 at 10microgram. Besides, rice can also have zinc, VitaminB1, B2 and B6 amongst other nutrients.