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7 Food Preparation Technology

7.1 Food preparation techniques

When preparing food, different food preparation skills and techniques are involved, e.g. cutting, dough making, pastry making, cake making. The following table shows the basic food preparation techniques.

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<td>Cutting, shredding, slicing, dicing, mincing, chopping, crushing, peeling and coring</td>
<td>Different blades in the food processor can do different jobs. e.g. chopping blade, slicing blade, meat grinder, sausage stuffer, juice extractor</td>
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<td>Cake making: whisking method, creaming method, rubbing-in method and melting method</td>
<td>Cake decoration, piping</td>
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7.2 Time- and labour-saving devices

Apart from using kitchen utensils, time- and labour-saving devices can be used in food preparation and processing to save time and energy. They are being used in both domestic and industrial levels, which should have the following features to perform their functions:

- They should have the power and capacity to do a wide range of jobs.
- They should be easy for cleaning.
❖ They should be made of durable materials.

❖ The accessories of the machines should be easy to be attached for use and detached for cleaning.

7.2.1 Electric beaters

Electric beaters are usually used in mixing. It can be used to mix different solids, liquids or even a mixture of solids and liquids. Some electric beaters use blades to create a movement or current to mix solids and liquids. Some electric beaters such as those used by bar tenders may make use of vigorous vertical movements for mixing different liquids. A number of purposes can be achieved by equipping the beater with different attachments. For example, using balloon whisk for whipping cream and egg white; using a flat beater for mixing batters; and a dough hook for kneading.

Electric beaters can be divided into two types:

(A) Hand-held beater

Its basic structure consists of a handle mounted over a large enclosure containing the motor, which drives one or two beaters. The beaters are immersed in the food to be mixed.

(B) Heavy-duty stand beater

Stand beater is mounted on a stand which bears the weight of the device. They typically consist of a special bowl that is locked in place while the beater is operating. Comparing with hand-held beaters, stand beaters are larger and have more powerful motors. Heavy duty commercial models of stand beaters have large bowl capacities for mass production.

7.2.2 Mincers

Mincers are ideal for mincing meats.

7.2.3 Liquidisers

Liquidisers are electrically powered mixers with whirling blades that mix or chop or liquefy foods.
7.2.4 Blenders

Blenders have blades to chop, blend, purée and liquefy solid foods like fruits, soybeans, butter, herbs, nuts etc. Blender can be used in various jobs, for example, making purée, fruit juice, soybean milk, mixing batters, mayonnaise, salad dressings, and chopping nuts, herbs. In recent years, dry blenders are very popular for crushing hard food ingredients into powder. Normally, the cup of a dry blender is smaller than a wet blender or mixer for controlling the volume of food to be processed.

7.2.5 Mixers

Mixers can do various jobs by using different attachments including dough hook, electric can-opener, mincer, potato peeler and juice extractor etc.

7.2.6 Food processors

(A) A food processor is a multi-purpose machinery. It can do a wide range of jobs by using different attachment or blades. Some food processors can even do all the jobs that can be done by mixers and blenders. Apart from mixing and blending, a food processor is usually used for making pastry, mincing meat, grating cheese and slicing and shredding fruits, vegetables and herbs.

(B) The cautions of using food processor include:

❖ Extra care must be taken when handling the blades of food processors since some of them have sharp edges.

❖ The food processor must be switched off before changing any parts of the processor.

❖ The blade should not be used alone without the bowl provided.

❖ Keep the blades and cups clean, since micro-organisms may grow on the surface especially inside the small gaps.
7.2.7 Ice-cream makers

Household ice-cream maker

Conventionally, the production of ice-cream involves the mixing of ingredients, homogenisation, pasteurisation, ageing and rapid freezing. During the freezing process, vigorous agitation is applied for incorporating air bubbles into the ice-cream mixture and allowing the formation of fine ice crystals. This results in a desirable soft and smooth texture of the products. A household ice-cream maker is a scraped-surface heat exchanger that contains a dasher driving scraper blades and a heat exchanging bowl including cryogen (coolant). The bowl is frozen overnight to ensure the cryogen is cold enough for freezing the ice-cream mixture. When the ice-cream mixture is poured into the pre-frozen bowl, ice-cream starts to freeze on the inner-surface of the bowl. The scraper blades will scrape off the frozen ice-cream on the surface followed by the immediate formation of a new layer of frozen ice-cream. In addition, the rotation of the scraper blades also plays the function of incorporating air bubbles into the ice-cream mixture. Soft-serve ice-cream can be formed after 1-2 hours in a household ice-cream maker.

7.3 Food cooking processes

7.3.1 Scientific principles and types of heat transference

When we talk about heat transfer, we must know the relationship between temperature and molecules. The higher the temperature, the faster is the rate of the vibration of molecules in a matter. Therefore, heat transfer is a process of changing the vibration rate of molecules.
(A) Conduction

Conduction occurs when two matters with different temperature come in contact each other and the kinetic energy of the molecules in the matter higher in temperature transfers to the other matter. Figure 7.3 shows two different spaces representing two matters in different temperatures. The molecules in the space higher in temperature move faster than that in the space lower in temperature. When the barrier between the two spaces is removed, the molecules collide with each other and kinetic energy is transferred from the faster molecules to the lower molecules. This type of transferring of kinetic energy is called conduction.

(B) Convection

Convection involves a bulk movement of molecules from a hot region to a cold region. This type of heat transfer occurs only in a fluid like air or liquid. Figure 7.4 shows the flow of matters in convection. When a local area is heated up, its density decreases. The molecules in the cooler area, which is higher in density, will move into the area with lower density. This creates a convection current that can be found when water is heated until boiling.
(C) Radiation

Radiation or electromagnetic radiation (no matter visible or invisible light) is one of the other forms of heat transfer. Heat and radiation are forms of energy which can be interchanged to a certain extent. There are many sources of radiation such as sun, lamp, etc. Matters absorb radiant energy and transfer the energy to different forms including heat, infrared light or visible light.

(D) Microwave cooking

Microwave vibrates millions of times per second. It penetrates food and makes water molecules vibrating in resonance. As a result strong friction is generated between water molecules and the heat generated warm up the food. Microwave is reflected by metal objects but can penetrate materials such as ceramics, glass and some plastics. Therefore, the container for holding food during microwave cooking should not be made of metal but those that can be penetrated by microwave.

(E) Induction

For induction cooking, heat is not generated directly by the heating source but the cooking vessel itself is a heat generator. In induction cooking, there is an electric coil generating a high power of electromagnetic field. This electromagnetic field penetrates the iron-made vessel and sets up an electric current which produces heat. The heat in the cooking vessel is then transferred to the contents in the vessel. The heat generated will stop when the vessel is removed from the electromagnetic field or the power for the coil is switched off. For this cooking method, the vessels must contain iron which is important for setting up the magnetic field in the vessels.
7.3.2 Cooking methods

(A) Moist heat cooking

Moist methods of cooking apply a relatively lower heat to food through a medium of liquid including water, steam, stock, milk, fruit juice, wine or beer.

(i) Boiling

Water evaporates and builds up a pressure over water surface. It is called the vapour pressure. When water is heated up, water evaporates more vigorously and the pressure increases. When the pressure overcomes the atmospheric pressure, it reaches the state of boiling in which bubbles form and escape. In boiling, liquid is heated to its boiling point (about 100°C for water) and the heat is then lowered until the liquid is bubbling quickly and evenly. Fish, vegetables, eggs, pasta and rice are foods suitable for boiling.

(ii) Simmering

Simmering is a method whereby food is heated in a more gentle way than boiling to prevent losing tenderness or breaking up of food. Fewer bubbles rise to the surface in simmering and the temperature is just below the boiling point.

(iii) Steaming

Steaming is a method using steam instead of water itself as the heating medium. During steaming, food is not immersed in water but is put over the water surface. Food is heated up by the hot steam generated from the boiling water. Fish and dim-sum are usually steamed in Chinese cooking. Food can maintain its original shape after steaming.

(iv) Poaching

Poaching is a method using a lower temperature (71-82°C) than simmering. It is a very gentle way of cooking. In poaching, food is just half immersed in the water and heat is applied to the food gently until the food is desirable for consuming. This method is suitable for foods rich in protein (for example, eggs or fish) which would become tough or curdled at higher temperature.

(v) Stewing

Stewing is a slow method of cooking similar to boiling but uses a temperature lower than the boiling point of water (< 100°C). It is carried out in a lidded pan or a covered dish at a low temperature. The food is served with the cooking sauce together. Meat, poultry, root vegetables and fruits are foods suitable for stewing.
(vi) Braising

Braising is a combination of stewing and roasting. Meat or poultry is heated in very little water in a pot with a well-fitted lid which prevents loss of water while the food is stewed in the pot. After the food becomes tender, it is browned in a hot oven with the lid off. During braising, the liquid should simmer, but not boil, to prevent the meat from being too tough. In Chinese cooking, the food is usually deep-fried for a minute or two before stewing.

(vii) Pressure cooking

If the container is tightly closed during heating, a higher pressure is built up inside the container. The water boils at a higher temperature and the very hot steam is forced through the food so that the food is cooked more rapidly and more energy is saved. Pressure cookers have a pressure gauge, control valve, safety valve, locking lid, separate containers and a trivet.

(B) Dry heat cooking

(i) Grilling

Grilling is the cooking of food by radiation under a gas or electric grill. Under grilling conditions, the surface of the food is quickly sealed, and the flavour is well developed. In order to prevent drying, the food must be smeared with fat and it is turned over frequently to ensure even cooking.

(ii) Baking

Baking is a cooking process by the convention of air in an oven. Heat is transferred by the movement of air from cool regions to warmer regions of lower density. Cakes, biscuits, pastries, bread, tarts etc. can be cooked using this method.

(iii) Roasting

Roasting is a method to cook meat or some vegetables involving basting with hot fat for preventing from drying and for developing brown colour and specific flavour, in an oven. There are three kinds of roasting methods.

❖ Searing

Searing involves firstly using a very hot oven (about 230°C - 240°C) for about 20 minutes followed by using a lower temperature. The former step is to sear the outside and develop the flavour of the meat while the latter is to complete the cooking. This method is only suitable for tender joints of meat such as topside of beef or leg of lamb or pork.
Slow roasting

For slow roasting, meat is heated up in a pre-heat oven at a relatively low temperature (about 170°C) using a cooking time longer than usual cooking time. This method is suitable for cuts such as breast of lamb, belly of pork or brisket of beef.

Cold oven method

The meat is put into a cold oven gradually rising in temperature up to about 220°C. Through this method, the meat is tenderised and its flavour is developed. This is suitable for any cuts of meat, particular for the less tender cuts such as shoulder of lamb or brisket of beef.

(iv) Frying

Frying is cooking food using fat heated usually to a temperature between 180°C and 205°C. It is a quick method of cooking because of the high temperature used. The ways of frying are:

Deep fat frying

In a deep-fryer or wok, food must be completely covered with sufficient fat or oil and cooked over high or medium heat (between 150°C and 200°C) until it becomes golden brown. Chinese yeast dough, doughnuts, spring rolls, pork chop, chicken wings, potatoes, onions, fish and prawns are suitable for deep fat frying.

Shallow frying

Food is cooked in heated fat covering the bottom of the pan or wok. As the heating of food is done on one side at a time, the food has to be turned to ensure that it gets cooked on both sides. Eggs, fish, steak and pork chop can be fried.

Stir frying

Food is stirred in a little hot fat in a frying pan. Vegetables, prawns, thin slices of meat and fish are stir-fried.

Dry heat frying

Food which contains fat in it, e.g. bacon, can be dry-fried. When heated, the fat in it melts and runs out. The food gets cooked in its own fat. Peanuts contain vegetable fat and may also be dry-fried.
<table>
<thead>
<tr>
<th>Cooking method</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
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<td><strong>Moist methods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiling</td>
<td>The transfer of heat by convection is fairly rapid and efficient and water is readily available, food is unlikely to be burnt.</td>
<td>Nutrient loss may be high, soluble matters may be lost into the liquid and some flavour is lost from meat. The disadvantages can be partly overcome by serving the cooking water as gravy, sauce, or stock with the meal.</td>
</tr>
<tr>
<td>Steaming</td>
<td>Loss of nutrients is reduced as the food does not come into direct contact with the water. The food is unlikely to be overcooked.</td>
<td>Food takes a long time to cook, so the heat destruction of vitamin C is more likely to occur.</td>
</tr>
<tr>
<td>Poaching</td>
<td>Cooks protein gently to avoid toughness or curdling development</td>
<td>Food requires careful preparation and handling. Longer cooking time.</td>
</tr>
<tr>
<td>Stewing</td>
<td>Stewing softens tough cuts of meat, and nutrient losses are kept to a minimum as the liquid is served with the meal. The flavour is retained.</td>
<td>Stewing is a long, slow method of cooking.</td>
</tr>
<tr>
<td>Braising</td>
<td>A whole meal can be cooked in one pan, saving time and fuel. Tough cuts of meat can be used.</td>
<td>Meat may not develop a good colour and may need to be grilled at the end of cooking.</td>
</tr>
<tr>
<td>Pressure Cooking</td>
<td>Pressure cookers are economical on fuel. Meals can be prepared quickly. Loss of nutrients is reduced, though heat destruction still occurs. Tough cuts of meat can be cooked quickly and softened.</td>
<td>Precautions and proper operating procedures must be taken when using pressure cookers. The pressure builds up in the cooker is very high that may become a danger. High quality pressure cookers must be chosen to avoid explosion.</td>
</tr>
<tr>
<td><strong>Dry methods</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grilling</td>
<td>Grilling is a quick method of cooking and is therefore suitable for snacks, and for time-saving meals. It is a healthy method of cooking because the fat from the meat, bacon, etc., drains away.</td>
<td>Grilling requires careful timing and temperature control to prevent overcooking.</td>
</tr>
<tr>
<td>Baking</td>
<td>Several items can be baked at the same time.</td>
<td>The oven has to be preheated. Baking requires careful timing.</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Roasting</td>
<td>Roasting tenderises joints of meat and develops their flavour. Little attention is required while the meat is roasting, except to baste the joint. Fuel can be saved if other items are baked in the oven at the same time.</td>
<td>A lot of moisture is lost by evaporation and the joint may dry out. Meat may shrink markedly as a result of moisture loss and protein denaturation. High temperatures may result in protein denaturation and reduced digestibility. Fat from the meat will spatter at high temperatures, making the oven dirty.</td>
</tr>
<tr>
<td>Frying</td>
<td>Frying is cooking foods using fat heated usually to a temperature between 180°C and 205°C. It is a quick method of cooking because of the high temperature used.</td>
<td>Fried food is greasy and high in calories. Deep-frying requires skill. It must be carefully done because the splashing hot fat can be dangerous.</td>
</tr>
</tbody>
</table>
Effect of heat on digestibility of food commodities

Heat may change or even destroy the nutrients in the food. It could make the nutrients more digestible or in the opposite, less digestible. Here are some brief notes on how heating affects the digestibility of nutrients in food.

1) Carbohydrates

(a) Starch
Dry heating like toasting bread or baking cakes changes starch to dextrin. Wet heating initiates gelatinisation when the temperature is higher than 70°C. This increases the starch digestibility. In addition, amylase inhibitors present in food may be denatured by heat and thus amylase in the saliva is not affected for the digestion of starch in the mouth.

(b) Sugar
When sugar is heated and melted, its colour is changed from white to golden brown (a process known as caramelisation). Further heating may eventually burn the sugar. The energy value of sugar will not be affected too much unless the sugar is burnt.

2) Proteins

Proteins in food coagulate on heating which increases their digestibility. The digestibility of protein may also be increased by heat due to inactivation of some antinutrients (protease inhibitors and hemagglutinins) which are destroyed through heating.

3) Vitamins

There are two kinds of vitamins according to their solubility. Fat-soluble vitamins including vitamin A, D and E are not affected by heating process. On the other hand, water-soluble vitamins including vitamin B1 and C are heat sensitive that may be degraded in the heating process.
7.3.3 Cooking Devices

(A) Microwave oven

The first microwave oven, called Radarange, was built by Percy Spencer in 1947. Percy Spencer discovered the heating power of microwave through the phenomenon of a melting chocolate bar in his pocket when he was working on an active radar set. Sales of microwave oven increased rapidly from 40,000 units for the United States of America (USA) market in 1970 to one million by 1975. The invention of microwave oven changed the cooking style of people in modern society since it is convenient and safe to be used. Microwaves can penetrate through the food and heating the inside and outside of the food at the same time. Therefore food can be heated up at a faster rate than many other methods. Microwave ovens use a timer as a standard operation method that the oven stops its operation as soon as the preset time is up. This lowers the chance of overcooking of food. Normally, the cooking temperature in a microwave oven is not higher than 100°C, so it can prevent the formation of tars and char. Most people may have a wrong concept that microwave oven heats up food from the inside to outside of the food. However, the fact is that microwave penetrates the food from the outside to inside. The difference between microwave oven and tradition heating method is that microwave can heat up every part of the food at the same time while convection heating transfers heat from the outside to inside of the food by conduction.

(i) Advantages of using microwave oven include:

❖ Cook food rapidly.
❖ Can retain more flavour, texture and wholesomeness.
❖ Can save up to 50% electric energy.

(ii) Cautions of using microwave oven include:

❖ Avoid using materials made from soft pliable plastics, melamine, pottery with a metal rim and all metal containers, including aluminum foil (except in small pieces for shielding) and coloured paper products.
❖ Stir liquids thoroughly before placing in the oven and stir again half way through the normal cooking time, this will help to ensure thorough cooking.
❖ Allow foods to stand for a while after cooking with microwaves, let the centre of the food cool off a little before it can be eaten safely.
❖ Unopened canned food or jars and air tight containers should not be heated in the microwave oven as they may cause an explosion.
(B) Pressure cooker

(i) Ensure that domestic pressure cookers used do not exceed the maximum capacity of 7 liters and the maximum working pressure does not exceed 105 kPa. (kPa – kilopascal)

(ii) Always maintain pressure cookers in an efficient and safe condition at all times.

(iii) Follow the manufacturer’s instructions for each type of pressure cooker in use.

(iv) Add adequate quantities of water bearing in mind the cooking time.

(v) Wear an oven glove when adding or removing the weights to or from a hot pressure cooker.

(vi) Never open the cooker nor remove the weights when still under pressure.

(vii) Allow the cooker to cool naturally or cool under cold, running water until the pressure has returned normal.

(viii) Clean the weight support or the indicator in the safety valve to ensure that the cooker is not blocked with food debris or an explosion may occur.
A vacuum pot makes use of different methods to reduce heat loss by conduction, convection and radiation. A vacuum pot is composed of an inner pot and an outer pot. The inner pot is made of aluminium which is a good conductor that the content inside can be heated up quickly and evenly. The outer pot and cover are made of insulating materials that reduce heat loss by conduction and convection. The silvery inside reduces heat loss by radiation. Vacuum is maintained in the space within the outer pot to greatly reduce heat loss by conduction and convection. There is also a thin layer of air between the inner and outer pot which acts as an insulation. This can keep the content inside under a high temperature and thus food can be cooked without continuous heating by a heat source. Food is firstly heated up to boil in the inner pot using a heat source, the inner pot is then put into the outer pot with the lid closed. The food inside can be cooked at a high temperature for a rather long period of time. This saves labour and energy during cooking. After several hours of cooking, the inner pot should be taken out and heated up again before serving.
(D) Induction cooker

Induction cooking provides a method of rapid heating, improved thermal efficiency, greater heat consistency and a greater degree of control than conventional heat method using gas stove. It can shorten the time for boiling a pot of water by 3 minutes or less. The structure of an induction cooker is just like an electrical transformer. A coil of wire is used for generating magnetic field inducing an electric current in the pot and generating heat.

For induction cooking, heat is not generated directly by the heating source but the cooking vessel itself is a heat generator. In induction cooking, there is an electric coil generating a high power of electromagnetic field. This electromagnetic field penetrates the iron-made vessel and sets up an electric current which produces heat. The heat in the cooking vessel is then transferred to the contents in the vessel. The heat generated will stop when the vessel is removed from the electromagnetic field or the power for the coil is switched off.

For this cooking method, pots must be made of conductors but not insulators that current can be induced in it by induction cooker. It is usually made of stainless steel or iron. The magnetic field generated by the induction cooker induces current in the pot and heat is generated by the resistance of the pot. Suitable cookware with a flat bottom or curved bottom should be chosen to fit on the surface of induction cooker.
Current is induced in a metallic container on an induction cooker. Any metallic objects for cooking such as knives, forks, spoons, and lids should be removed from the induction cooker. Sealed cans should always be kept out of induction cooker. The cooker should be switched off whenever after use or otherwise its surface will be cracked. Since the surface of induction cooker is still hot after cooking, do not touch it immediately after cooking.

**Figure 7.8** Principles of induction cooking

![Diagram of induction cooking](image)

**E) Oven (gas or electric)**

Both gas ovens and electric ovens work in similar ways. Each has its own thermostat and most are controlled electrically.

(i) Gas ovens tend to heat and cool down quicker than electric ovens.

(ii) Gas ovens could be far more economical in the long run, even though they may cost more initially to acquire.

**7.3.4 Industrial devices**

**A) Conveyor belt**

(i) Conveyor belts are used in warehouses and industries for saving time and labour of transportation. Conveyor belt consists of two or more pulleys and a belt which is made of rubber, metals or plastics. Materials carried by the belt can be transported from one point to another or from one machine to another one.

(ii) There are many segments or so-called unit operations in an industrial food production process. For example, in the production of potato chips, peeling, de-starching, deep-frying, seasoning, weighing, packaging are some of the unit operations. Each unit operation can be done by labour or automatic systems.
(iii) Most of the automatic systems cannot work without a conveyor belt system for moving materials right in the way of the processing machines. One of the functions of a conveyor belt is to carry materials, semi-food products, from one unit operation to another through the same level (i.e. same floor) as well as different levels (i.e. different floors). Conveyor belts can combine with processing machines so that the food can pass through the machine without being handled by workers. Sliced potatoes are fed on a conveyor belt to a continuous formed potato products fryer and deep-fried potato chips come out from another side of the fryer by the help of conveyor belt.

(B) Automatic machines in poultry industry

(i) Debboning and cutting of poultry products are labour intensive tasks in poultry industry. Automatic devices are certainly a labour- and time-saving alternative for completing such jobs in poultry industry. It is a challenge for designing a machine for the purpose of these jobs due to the variation in the shape and size of animals as well as the complexity of the processes.

(ii) For example, to cut the wing of a chicken, you have to first pull out the wing, followed by cutting off at the joint. This is a complex task combining vision and action. Automatic deboners were first introduced in the 1980s without good response due to the reduction of yield and bone fragment residues. Improvements are continuously introduced to the systems to reach a better performance. The techniques for thigh and leg deboning are now better than before with the aid of computer controlling systems which are used by some industries.

(iii) Apart from debonning, portioning can also be done by using computers nowadays. Machines are being enhanced for flexible cut-up of poultries. These machines can speed up the process of debonning and portioning with less input of manpower.

(C) Automatic machines for cake decoration

Cake decoration processes can be done partially by robots e.g. robotic writing on cakes, piping. This makes mass production of cake possible especially in some festivals like Christmas and Easter when the demand of cakes increases dramatically.
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Learning and Teaching References

1 Family and Lifestyle
2 Consumer Behaviour in Food Choices and Implications
3 Health and Nutrition
4 Chemistry of Foods
5 Diet and Meal Planning
6 Food Commodities

7 Food Preparation Technology
8 Food Hygiene
9 Food Spoilage and Food Poisoning
10 Food Preservation Technology
11 Food Culture
12 Food Science and Technology Extended Study
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