Fresh pork and pork products are very susceptible to quality loss due to microbiological spoilage, discolouration, dehydration, etc. Pork has to be stored, transported and distributed through a retailer or supermarket, all of which is considerably time-consuming. In order to safeguard fresh pork during this extended time, along with application of certain methods of preservation such as refrigeration, curing, smoking and packaging of meat gains great importance.

**Meat Curing:**

Curing may be defined as the addition of common salt and nitrate/nitrite/nitric oxide to the meat, which results in the conversion of meat pigments, predominantly myoglobin to the nitroso or cured form. While curing may be applied to all kinds of meat it is best adopted to those with high fat content like pork. Salt is the principle preserving material used in curing though it has little direct harmful effect on bacteria it works on the osmotic pressure principle removing the water from meat, which is necessary for bacterial growth.

Distinction must be made between salted pork and cured meats (bacon, ham). In salted meat, salt first dissolves in the surface fluids and then passes slowly inwards until it is evenly distributed throughout the meat substance. A considerable amount of moisture is removed when the salt draws to the surface some of the fluids in which it dissolves.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Curing salts and additives</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sodium chloride 15 to 30%</td>
<td>Preservative, improves texture</td>
</tr>
<tr>
<td>2</td>
<td>Sodium nitrate 0.15 to 1.5%</td>
<td>A source of nitrite</td>
</tr>
<tr>
<td>3</td>
<td>Sodium nitrite 500 to 1000 ppm</td>
<td>Preservative gets reduced by meat enzymes to nitric oxide, which combines with myoglobin (the uncured meat pigment) forms nitroso-myoglobin, the cured meat pigment.</td>
</tr>
<tr>
<td>4</td>
<td>Poly phosphates 2 to 4%</td>
<td>Reduce cooking losses and during smoking, improve texture.</td>
</tr>
<tr>
<td>5</td>
<td>Sugar eg: Sucrose 1 to 4%</td>
<td>Improve flavour by masking the harshness of the salt</td>
</tr>
<tr>
<td>6</td>
<td>Smoke</td>
<td>Flavoring agent</td>
</tr>
<tr>
<td>7</td>
<td>Sodium ascorbate 0.2 to 1%</td>
<td>Reducing agent, improved colour formation and stability by effecting rapid reduction of nitrite to nitric oxide in the meat</td>
</tr>
<tr>
<td>8</td>
<td>Monosodium glutamate 500 ppm</td>
<td>Flavour enhancer</td>
</tr>
</tbody>
</table>

*Pork we eat*
Preservation by Temperature Control

The most widely used method for pork preservation is refrigeration. Low temperatures retard microbial growth and enzymatic and chemical reactions that cause deterioration and spoilage. The rate of such changes is roughly proportional to the temperature of the meat. If the temperature of meat is reduced below -2°C (26°F), it will freeze, which changes the physical state of the tissue as well as the rate of enzymatic and chemical changes. The term refrigeration is restricted to refer to temperature above the freezing point of meat and freezing is below 2°C.

The carcasses of pork normally are refrigerated immediately after slaughter. Rapid cooling is necessary in order to prevent spoilage around the lymph nodes deep in the carcass.

The preservative action is by lowering the temperature to prevent the multiplication of harmful bacteria, yeasts and mould. At a temperature of -8°C the multiplication of all microorganisms stop and only resume when the temperature is raised later to a suitable level, and this is due to removal of available water as ice. The surface growth of moulds on meat is controlled not only by the temperature but also by the relative humidity of the atmosphere and so prevention of moulds calls for reduction of both temperature and relative humidity.

The refrigeration has two principles:
1. To preserve meat at temperatures low enough to prevent the growth and multiplication of spoilage organisms.
2. To avoid slow freezing which alters the texture of meat when thawed and lowers its keeping quality and marketability.

Refrigeration usually begins with chilling of the carcass shortly after slaughter. The temperature utilized in refrigerating chambers falls into two categories according to temperature-a) Chilling and b) Freezing, though good air circulation, right humidity and constant temperature range are common features.

a) CHILLING

It refers to holding of the meat just above the freezing point (-1.5°C) at about -1°C. The cold temperature method is the simplest method of preservation of foods. Efficient refrigeration can preserve meat in the condition approaching its natural state for commercial requirements, its appearance, weight and flavor are little altered and no substance is added to meat nor anything extracted.

At the completion of slaughter, the internal temperature of the animal carcass generally ranges between 30-39°C. This body heat must be removed during initial chilling and the internal temperature of the thickest part should be reduced to 5°C of less. In order to preserve the quality, bloom and weight of meat, it is highly desirable to begin refrigeration as soon as possible after slaughter.
Chilling scarcely affects flavour, appearance or nutritional value of meat and is particularly useful for short term handling. The meat is maintained at about -1°C and preferably in dark, for light accelerates the oxidation of fat with the liberation of free fatty acids and production of rancidity. The atmosphere is kept dry to hinder the mould growth, which is more common in chilling than freezing.

The temperature in the chill room is between -1 to 5°C. In chilling of meat three main factors need consideration-temperature, relative humidity and air speed. As per the EEC, pig carcasses should be stored at +4°C and offal at +3°C. The temperature during the initial stages of chilling should be <7°C and air speed> 0.75 m/second and at the final stages a temperature of about – 1 to 2°C with an air speed of 0.75 m/second is considered optimum. The relative humidity should be maintained between 85-90% so that losses due to shrinkage can be kept minimal during storage.

Factors affecting chilling rate:
1. Specific heat of meat which depends on the lean: fat ratio (Pork-0.51-0.57), carcass size and the amount of external fat.
2. Temperature of the chilling environment.
3. Number of carcasses placed in the chilli room and the space between each carcass for efficient air circulation.
4. Speed of the air.

In recent years, emphasis has been placed on shorter chilling cycles and lower temperature called Quick Chilling. This refers to a rapid lowering of carcass temperature not later than 1 hour after slaughter and avoid freezing. This process has the advantages of saving time and space, better keeping quality because of low air temperate, substantial reduction in shrinkage and enhancement of bloom.

**Expected storage life a different meats at Chilling (-1°C)**

- Pork 1-2 weeks
- Edible offals 7 days
- Bacon 4 weeks (at -3°C)

The cooler conditions should be such that a deep carcass temperature of 6-7°C is achieved in 12-16 hours for pigs.

**Physical changes in chilled meat**

Meat undergoes certain physical changes as a result of chill storage:

1. **Shrinkage:** Shrinkage or loss of weight occurs as a result of evaporation of moisture from the surface of the meat during the process of storage.

A freshly killed carcass dissipated body weight slowly, losing about 1.5-2.0% of weight during first 24 hours of storage due to evaporation. The rate of loss is dependent on the temperature, relative humidity and air velocity in the chill room. High temperature, drier air and low RH in the chill room cause much higher shrinkage.
Hence maintenance of low temperature with RH of 85-90% and air velocity of 0.75 m/second during initial stages and 0.5 m/second during final stages of storage (Once the temperature gradient between the meat surface and air narrows the speed must be reduced to avoid moisture loss) will help reduce shrinkage.

2. **Sweating**: This denotes the condensation for water vapor on the meat especially chilled meat when taken out of the chill room and kept at room temperature. The condensation occurs because the chilled carcass lowers the temperature of the surrounding air to below its dew point and thereby water condenses on the surface, which encourages microbial growth.

3. **Loss of Bloom**: Bloom is defined as the color and general appearance of the carcass surface when viewed through the semitransparent layer of connective tissue, muscle and fat, which forms the carcass surface. The moisture in tissues due to condensation or excess RH in the chillers causes the collagen fibers in the tissue to swell and they become opaque and hence the meat surface assumes a dull and lifeless appearance. This loss of bloom may also be caused by undue oxidation but can be prevented by avoiding temperature fluctuation, RH and appropriate air velocity in the chill room.

b) **FREEZING**

It refers to storage of meat or meat products below its freezing point. The basic principle behind is to reduce the water available to the microbes by ice crystal formation and also by lowering the temperature to a very low level where their growth is retarded.

Freezing has been recognized as an excellent method for preservation of meat. It results in fewer undesirable changes in qualitative and organoleptic properties of meat than other storage methods and in addition most of the nutritive value of meat is retained during freezing and throughout the freezer storage.

The outstanding and unfavorable changes that take place following freezing of meat are:

1) When temperature goes below -2°C slowly, the ice crystals formed raise the concentration of globulin and albumin proteins so that they become insoluble and their solubility does not get regained when the meat is thawed. This is the same irreversible change which happens when the eggs are frozen.

2) The freezing point of meat lies between -1 and -1.5°C when ice crystals begin to form.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Water Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.5°C</td>
<td>35.5% of water in muscle becomes ice</td>
</tr>
<tr>
<td>-5°C</td>
<td>82% of water in muscle becomes ice</td>
</tr>
<tr>
<td>-8°C</td>
<td>90% of water is frozen</td>
</tr>
<tr>
<td>-10°C</td>
<td>94% of water is frozen</td>
</tr>
<tr>
<td>-20°C</td>
<td>98% of water is frozen</td>
</tr>
</tbody>
</table>

During freezing the water present in the muscle fibers diffuses from the sarcoplasm to form crystals of ice. The speed of freezing has an important bearing on the size of the crystals and future quality of the product.
Depending on the freezing rate, freezing process can be classified as:

1. **Fast freezing:** Rapid heat transfer is required for fast freezing and may be accomplished by extremely low temperature (-40°C), rapid air movement or direct contact with freezing medium at intermediate temperature. Here the temperature is lowered to about -18°C within 30 minutes. Numerous ice crystals with filament like appearance are formed both in intra and extra cellular space at approximately same speed. Because of the rapid heat transfer small ice crystals formed have little opportunity to grow in size and also very little translocation of water and most of the water inside the muscle freezes intracellular and so drip losses during thawing are minimal. The muscle fiber shrinkage and distortion are minimized in fast freezing and since the ice crystals are smaller and more numerous they reflect more light and hence the colour appears lighter.

2. **Slow freezing:** In this process the temperature of the meat product remains near the initial freezing point for an extended period of time. As a result freezing boundary forms and proceeds slowly from exterior to interior. Extracellular water freezes more readily than the intracellular water because of its lower solute concentration. As extracellular ice formation proceeds the remaining unfrozen extracellular fluid increases in ionic strength and draws water osmotically from the super cooled interior of the muscle cell. This freezes on to the existing ice crystals, causing them to grow thus distorting and damaging the fiber. Migration of water from intra to extracellular space occurs and because of longer time available these small crystals formed coalesce to form large ice crystals, which are more extracellular. Drip losses are more on thawing.

**Methods of Freezing:**

Several commercial methods are available:

1. **Still air freezing:** In this the air is the heat transfer medium. This method is entirely dependent on convection and the meat freezes slowly. Home freezer units and refrigerator freezer units and refrigerator freezer unit operate on this principle. Temperature commonly used ranges from -10 to 30°C.

2. **Plate freezing:** The heat transfer medium is metal and heat transfer occurs by conduction. Trays containing meat are placed directly in contact with metal freezer plates or shelves. This method is generally limited to thin pieces such as steaks, chops, fillets and patties. The freezing rates are faster compared to still air freezing and the temperature commonly used ranges from -10 to -30°C.

3. **Blast freezing:** The most commonly used commercial method for freezing meat products is cold air blast freezing in rooms or tunnels equipped with fans to provide rapid air movement. Heat transfer medium is air, but because of its rapid movement rate of heat transfer is greater and hence freezing is faster. Proper spacing and stacking of meat on pallets or shelved racks in blast freezer is important for rapid and efficient freezing.

   Temperature: -10 to -40°C

   Air Velocity: 30 to 1070 meters/minute (mpm) . Commercially - 30°C with air velocity of 760 mpm is employed.

---

Pork we eat

107
4. **Cryogenic freezing:** This is very low temperature freezing and is done by use of condensed or liquefied gases. Meat frozen by this method has excellent qualitative characteristics but the cost involved is very high. These agents are applied either as immersion or liquid spray or as cryogenic vapor on to the product. Most commonly used cryogenic agents are Nitrogen (liquid/vapour) and Carbon dioxide (liquid under pressure or snow).

**DURABILITY OF FROZEN MEAT**

The condition under which the frozen meat is stored is an important factor for maintaining quality. The length of time frozen meat may be stored depends upon type of product, freezer temperature, temperature fluctuation and quality of wrapping material. In general rates of chemical deterioration are greatly reduced by freezing, but reactions such as oxidative rancidity continues slowly even in frozen state.

The amount of time meat may be held in frozen state, while maintain acceptable quality, depends on the degree of saturation of meat fats. Pork fats are highly unsaturated than beef and lambs and hence are highly susceptible to oxidative rancidity. Frozen meat stored too long becomes dry, rancid and less palatable, the most important change being the breakdown of the fat into free fatty acids with the production of rancidity. It is generally accepted that frozen beef has the longest storage life and frozen pork the shortest.

The processing state of meat also influences the storage period. Products containing slats generally have shorter frozen storage life because salt enhances development of rancidity.

The main factors ensuring the best results in the storage of frozen meat are controlled humidity and unchanging temperature. With regard to the storage temperature of frozen beef – 12.5°C or slightly above is considered suitable commercially, but – 18 to - 15°C is preferred.

Pork for long storage is held at temperatures of – 12 to - 24°C the lower one being essential for 6 months storage without rancidity and discoloration of the cut surfaces.

**PRACTICAL STORAGE LIFE (in month) OF FROZEN CARCASS MEAT**

<table>
<thead>
<tr>
<th>Meat</th>
<th>-18°C</th>
<th>-25°C</th>
<th>-30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork</td>
<td>06</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Edible offals</td>
<td>04</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Changes in frozen stored meat

1. **Weep or Drip:** Weep denotes the presence of a watery, blood stained fluid, which escapes from frozen meat on thawing. It consists mainly of water together with salts, extractives, proteins and damaged blood corpuscles, the latter are responsible for the pin coloration of the fluid and readily recognizable on microscopic examination. It is an undesirable feature and is caused by partly by the rupture of the muscles and the tissues by the large crystals of ice and partly by the permanent irreversible changes in the sarcoplasm which prevent frozen muscles from reabsorbing water on thawing.
As the time of freezing increases structural damage to muscles also increase. It important that as the time to freeze (time to pass between -1 and -7°C) decreased below 15 to 20 min, the extent of drip decreased rapidly, this being associated with increasing proportions of intracellular ice formation with times of freezing and between 20 to 200 min the amount of drip was appreciable and associated with extracellular ice formation. The extent of drip is determined by two factors, the ratio of cut surface of the meat (higher the surface area greater the drip) and the rate of freezing (slow or fast freezing). The amount of drip is greater in beef than in mutton, lamb or pork.

2. **Freezer burn:** During freezer storage an excessive loss of moisture from meat surface will result in localized area of dehydration and discoloration. This condition is known as freezer burn and is characterized by cork like texture and gray to tan color.

This occurs on the outer surface of the frozen offals, particularly livers and kidney and is attributed to loss of moisture from the outer tissues and is manifested in the form of whitish or amber colored patches following the sublimation of ice crystals in the atmosphere of the cold storage. It can result when wrapping materials have been punctured or when waterproof wrapping is not used. Improper maintenance of temperature, with frequent cycles of partial defrosting followed by refreezing during storage also contributes to freezer burn. During freezer burn the protein gets denatured and hence rehydration is poor. Meat with severe freezer burn is dry and tasteless and results in oxidation of myoglobin to met myoglobin and surface fat gets oxidized giving a bitter flavour.

**Effect of freezing on pathogenic microorganisms and parasites:**

Freezing destroys some bacteria but in case of other low temperature merely inhibit their growth and multiplication until conditions favourable to their growth to reappear. Freezing is therefore of no great value in rendering a carcass affected with pathogenic bacteria safe for human consumption nor are the bacteria commonly found on beef carcasses are destroyed by slow or sharp freezing.

Anthrax bacilli can withstand a temperature of -130°C while Salmonella can withstand exposure to -175°C for 3 days and tubercle bacilli have been found alive after two years in carcasses frozen at-10°C. FMD virus can remain viable for 76 days and the virus of swine fever may remain infected in the bone marrow at least for 73 days and the virus has been shown to be viable in frozen pork for 1500 days.

Freezing is however a valuable method for the treatment of meat affected with certain parasitic infections. Pork affected with Cysticercus cellulosae can be rendered safe if held for four days at -10.5 to -8°C. Trichinella cysts in pork are destroyed by holding the carcass for 20 days at -15°C or by quick freezing for 24 hours at -18°C.
THERMAL TREATMENT

Principles of Heat transfer: Conventional method of thermal processing involves heat transfer by conduction, convection and radiation. Heating by conduction involves direct heat transfer from particle to particle without use of medium other than the product itself. Convection heating involves heat transfer by movement of heated particles in medium such as air, steam or water. Heating by radiation is transfer of heat energy through space.

The rate of heat transfer is dependent on various factors:
- Temperature differential between the product and the heat source
- Length of time heat is applied
- Specific heat of the product and its thermal conductivity—meat with more fat has lower specific heat and hence requires less heat. Fluids and semi-fluids transfers heat energy faster than solids because heat transfer occurs by both conduction and convection.

Methods of thermal processing:

Canning: Canning may be defined as process of preservation of meat in sealed containers and usually implies heat as principal factor in prevention of spoilage. The principles of canning was given by Nicholas Appert (Father of Canning) and this process is also called as Appertization.

If pH ≤ 4.5, Clostridium spores don’t germinate and hence less treatment may be applied but meat has a pH of 5.5-6.0 and hence sufficient heat should be applied.

Formation of cans: For meat purpose, metallic cans (tin) are used. The main body is constructed of mild steel with a thin coating of tin representing 1.5% of the can weight.

Coating of steel plate is necessary to prevent corrosion. Lacquer is an organic material applied as an inner layer of coating over the tin layer. Insightly staining (Sulphiding) may occur on surface of certain food stuffs and can be prevented by phenolic meat lacquer of sulphur resistant lacquer.

Types of can: Sanitary or open top can, double seamed cans, Pullman base, pear shaped and oblong cans.

Canning operation

The foods to be canned must be clean and of good quality, the use of any material showing obvious signs of spoilage will result in deterioration of quality of the product.

The various processes involved in canning are:

a) Blanching
b) Filling of cans
c) Exhausting
d) Retorting or Heat Processing this is an important step in canning process which ensures killing of pathogens and their spores and increases the shelf life and cooks the product.
In non-acid foods like meat, the destruction of bacterial spores is slow, the temperature of about 115°C are required within a practical time limit. The cans can be placed in retort and processed by pressurized steam.

e) Cooling: Prompt cooling after processing is important as it checks the action of heat and prevents undue change in texture and color in addition to considerable reduction in internal pressure in cans which builds in during processing. The cans may be placed in cold water shower or pressure cooled in retorts. Water used should be of potable quality and sometimes chlorinated water can be used as surface decontamination. In commercial practice cans are water cooled at 30°C.

f) Can Washing

g) External Lacquering

h) Labelling and handling: The cans can be labelled with labels containing the ingredients, date of manufacture, storage condition manufacturers address and expiry date. Excess manual handling needs to be prevented, which can act as a source of can contamination with microbes around the seal area or the seam.

Commercial Canned pork meat products
1. Canned Hams: Ham packed in double seamed container, sealed manually by hand soldering machine and cooked at 93.5° C for several hours. It is not retorted.
2. Canned luncheon meat

Spoilage of Canned Foods
Spoiled cans show obvious abnormalities such as distortion, blowing, concave ends or slightly constricted ends or sometimes may be normal
1. Swell or Blower: A can with its ends bulged by positive internal pressure due to gas generated by microbial or chemical activity.
2. Flipper: A can with normal appearance and one end flips out when the can is struck against solid object, but snaps back to normal under light pressure.
3. Springer: A can in which one end bulged but can be pushed back to normal whereupon the opposite end bulges.

4. Microbial Spoilage: Insufficient processing and post-process contamination's are responsible for unsoundness of canned products
   - Flat Souring: Production of sour odour of food stuffs especially those containing sugars or starches and meat products such as sausages and is caused by thermophilic organisms such as *Bacillus coagulans*, *B. Stearothermophilus* and *B. circulans* which attack carbohydrates and produce acid but not gas.

5. Chemical Spoilage:
   - Hydrogen Swell: Imperfection or scratches in tin layer may expose the steel and when it comes in contact with acids in foods, it reacts and produces hydrogen gas in the cans following internal corrosion.
   - Purple Staining: This occurs on the inner surface of the can containing foods especially liver, Kidney, and tongue.

Pork we eat
It is due to the breakdown of sulphur containing proteins by thermophilic sulphur stinker *Clostridium nigrificans*, producing hydrogen sulphide resulting in formation of thin layer of sulphur on the inner surface of the can.

6. **Other changes:** this involves rust or damage, which can be due to exposure to hygroscopic environment or damage due to handling.

**Packaging of pork**

Packaging continues to be one of the important and innovative areas in meat processing. Packaging of meat and meat products with appropriate plastic films and laminates plays significant role in retention of the quality and extension of shelf life during refrigeration and frozen storage and in promoting their marketability. This technique similar to marketing the products like Lays (potato chips) as a value added product can be adapted for meat products too.

“Packaging can be defined as, efficient containment, preservation and protection of a meat product and all necessary information required during packing, transport, storage, sale and use, along with the provision of convenience, taking into consideration all legal and environmental issues”

**Packaging films:**

Packaging films mainly used are *plastic films*, *cellulose films* *(bio-based film)* and *aluminium foil*. They can either be used as monofilms or as two or more different films laminated together. These materials differ in:

1. oxygen permeability;
2. water vapour barrier ability;
3. resistance to hot and cold temperatures; and
4. mechanical strength.

Nearly all available films are of thermoplastic materials, and therefore *heat sealable*, resulting in hermetically sealed plastic pouches, bags, etc. A high oxygen barrier is important in the application of films for packaging meat and meat products. Films made of polyvinylchloride (PVC), polyethylene (PE) or polypropylene (PP) have a relatively high oxygen permeability, whereas polyvinylidenechloride (PVDC), polyester (PETP), polyamide (PA) and cellulose film (ZG) are less or almost non-permeable to oxygen.

Selection of packaging material mainly depends upon product factors such as color, stability, storage conditions, microbial condition, preservatives and degree of processing. Eg. Fresh meat requires presence of oxygen for maintaining its color for consumer appeal, therefore, it should be packed in relatively O₂ permeable packaging films while cured meats degrade in presence of oxygen so, they should be packed in O₂ impermeable films.

**Types of packaging:**

1. Over wrapping
2. Vacuum / vacuum-skin packaging (VP)
3. Modified Atmosphere Packaging (MAP)/ gas flushing with Carbon dioxide, Nitrogen and Oxygen individually or in combination
Advanced packaging technologies:

Due to the diversity of product characteristics and basic meat packaging demands and applications, any packaging technologies which will cover product and quality control in more economic and diverse manner will be useful. Two such packaging approaches currently exist and can be divided into two distinct categories; active packaging technologies and intelligent packaging technologies.

Active Packaging:

Active packaging refers to the incorporation of additives into packaging systems (whether loose within the pack, attached to the inside of packaging materials or incorporated within the packaging materials themselves) with the aim of maintaining or extending meat product quality and shelf-life. Active packaging has been defined as packaging, which ‘changes the condition of the packed food to extend shelf-life or to improve safety or sensory properties, while maintaining the quality of packaged food’.

Packaging may be termed active when it performs some desired role in food preservation other than providing an inert barrier to external conditions. Active packaging systems include use of oxygen scavengers, carbon dioxide scavengers and emitters, moisture control agents and anti-microbial packaging technologies. Thus these additives enhance the preservation function of the primary packaging system.

Intelligent / Smart packaging:

Intelligent packaging systems are those that monitor the condition of packaged foods to give information regarding the quality of the packaged food during transport and storage.
Thus this packaging system senses some properties of the food it encloses or the environment in which it is kept and which is able to inform the manufacturer, retailer and consumer of the state of these properties. Intelligent packaging mainly involves the use of sensors, indicators and Radio frequency identification (RFID) Labels.

Potential future applications:

Since consumer demands for ready to eat convenience meals are constantly increasing, packaging of ready meals in self-heating active packaging is an important future application. Examples of such self heating packaging is microwave susceptors which consist of aluminium or stainless steel deposited on substrates such as polyester films or paperboard which serve dry, crisp and ultimately brown microwave food.

Self heating aluminium or steel cans and containers, currently used by some manufacturers may have applications in the production of ready meals containing various meats. Flavour/odour adsorbers may also have potential in active packaging technology for muscle foods.

These adsorber systems are made up of cellulose tri- acetate, acetylated paper, citric acid, ferrous salt/ascorbate and activated carbon/clays/zeolites which are useful in removing off odours and flavours generated as a result of the oxidation of lipids in packaged food.