SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF FOOD TECHNOLOGY

MICROWAVW COOKIND AND FOOD

SAFETY

INTRODUCTION

- During World War II, scientists found that birds collided with radar masts would drop to the ground, become sizzling and well cooked.
- From then the idea of cooking food with microwaves emerged1 . Shortly after the War, microwave oven was introduced to the public.
- Thawing, cooking or reheating foods by microwave oven is convenient and is becoming popular nowadays.
- Most of the families and restaurants would install microwave ovens for meal preparation. However, the safety of the microwaved food has on and off aroused some public interest.

PRINCIPLES OF MICROWAVE COOKING

NATURE OF MICROWAVES

- Microwaves refer to the electromagnetic waves in the frequency range of 300 to 300,000 mega hertz (MHz) (million cycles per second).
- Electromagnetic waves are waves of electrical and magnetic energy moving together through space. They include gamma rays, x-rays, ultraviolet radiation, visible light, infrared radiation, microwaves and the less energetic radio waves.
- Microwaves can pass through materials like glass, paper, plastic and ceramic, and be absorbed by foods and water; but they are reflected by metals.

THE HEATING PROCESS

The alternating electromagnetic field generated inside the microwave oven would lead to excitation, rotation/collision of polar molecules and ions inside the food.

The two major mechanisms, namely dipolar and ionic interactions, explain how heat generated inside food.

DIPOLAR INTERACTION

- Once microwave energy is absorbed, polar molecules such as water molecules inside the food will rotate according to the alternating electromagnetic field.
- The water molecule is a “dipole” with one positively charged end and one negatively charged end.
- Similar to the action of magnet, these “dipoles” will orient themselves when they are subject to electromagnetic field.
- The rotation of water molecules would generate heat for cooking

IONIC INTERACTION

- In addition to the dipole water molecules, ionic compounds (i.e. dissolved salts) in food can also be accelerated by the electromagnetic field and collided with other molecules to produce heat.
- Hence the composition of a food will affect how it will be heated up inside the microwave oven. Food with higher moisture content will be heated up faster because of the dipolar interaction.

STRUCTURE OF A MICROWAVE OVEN

Nowadays, microwave oven generally consists of the following basic components–

- (i) power supply and control: it controls the power to be fed to the magnetron as well as the cooking time;
- (ii) magnetron: it is a vacuum tube in which electrical energy is converted to an oscillating electromagnetic field. Frequency of 2450 MHz has been set aside for microwave oven for home use;
- (iii) waveguide: it is a rectangular metal tube which directs the microwaves generated from the magnetron to the cooking cavity. It helps prevent direct exposure of the magnetron to any spattered food which would interfere with function of the magnetron;
- (iv) stirrer: it is commonly used to distribute microwaves from the waveguide and allow more uniform heating of food;

- (v) turntable: it rotates the food products through the fixed hot and cold spots inside the cooking cavity and allows the food products to be evenly exposed to microwaves;
- (vi) cooking cavity: it is a space inside which the food is heated when exposed to microwaves;
- (vii) door and choke: it allows the access of food to the cooking cavity. The door and choke are specially engineered that they prevent microwaves from leaking through the gap between the door and the cooking cavity.

COMPARISON WITH CONVENTIONAL OVEN

HEATING PROCESS

- Food cooked in conventional oven is heated by surrounding hot air whereas food cooked in microwave oven is heated as a result of the alternating electromagnetic field. The electromagnetic field generated is not uniformly distributed inside the cooking cavity and hence it leads to uneven heating of food.
- Fat will be heated more quickly than water because of its relatively low heat capacity. On the other hand, food of high fat content can be heated at a temperature greater than 200o C whereas food of high moisture content would be cooked at temperature no greater than 100o C unless all water was evaporated. It is because water has a lower boiling temperature.

ORGANOLEPTIC PROPERTIES OF FOOD

- Another difference between microwave oven and conventional one is that microwave oven cannot induce browning or crisping of food.
- However, this can be resolved by using microwave packaging materials called microwave susceptors when heating food.

CHEMICAL RISKS ASSOCIATED WITH MICROWAVE COOKING

- Cooking processes, especially the high temperature ones (e.g. grilling, baking, etc.) are known to induce the production of potential carcinogens.
- There have been concerns that microwave cooking may also increase the production of carcinogens or mutagens in foods.

HETEROCYCLIC AMINES (HCAS)

- HCAs are a group of compounds that are present in cooked muscle meat after high-temperature cooking such as grilling / barbecuing, broiling or pan-frying.

POLYAROMATIC HYDROCARBONS (PAHS)

- PAHs refer to a large group of organic chemicals containing two or more fused aromatic rings made up of carbon and hydrogen atoms.
- Food processing or cooking steps such as roasting, grilling, barbecuing and smoking generate PAHs and increase the level of PAHs in the food being cooked.

NITROSAMINES

- Nitrosamines are formed by a reaction between a nitrosating agent (e.g. nitrites) and a secondary or tertiary amine. The reaction may take place in certain types of foods as a result of curing, drying or cooking

MICROBIOLOGICAL RISKS ASSOCIATED WITH MICROWAVE COOKING

- Nearly all foods may be contaminated by microorganisms to a certain extent.
- Concerns have arisen regarding whether microwave cooking can kill the food-borne pathogens as effective as conventional methods since microwave cooking generally requires shorter times and may sometimes result in lower temperatures at the food surface.
- Results of many studies concluded that the effectiveness of microwave cooking in killing microorganisms and spores is comparable with conventional methods provided that appropriate temperature and time are reached
- The same temperature-time relationship applies to both cooking methods, i.e. it is generally advised that raw animal food should be heated to a temperature of at least 75o C for 15 seconds to kill any foodborne 12 pathogen that may be present in the food.

NUTRIENT LOSSES ASSOCIATED WITH MICROWAVE COOKING

PROTEINS

- Proteins would be denatured with the modification in molecular structure upon heating.
- The degradation rates depend on the heating time and temperature.
- It has been shown that the nutritive value of proteins in foods treated by conventional and microwave heating are comparable

LIPIDS

- Heating of food would lead to various decomposition reactions (i.e. thermolytic and oxidative reactions) of its lipid components, including triglycerides, saturated and unsaturated fatty acids, as well as cholesterol in the 13 presence of oxygen.
- The subsequent increase in fat oxidation products is of particular health concern.
- Various studies have been conducted to investigate the stability of lipids upon microwave cooking, including studying the hydrolysis of triglycerides in soya, egg yolk and meats;

VITAMINS

- Many studies have been conducted to compare the retention of vitamins in different types of meat and vegetables subject to conventional and microwave cooking.
- Generally speaking, water soluble vitamins such as vitamin B and C are more susceptible to heat treatment.

MINERALS

- Minerals are generally not destroyed during cooking including microwave cooking. However, they might be lost in cooking water or meat drippings.
- Nevertheless, a study comparing microwave and conventional braised beef found that significantly more phosphorus and potassium were retained in microwave cooking

THANK YOU