

Unit - 3

Food Processing and Preservation

Objectives

- To get acquainted with different methods of food preparation for creating various delicacies.
- To understand heat transfer methods involved in food processing.
- To provide an understanding of the causes of food spoilage and principles involved in its preservation.
- To know the methods and techniques of food preservation for different food products.

“Process of transforming raw food into value added and nutritious finished food product is an art perfected by science.”

Food preparation is the process of producing safe and edible food. Various ingredients used in food preparation are derived from living organisms. Vegetables, fruits, grains, nuts, herbs and spices come from plants, while meat, eggs and dairy products come from animals. There are different methods of food preparation, most of which have been known since antiquity. These include baking, roasting, frying, grilling, boiling, steaming, etc. A recent innovation is the use of microwave and retorting in food industries.

Food spoilage is the deleterious process leading to a product undesirable or unacceptable for consumption. It is caused due to variety of factors and mechanisms, including microbial, chemical, enzymatic, physical reactions and insects. A number of methods of preservation can be used that can totally prevent, delay or otherwise reduce the food spoilage.

Food preservation is one of the oldest technologies used by the mankind. The highly perishable foods like fruits, vegetables, milk, meat, fish, etc. deteriorate or decay quickly, leading to considerable loss of such commodities in various stages of food supply chain unless special methods are applied for their preservation. Preservation of food involves the processes (techniques) in which, the perishable food commodities are given a suitable physical or chemical treatment to prevent their spoilage and to retain their nutritive value and wholesomeness for longer periods.

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In pre-historic times, man used to eat raw food. After discovery of fire, he realized the importance to make the food more palatable and acceptable. Gradually he learnt the art of cooking with heat or fire which was a unique activity to humans. These days with the advancement of technology and new equipment, various ways of cooking are available.



WHY DO WE COOK FOOD?

6.1 Objectives of cooking food:

Definition :

“Cooking is the application of heat to food for the purpose of making it more digestible, safer to eat, more palatable and to change its appearance”.

- a) Improve taste and food quality
- b) Destruction of micro-organisms
- c) Improve digestibility of food
- d) Increase variety in diet
- e) Eliminate antinutrient (toxicants) in food

Cooking or cookery is the art, technology, science and craft of preparing food for consumption and preservation. Cooking techniques and ingredients vary widely across the world, from grilling food over an open fire to using electric stoves, to baking in various types of ovens, reflecting unique environmental, economic and cultural traditions and trends. Cooking is done both by people in their own dwellings, by professional cooks (chefs) in restaurants and other food establishments.

**a) Improve taste and food quality**

Cooking helps to improve the overall sensory properties like natural flavour, taste, colour, texture, appearance and overall acceptability of the food. For example, roasting groundnuts, frying onions and papads, cooking rice, roasting coffee seeds improve the flavour, colour and taste. Cooking meat with spices, rice with spices in making *pulao*, frying cashew nuts in ghee, addition of turmeric, curry leaves, pepper in *pongol* blend flavour with one another during cooking. Prolonged cooking may lower the flavour as flavouring compounds are volatile in nature.

b) Destruction of micro-organisms and extension of shelf life

Microorganisms are present everywhere and some are useful (friends) in making curd, cheese and bread. Some microorganisms are harmful (foes) as they produce toxins like *Clostridium botulinum* and *Salmonella*. Application of heat during cooking is one of the most effective methods for protecting the food against microorganisms. Cooking food for specific time at specific temperature may destroy harmful micro-organisms in food, reduce naturally occurring antinutritional factors, thus making it safe, palatable and digestible for consumption and increasing the keeping quality e.g. pasteurization of milk or juice.

c) Improve the digestibility of food

Cooking softens the connective tissues of meat and the coarse fibres of cereals, pulses and vegetables. Cooking improves the texture, hence it becomes more chewable and soft. When dry heat is applied to starches in food they get converted to easily digestible dextrins i.e. during cooking complex substances are broken down into simpler one. The human body can absorb and utilize these simpler substances more readily.

d) Increase variety in diet

Variety can be brought about in meals easily by using different methods of cooking e.g.

rice can be made into, *jeera rice*, *biryani*, *pulao*, *lemon rice*, *khichdi*, etc. Wheat can be converted into *phulka*, *chapatti*, *paratha*, *puri*, *halwa*, etc. simply by changing the methods of cooking. The variety preparation decreases monotony and makes eating a pleasure.

e) Eliminate anti-nutritional factors

Some food grain, fruits and vegetables contain a number of naturally occurring antinutritional factors. During cooking, the antinutritional factors can be destroyed from food, thus increasing the availability of nutrients and making it more safe e.g. raw egg contains avidin which binds biotin making it unavailable to body. Cooking destroys this property of avidin and hence increasing availability of biotin. Other toxic substances like trypsin inhibitor, haemagglutinins, saponin, tanins, etc. occurring in pulses are also destroyed during cooking, thereby increasing the availability and absorption of nutrients.

6.2 Preliminary treatments of cooking food:

The different preliminary treatments used for various food preparations and the changes brought are listed in table, 6.1.

Table 6.1 : Preliminary Treatments and its effects on foods

Food product	Ingredients	Preliminary treatments	Effect on food
1. <i>Chapati/ Roti</i>	Wheat flour	Addition of water and kneading	- Easy for rolling to give desired specific shape
2. <i>Pulao</i>	Rice Vegetables	Washing Washing, peeling, cutting, slicing	- Clean and safe - Attractive
3. Sprout salad	Moth beans Carrot Onion, tomato	Soaking, germination Peeling, grating Cubing, chopping	- Reduces cooking time - Easy to digest - Reduces antinutritional factors - Increases nutritive value

4. <i>Idli</i>	Rice and black gram	Cleaning, soaking, grinding, fermentation	<ul style="list-style-type: none"> - Spongy texture - Increase in nutritive value - Reduces antinutritional factors - Easy to digest
5. Sago Khichadi	Sago Groundnuts	Cleaning, soaking Roasting, grinding or pounding	<ul style="list-style-type: none"> - Easy to cook - Improves flavour - Avoids sticky and lumpy texture

The quality of final product is partially affected by the preliminary treatment given to foods. Incorrect preliminary treatment will result in unacceptable final product. Hence appropriate preliminary treatment should be carefully used so that the colour, flavour, texture, taste and nutritive values are preserved to its maximum, e.g. *Idli* prepared from over fermented batter, may give an off flavour to the product which is not acceptable.

6.3 Modes of heat transfer:

Do You Know ?



How food is cooked?
How heat is transferred during cooking?

Heat naturally moves from hot surfaces to cooler surfaces. The movement of heat is commonly referred to as heat transfer. There are three methods of heat transfer: conduction, convection and radiation. Cooking of food usually takes place by a combination of these methods.

1. Conduction :

Conduction is the transfer of heat between substances that are in direct contact with each other. Here, heat flows from the source to the utensil and the utensil gets heated. The efficiency

of the heat transfer depends on the conductivity of materials in contact with the food. Copper is one of the best conductors of heat. Heat transfers quickly from the heat source into the food through the copper cookware (container).

2. Convection :

Convection heat transfer is faster than conduction. Convection occurs by the movement of air, liquid or steam around the food. It uses the motion of fluids to transfer heat. When liquid or air is heated, the particles nearest to the source of heat become warm and rise upward. These are replaced by the cold particles which are away from the source of heat. The movement of particles results in formation of convection currents which ultimately heats all the liquid or air present.

3. Radiation :

Heat can be transferred in the form of electromagnetic waves emitted from one body and absorbed by another body. It is rapidly transmitted to the surface of material so used primarily for surface heating. Examples of use include: a) Dehydration of fruits and vegetables

b) Roasting of cocoa beans

c) Dehydration of grains, tea, etc.

d) Baking

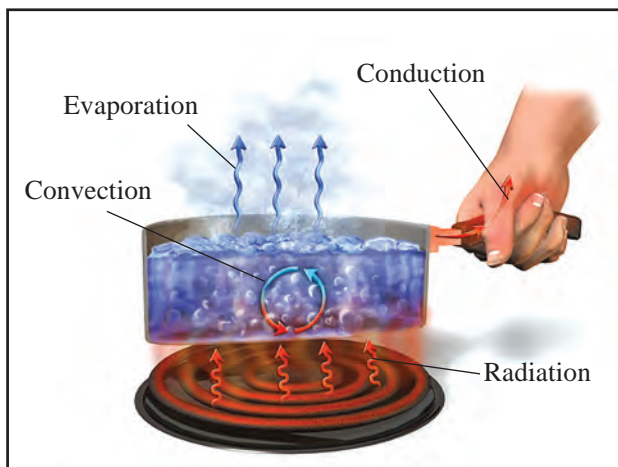


Fig. 6.1 : Modes of heat transfer

6.4 Methods of cooking :

The methods of cooking are classified into different groups mainly according to the medium of heat transfer.

- A) Moist heat methods: Direct and Indirect Methods
- B) Dry heat methods
- C) Use of fat
- D) Microwave cooking
- E) Solar cooking
- F) Combination cooking or Braising

A. Moist heat method

Water is the medium of heat transfer. The food may come in direct contact with water or indirect contact with water (steam).

- (a) **Direct methods:** In this method food comes directly in contact with water. These methods are boiling, simmering and stewing.
- (i) **Boiling :** In this method the foodstuffs are cooked in boiling water (at about 100°C). The water is enough to completely immerse the food in it. Once a vigorous boiling starts, the heat can be reduced and cooking continued till the food is tender. Food may be boiled in any liquid, which is bubbling at the surface such as water, milk, juices or syrups. Foods that are cooked by

boiling are rice, eggs, *dals*, potatoes, meat, etc.

Advantages

- It is simplest method of cooking.
- It does not require any special skill and equipment.
- Uniform cooking can be done.
- The food cooked is light and easily digestible.

Disadvantages

- It is time consuming.
- Loss of water soluble nutrients, color and flavour may take place if water is discarded.



Fig. 6.2 : Boiling

(ii) Simmering

Simmering is a food preparation method in which foods are cooked in hot liquid kept just below the boiling point of water at $85-90^{\circ}\text{C}$. It is a useful method when foods have to be cooked for a long time to make it tender as in the case of cheaper cuts of meat, fish cooking, custards, *kheer*, *dal*, curries, soups etc. This method is also employed in making soups.

Advantages

- Uniform cooking takes place
- Due to low temperature loss of

nutrients are less as compared to boiling.

- Useful for foods which curdles by boiling temperatures, e.g. *kadhi*, *kheer* etc.

Disadvantages

- Loss of water soluble nutrients, colour and flavour.
- Requires more time to cook.

Do You Know?

Poaching is the cooking of food in water at just below the temperature used for simmering. It is therefore a very gentle method of cooking. Foods containing protein which would become tough or curdled at higher temperature like eggs and fish are suitable for poaching.

(iii) Stewing

This is slow method of cooking, in which the food is cooked in a closed pan using only a small quantity of liquid. Temperature is similar to simmering temperature (85°C to 90°C). The water should be enough and temperature should be low, otherwise the food may burn due to quick evaporation of water. The amount of water left after cooking is only marginal which is served along with the food. The foods which are generally stewed are fruits, vegetables, meat etc.

Advantages

- A minimum nutrient loss is observed as the temperature is low and food is served with left over gravy.
- The flavour is retained.

Disadvantages

- It is a very slow method of cooking and requires constant attention.
- A significant amount of vitamin C is destroyed because of the slow process of cooking.

(b) **Indirect methods:** In this method, food does not come in direct contact with water. Here two methods are commonly used.

(i) Steaming

Food is cooked with the heat generated by steam and therefore it requires slightly longer time as compared to boiling. Steaming is carried out in two ways i.e. direct steaming and indirect steaming.



Fig. 6.3 : Direct steaming



Fig. 6.4 : Indirect steaming

• Direct steaming:

Food comes in direct contact with the steam. e.g. steaming of cut vegetables or sprouted pulses, fish, *idli*, *dhokla* etc.

• Indirect steaming:

Food does not come in direct contact with the steam. The process takes a slightly longer

time than direct steaming method. e.g. melting of chocolates in double boiler.

Advantages

- The food cannot be easily overheated.
- It does not require constant attention.
- The food cooked by this method is easy to digest.
- It requires less time, thus it saves fuel and money.

Disadvantages

- This method cannot be used for all foodstuffs.
- Special equipment is required for this method.

(ii) Pressure cooking

In this method, food is cooked using water or other cooking liquid, in a sealed vessel. The equipment used for this purpose is a pressure cooker. The cooker works by trapping the steam produced from boiling the cooking liquid inside the vessel. This leads to increase in internal pressure and temperature quickly. After use, the steam is slowly released so that the vessel can be opened safely. All types of cereals, pulses, vegetables and meat can be cooked in a pressure cooker.



Fig. 6.5 : Pressure cooker

Advantages

- Time required for cooking is less than steaming.

- Retention of nutrients is maximum.
- This is economical method of cooking because it saves fuel.
- By using the separate containers, more than one type of food can be cooked at one time in one vessel.

Disadvantages

- Special equipment is required for this method.
- Food can be mushy if cooked for longer time period.

B. Dry heat method

In dry-heat method of cooking, air is the medium of heat transfer. Foods cooked using these methods have a rich flavour due to caramelization and browning. There are different dry methods of cooking which are as follows;

(a) Roasting

This method involves cooking of food in open fire i.e. dry heat. This can be done in a tandoor, in an oven or in a thick heavy pan. Sometimes chicken is roasted with occasional addition of a little fat, so as to prevent the surface from drying that helps to add the flavour whereas vegetables likes potatoes, sweet potatoes and brinjals (egg plant) are roasted on a direct flame or in an oven without addition of any fat.



Fig. 6.6 : Roasting

Some foodstuffs can also be roasted in a suitable medium like sand or salt which gets heated faster and can retain the heat. They immediately puff up and are ready to eat e.g. popcorn.

Advantages

- The food develops good color and flavour.
- It becomes easy to digest.
- Nutrient losses are less.
- It reduces the moisture content of food and thus improves keeping quality and flavour e.g. *rawa*, groundnuts, etc.

Disadvantages

- The foodstuff being roasted requires constant attention otherwise food may get burned.

(b) Baking

Baking is the cooking of food with hot air in a closed compartment known as oven. A uniform temperature of 160°C to 220°C is maintained. Usually the oven is heated to a particular temperature according to the type of food which is to be baked and this temperature is maintained throughout the cooking time. Food cooked by baking includes cakes, biscuits, pies, pastries, pudding, breads, etc.

Advantages

- Food develops a good colour, flavour and texture.
- Uniform bulk cooking can be done.
- Less loss of nutrients as compared to the moist heat method.



Fig. 6.7 : Baked food products

Disadvantages

- Specific equipments i.e. an oven is required.
- It is a slow method of cooking and takes a longer time.



Fig. 6.8 : Electric baking oven

(c) Grilling

This method involves application of dry heat to the surface of food, on grilled bars, commonly from above or below so that it gets cooked by radiant heat like in grilled sandwich or grilled chicken. Grilling usually involves a significant amount of direct radiant heat and tends to be used for cooking meat and vegetables quickly. This method is generally used for surface browning. Temperature range is 163°C to 177°C.

Advantages

- Grilling is quick method of cooking and therefore suitable for snacks and time saving meals.
- Food is crispy, brown, tasty and more attractive.
- Less loss of nutrients.
- Healthy method of cooking as it requires less or no fat.



Fig. 6.9 : Grilling

Disadvantages`

- Special grilling equipment is required.
- Grilling requires careful attention to prevent overcooking.

C. Use of Fat

In this method fat or oil is the medium of heat transfer. Fat or oil can be heated to a much higher temperature as compared to water. Frying is a quick, convenient and traditional method of cooking. Fried foods are very tasty, crispy, crunchy and popular in our meals. Different methods of frying used are as follows:

- Sauteing
- Shallow fat frying
- Deep fat frying

(i) Sauteing

In this method a small quantity of fat is used which is just enough to be absorbed by the food. The food is stirred frequently for uniform cooking. It is usually done as a pre-preparation step in many dishes. e.g. sauteing of vegetables for preparations of *pulao*, noodles, fried rice, etc.

(ii) Shallow fat frying

In his method sufficient amount of fat is used in pan or *tawa*, but not enough to cover (dip) the food completely. Usually thin foods like *dosa*, *paratha*, pancake, omlet etc. are cooked by this method where food is turned on both the

sides equally for uniform cooking. Excess fat, if any should be drained on paper.

(iii) Deep fat frying

Enough oil or ghee is used to completely cover the food, then it is cooked uniformly on all the sides. This is faster method as compared to boiling because fat can attain a much higher temperature of 180°C to 220°C. This high temperature results in immediate removal of moisture and hardening of the outer surface, preventing any loss of flavour and juices. Foods like *batata wada*, *samosa*, *gulabjamun*, etc. are cooked by this method.

During frying the moisture in the raw food is transformed into vapour at - high temperature, and more oil gets absorbed in the food. Thus the food becomes more spongy and crispy. It attains golden brown attractive crust colour and pleasant flavour.

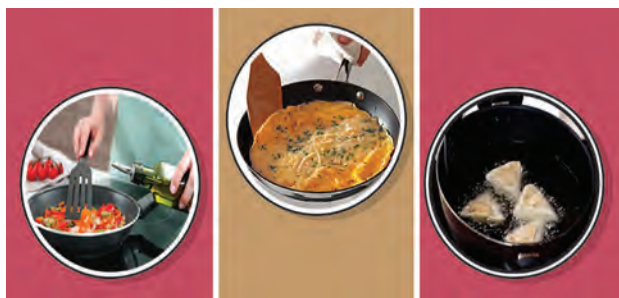
Advantages

- It is quick method of cooking.
- Fried foods are very appetizing and tasty.
- Fried foods have better keeping quality e.g. *puries* can be kept for a longer time as compared to *chapatis*.
- Frying introduces variety in the meals, as fried foods are crispy in texture.

Disadvantages

- Fried foods are difficult to digest due to high fat or oil content.
- Frying increases the calorific value of food products.
- Due to high temperature the nutrient losses are higher particularly of fat-soluble nutrients.
- As fats and oils are expensive, it is not an economical method of cooking.
- More attention and care should be taken during frying. Otherwise there would be excessive browning and caramelization.

- Repeated use of heated oils may produce harmful substances (Poly acril amide) and reduce the smoking points.



Sauteing Shallow frying Deep fat frying

Fig. 6.10 : Methods of frying

4. Microwave cooking

With changing food patterns, the popularity of microwave oven is increasing because it is convenient and fast method of cooking. Microwave oven is an electronic oven containing an instrument called the magnetron tube. This tube converts electric current into high frequency microwaves (electromagnetic energy radiations). These are absorbed and penetrated in the food. These waves cause vibration of food molecules resulting in friction. Due to friction, heat is generated within the food and it results in cooking of food. The water molecules in the centre of food first get heated then that heat diffuse out towards surface thus heating takes place of the whole commodity.

Since heat is generated in the food, there is no medium of heat transfer. Microwave heating of food require to use paper, bone china, glass, some plastics and special microwable containers.



Figure 6.11 : Microwave oven

Advantages

- It is time saving and convenient method to use.
- There is less loss of nutrients.
- The food gets cooked uniformly as the microwaves directly enter the food.
- The oven or containers do not become hot.
- It is useful for defrosting frozen foods or heating cold foods.
- Oil consumption is less in microwave cooking, thus helps to prepare low-fat diet, food.
- It is an economical method because electricity consumption is lesser than traditional method.

Disadvantages

- This method is not suitable for bulk cooking as the time taken for cooking is directly proportional to the amount of food.
- Special containers made of paper, glass, plastic, etc. have to be used in microwave oven.
- Metal containers are not suitable for microwave cooking.

5. Solar cooking

For solar cooking, an appliance called solar cooker is required. A solar cooker is a device which uses the energy of direct sunlight to heat, cook or pasteurize food materials. Solar cooker is a box like structure, the lid of which holds mirror. The containers in which food is kept are placed in the chamber of box, which is covered by glass. When solar cooker is placed in the sunlight, solar energy from the sun heats it, by radiation.

The sun rays containing solar energy fall on the mirror, get reflected by it to the glass cover and pass through the glass to the inner chamber where food is kept. The principle involved in this method is that solar energy is converted to heat energy. The inner walls of chamber and food container are coated with black colour, so that the heat is absorbed and retained to the maximum.

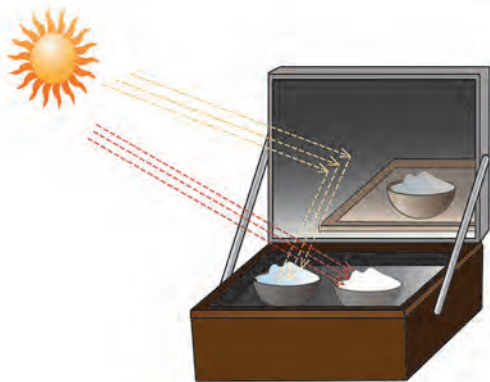


Figure 6.12 : Solar cooker

Advantages

- It is economical method as conventional fuels like gas, kerosene, coal, etc. are not required.
- Constant attention is not required.
- Food remains hot for longer period when kept in this cooker.
- This is eco-friendly method as it does not cause any pollution.

Disadvantages

- The process is slow at low temperature and takes 2-4 hours depending on the intensity of sunlight available.
- The method is weather dependant and cannot be used in rainy and cloudy season.

- The solar cookers position has to be changed with changing position of the sun light.
- Frying is not possible in solar cooker.
- It cannot be used at night.
- Frequent cleaning of cooker is required.

6. Combination cooking or Braising

Many food preparations are made not by single method but by a combination of different cooking methods. Two mediums of heat transfer such as fat and water or air and water are used very commonly in many food preparations. This is usually referred as Braising. e.g. vegetable curry (sauteing and simmering), *upma* (roasting and boiling), meat cutlet (boiling and deep fat frying), *matar paneer* (frying and stewing), etc.

Advantages

- The food is very tasty and full of flavour. Even most of the nutrients are retained.
- Excellent sensory quality properties (colour, flavour, taste, texture and appearance)

Disadvantages

- It is a time consuming method and requires constant attention.

Activity-1

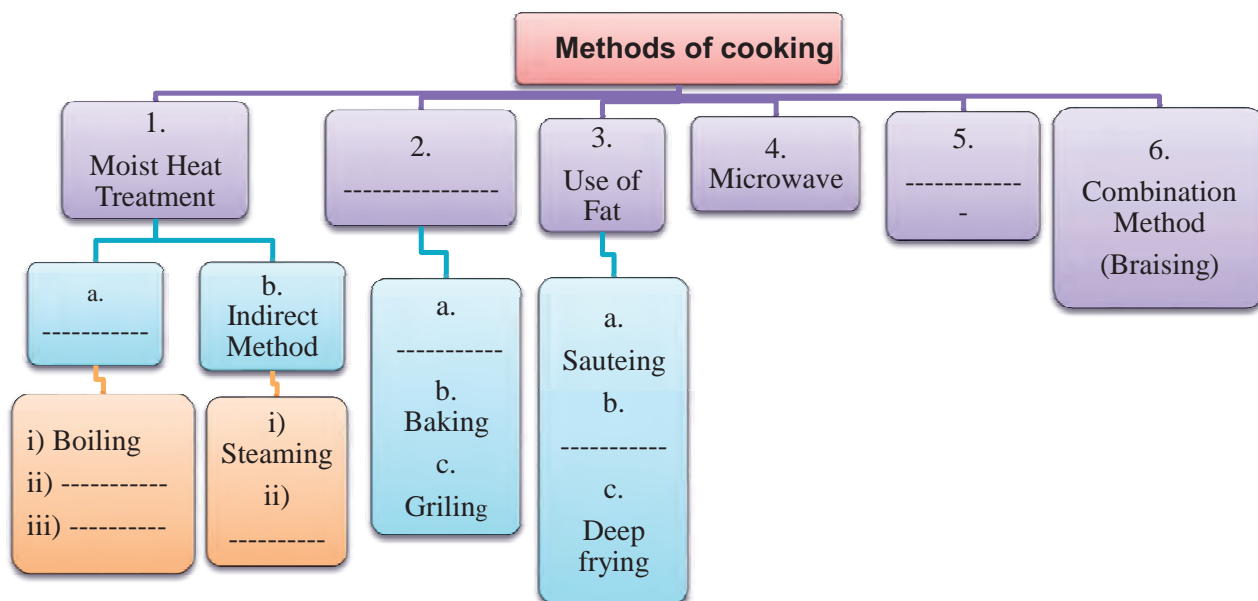


Table 6.2 : Methods of cooking food

Sr. No.	Medium of heat transfer	Method of cooking	Temperature	Examples
1.	Water	A. Direct method		
		1. Boiling	100°C	<i>Dal, rice</i>
		2. Simmering	85°C to 90°C	<i>Kadhi, kheer, egg, soup</i>
		3. Stewing	85°C to 90°C	Meat stew, vegetable stew, vegetables with little gravy, stewed fruits
		B. Indirect method		
		1. Steaming	100°C	<i>Idli, Dhokla, Aluwadi</i>
		2. Steaming under pressure	110°C to 120°C	Rice, <i>dal</i> , vegetables
2.	Hot Air	1. Roasting	160°C to 175°C	<i>Phulka, papad, rawa, groundnuts, corn on cob</i>
		2. Baking	160°C to 220°C	Cake, cookies, biscuits
		3. Grilling	163°C to 177°C	Grilled sandwich, grilled fish, grilled paneer
3.	Fat	1. Sauteing	-----	Sliced vegetables for noodles, fried rice
		2. Shallow frying	-----	<i>Dosa, paratha, thalipeeth</i>
		3. Deep frying	180°C to 220°C	<i>Jalebi, samosa, puri</i>
4.	Combination of two mediums A. Fat and water or B. Air and Water	Braising	-----	Meat cutlet, vegetable noodles, potato <i>wada upma, sheera</i>

Activity-2

Enlist the products which can be prepared using different cooking methods from following food.

1. Potato 2. Rice

Activity-3

Write down an explanation of the following methods and give at least 5 examples of food cooked in this way. One example is shown in table.

1) Moist Heat Cooking Methods

a) Boiling

Cooking foods in a liquid at temperature of about 100°C.

e.g. eggs, potato, rice, *dal*, meat

b) Simmering

c) Steaming

2) Dry Heat Cooking Methods

a) Roasting

b) Grilling

c) Microwave heating

3) Fry Cooking methods

a) Sauteing

b) Shallow frying

c) Deep fat frying

Points to remember

- Cooking is important food processing method to prepare variety of food products from single ingredient by applying different cooking methods.
- Cooking improves palatability and digestibility of food. Adds variety to diet and also make it safe for consumption.
- Heat can be transferred to food during cooking with modes like conduction, convection and radiation.
- The cooking methods are mainly classified according to the medium of heat transfer such as air, water and fat.

Exercise

Q.1 (a) Select the most appropriate option:

- In _____ heat transfer occurs when microwave or infrared energy are spread into the food.
(Convection, Radiation, Conduction)
- In _____ method food is cooked with water in a sealed vessel.
(Pressure cooking, Grilling, Roasting)
- _____ foods are difficult to digest due to high fat content.
(Roasting, Fried, Boiled)
- Combination of different cooking methods is known as _____.
(Braising, Boiling, Steaming)

(b) Match the following:

A	B
i. Roasting	a. Cookies
ii. Simmering	b. Dhokla
iii. Steaming	c. Kheer
iv. Baking	d. Papad
	e. Cutlet

(c) State whether the following statements are true or false:

- In conduction method, heat transfer is faster than convection.
- Roasting is dry heat treatment method of food processing.

- iii. The principle effect of heat on fats is denaturation.

Q.2 Answer in brief

- i. Give two examples of food prepared by steaming.
- ii. Give two examples of food prepared by shallow frying.
- iii. Enlist objectives of food cooking method.

Q.3 Short answer questions

- i. Define conduction/ convection/ radiation.
- ii. Give advantages and disadvantages of microwave food cooking.

Q.4 Long answer questions

- i. Discuss modes of heat transfer to food during cooking.
- ii. Describe solar cooking with diagram

❖ Project :

Select any 10 recipes prepared with braising and prepare an attractive booklet.

