FOOD MANUFACTURE

PRODUCTION AND PROCESSING OF FOOD

Quality and quantity control in the selection of raw materials for food processing

Raw materials

- Any product that is used in the manufacture or production of a processed good.
    - Ingredients e.g. Fruit and vegetables
    - Processing materials e.g. Steam and water
    - Food additives e.g. Emulsifiers, starches, colours and flavours
    - Packaging materials e.g. Cans, bottles and fibreboard containers
- Raw materials make up a large percentage of costs, so specifications are enforced to avoid contamination

Specification criteria

- Description of raw material features:
    - Physical (shape, size)
    - Sensory (colour, aroma, texture, flavour)
    - Chemical (moisture %, nutrient %, pH)
    - Microbiological limit
- Sampling method for raw material
- Test each specific feature needed
- Action taken based on results
    - Accept
    - Reject – start method of controlling problem

Role of food additives in the manufacturing process

- Substances that are added to foods that are not normally consumed by themselves
- Primarily used in processed foods, in small quantities
- Necessary to provide consumer with wholesome, safe, convenient and nutritious foods
- Some people have allergies or intolerances to these

Additives and consumer safety

- FSANZ controls the use of additives in manufactured products sold in AUS and NZ
- FSANZ has a list of substances allowed, if a manufacturer wants to use another, they must apply to FSANZ
- Additives must be included on the label

Code numbering system

- 1986
- Based on an international system used to identify all food additives
- Each additive has its own number which is used on the label

Uses of food additives

- Improve stability of foods
- Restore or improve taste
- Provide foods for special dietary needs (e.g. active heart milk)
- Extend shelf life of food

Additive	Function	Example	Product
Flavouring	Restore flavour and order lost through processing. It helps maintain uniformity and make food more palatable	Natural – extracted from plants and animals Laboratory – identical to natural flavouring Artificial – cannot be found in nature	Ice confectionary Soups Biscuits
Flavour enhancer	Improving existing flavour or aroma of food without imparting any flavour of their own	Glutamic acid (620) Maltol (636) Monosodium glutamate – MSG (621)	Soup Snack foods Flavoured noodles
Colours	Either used to restore colour lost during processing or to enhance the physical appearance	Tartrazine (102) Amaranth (123) Caramel (150)	Confectionary Jellies Jams Soft drink
Vitamins and minerals	Used to make up for nutritional losses incurred in processing and storage. It can also be added to supplement dietary intake	Vitamin B2 (101) Vitamin C (300) Niacin (375)	Fruit juices Processed cheeses Margarine
Mineral salts	Used to enhance texture and mouth feel of foods	Sodium carbonate (500) Magnesium carbonate (504) Potassium chloride (508)	Low sodium salt Soda water mayonnaise
Anti-caking agents	Added to powdered products to ensure that no clumping occurs	Talc (553b) Calcium carbonate (170)	Salt Polished rice Beverage whitener
Antioxidants	Prevents oxidation which can cause rancidity and severe colour changes	Ascorbic acid (300) Sodium ascorbate (301) Octyl gallate (311)	Frozen cooked prawns Margarine Edible fats
Humectants	Used to absorb moisture from the atmosphere and prevent food from drying out	Sorbitol (420	Pastries Mixed dried fruit Pre-packaged cakes confectionary
Artificial sweeteners	Used as a substitute for sugar and impart a sweet taste while having fewer kj	Saccharides (954)	Diet soft drinks Diet jellies Sugarless chewing gum
Emulsifiers	Used to allow for water and oil to be combined in a product	Lecithin (322)	Salad dressing Bread Ice-cream
Food acids	Help maintain a constant level of acidity despite all ingredients added to food having different acid levels	Tartaric acid (334)	Processed cheese Fruit juice drinks Packet spaghetti sauce mix

Preservatives	Inhibit the growth of moulds, bacteria, yeast and viruses in foods thus prevent deterioration and spoilage	Sulphur dioxide (220)	Tomato products Brewed soft drinks Pickles
Thickeners	Used to make food more viscous and ensure a constant texture	Dextrins (1400)	Casserole mixes Instant puddings Desserts and sauces
Vegetable gum	Used to ensure consistency in foods so they do not break into separate parts	Xanthan gum (415) Pectin (440)	Cocoa Dessert mixes jam
Bleaching agents	Used to whiten foods	Chlorine dioxide (926) Benzoyl peroxide (928)	Flour
Propellant	Gasses or volatile liquids used in aerosol containers to expel the contents when the button is depressed	Carbon dioxide (920)	Soft drinks Instant whipped cream Toppings

Characteristics of equipment used in different types of production and the factors influencing their selection

- Processing equipment varies in size and shape depending on the amount of food to be processed
- The equipment needs to be
    - Strong – to work continuously with large quantities
    - Durable – reliability is very important, so production is not held up by breakages
    - Hygienic – easily cleaned, non-reactive, scratch resistant surfaces
    - Efficient – automated with conveyers transporting the product
- Industrial equipment may operate 24 hours a day, so it needs to be energy efficient

Production systems used in the manufacture of food e.g. small scale, large scale, manual, automated

Production systems

Production system	Description	Examples
Small-scale	Used on a domestic level and generally use manual production, and are therefore simple in their operation	Making bread at home or in a small bakery
Large-scale	Used within larger production operations. They are generally based on a production line and therefore use automated and/or computerised production and processing systems	Manufacturing bread in a large factory
Manual	Involves an operator physically handling material. Manual systems are most commonly used in small scale production. Some mechanical equipment may be used in a manual system such as a food processor.	Filling pie cases by hand
Automated	This occurs in large scale production and is when specially designed machines handle and control the processing. These machines carry out repetitive actions and there are pre-determined conditions for operation	

	such as temperatures and mixing times etc. this is to ensure product standardisation. A fully automated system may control all processes from the mixing of raw materials to the packaging and labelling of the product	
Computerised	Computerisation exists in large scale production systems and involves monitoring and controlling the production process using sensors. These sensors note changes in variables such as temperature or detect foreign objects such as metal. These changes are sent through to a microprocessor which analyses the data and makes changes if necessary e.g. increasing the temperature. This process is known as computer aided technology.	Technology - robotics

Unit operations

Separation processes

- Separation - To isolate or remove certain components of food
    - Domestic – sieving, removing the peel from fruit and vegetables
    - Industrial – potato rumbler
- Filtration - Passing liquid through a filter
    - Domestic – sieving
    - Industrial – filtration system
- Centrifuge - Separation of food particles that have different densities
    - Domestic - Spinning salad to remove water from leaves after washing
    - Industrial – Centrifuge

Size Reduction

- Grinding and milling – To make food smaller or into a paste
    - Domestic – Salt or pepper mill, spice grinders, mortar and pestle
    - Industrial – Computerised grinding and milling machines, grinders and processers
- Cutting, slicing, dicing and grating – to make food smaller
    - Domestic – Using a knife to cut vegetables into small pieces
    - Industrial – Dicing, strip-cutting and grating machines

Mixing

- Mixing – To incorporate food ingredients into each other
    - Domestic – Using a wooden spoon, electric beater or whisk
    - Industrial – High-pressure mixers Industrial mixers, Bread-kneading machines

Heating

- Blanching – Low-intensity heat-transfer method used to destroy enzymes that may cause food spoilage
    - Domestic – Plunging food into boiling water on a stove
    - Industrial – Blanching tanks and steam blasters
- High Temperature short time – To destroy pathogenic micro-organisms
    - Industrial – Tubular heat exchangers and plate heat exchangers
- Canning and bottling – To preserve food in metal or glass containers and extend its shelf life

    - Domestic – Fowlers Vacola home bottling and preservation systems
    - Industrial – Canning, aseptic canning and glass production lines, Retort machines
- Baking – To cook food, and in some cases such as biscuit making, to remove moisture
    - Domestic – oven and microwave
    - Industrial – industrial ovens, tunnel ovens

Cooling

- Cooling – To reduce the temperature of food and slow down (deactivate) the activity of micro-organisms or enzymes that cause food spoilage
    - Domestic – Refrigerator
    - Industrial – Industrial refrigerators, Blast chillers, Plate coolers (confectionary), Chilled water exchangers

Freezing

- Freezing – used to change liquid into a solid so it becomes inaccessible for micro-organisms (formation of ice crystals)
    - Domestic – freezer
    - Industrial – Air blast freezers (-240 degrees, small ice crystals), Plate freezers, Blast freezers, Immersion freezers (liquid nitrogen e.g. berries)

Evaporation

- Evaporation – to concentrate the flavour of liquids by removing moisture
    - Domestic – reduction process by boiling sock on stove top
    - Industrial – evaporators, spray dryers

Dehydration

- Dehydration – to remove moisture from food. By removing moisture, it prevents microbial growth
    - Domestic – domestic food dehydrator
    - Industrial – industrial dehydrators
- Cabinet drying - Placing food on trays in an enclosed space where hot air is circulated (fruit and vegetables)
    - Industrial – cabinet dryer
- Tunnel drying – Used in automated production – food moves through a heated tunnel
    - Industrial – Tunnel drying conveyer belts
- Sun drying – Using the heat from the sun to try out food (fruit – apricots and tomato's)
    - Domestic – laying food out in the sun
    - Industrial – large mesh trays placed outside in direct sunlight
- Spray draying - Liquidised food is forced through a spray nozzle into hot air; the liquid dries instantly to a powder (powdered milk, instant coffee, soup powder)
    - Industrial – spray drying, cabinets, spray dryers

Flow Process Chart

- A flow process chart is a graphic representation of a production process relating to the production and manufacture of a specific product
- Generally, represents all the steps that the raw materials go through to become a finished product
- Closely linked and aligned to the quality assurance and hazard analysis critical control points (HACCP) plans of an organisation
- Used for geol and assurance
- Process flowcharts are constructed using five symbols
    - Operation (circle)

        - Takes place when a raw material is purposely changed in any way, shape or form.
        - This could be either a chemical or microbiological change or a step-in processing where an item is put together or separated from other raw materials.
        - Generally, requires some form of labour along with the use of equipment.
        - Examples of an operation in food processing are cutting, grinding, milling, peeling, mixing, cooking, chilling and freezing
        - Look for cross contamination
    - Inspection (square)
        - happens when raw materials or the final product are examined, tested, sampled and compared to set standards. These standards measure quantity, quality and other characteristics set by the manufacturer.
        - Inspection requires some form of human labour along with the use of sophisticated equipment and machines designed to determine if the product meet the specific cations determined by the process.
        - Inspections are designed to ensure that the process is being performed correctly and they can also measure quality or quantity of foods produced.
        - Examples of inspection would be recording the temperature of ingredients that are being cooked and canned or inspecting eggs for cracks in shells before use.
    - Transportation (arrow)
        - Occurs when human labour and equipment such as conveyer belts, forklifts, robots and laser-guided vehicles are used to transport a product from one place to another.
        - This may be from the production line to the warehouse or to another part of the processing plant in order for another operation to be performed.
        - It is important that this type of transportation occurs without altering the product or packaging material.
        - Examples of transportation in food processing would be pumping tomato paste from a holding tank to the production line, moving beetroot from the cool room to be peeled and sliced before being cooked and canned or shifting pallets of drinks to the warehouse for distribution.
    - Delay (D)
        - A delay may be a momentary halt in the production and processing of a product and often occurs when internal systems do not allow the next step of the process to take place.
        - Delays rarely occur as they are costly for the organisation in terms of time and money
    - Storage (upside down arrow)
        - occurs when a raw material or finished product is held in a controlled environment. This may be in temporary storage where a finished product may be held in a warehouse or when raw materials and ingredients are stored prior to use.
        - Examples include keeping perishable items in refrigeration, keeping frozen foods in freezers, keeping canned products in specialised laboratory storage conditions to ensure the product remains shelf stable and for record keeping processes in case of future consumer complaints or product recalls.
- Combination of two procedures
    - If two procedures or operations occur at the same time, such as an operation and an inspection, then the corresponding symbols are used together.
    - This is represented on a flow diagram a by placing one symbol inside the other.
    - This may occur when adding raw materials into a mixing bowl that are added or mixed into other ingredients

QUALITY MANAGEMENT CONSIDERATIONS IN INDUSTRIAL PRACTICES TO ACHIEVE SAFE FOODS FOR PUBLIC CONSUMPTION E.G. HAZARD ANALYSIS

AND CRITICAL CONTROL POINTS (HACCP); WORK HEALTH AND SAFETY AND HYGIENE

Quality Assurance

- QA is the process of ensuring that certain standards relating to the quality of the product are met at all stages of the production process
- QA is needed to ensure consistency in products, which leads to consumer satisfaction and a positive company image
    - All parts of the company from management to factory staff and individual departments must work together and take responsibility for achieving quality standards.
- QA procedures include
    - A final product specification statement of the level of quality to be attained
    - Methods for assessing and measuring the quality of the final product
    - Clear specifications for all production areas
    - Sampling schedules and testing procedures
    - Recording and reporting and troubleshooting

Quality Management

- QM systems can be defined as a set of policies, processes and procedure required to plan and execute a safe and reliable food supply for consumers
- Manufactures integrate various quality management systems in their internal processes, which enables them to be proactive in identifying and controlling potential issues
- Examples of these management systems include:
    - HACCP
    - Good manufacturing practice (GMP)
    - WHS
    - International organisation for standardisation (ISO)

Quality Control

- QC refers to the procedures employed to meet the standards
- QC is the process by which we measure characteristics, compare them to a standard and act on any differences that may occur

Hazzard Analysis and Critical Control Points (HACCP)

- HACCP is a quality assurance and food safety system that identifies potential food hazards and their control points at all stages in the production of food
- HACCP has become the basis for ensuring that all food is prepared, manufactured and handled safely
- Employees using HACCP system are trained in the seven steps and are responsible for is implementation and monitoring when working on production lines
- Steps in a HACCP system
    1. **Conduct an assessment of the hazard.** Personal and environmental hygiene and food production hazards are identified. These hazards may include ingredients such as eggs or chicken, cooking or holding temperatures for the food or the use of chemical cleaning agents in the production process
    2. **Identification of critical control points during each stage of manufacturing**. CCP's are the stages at which problems may arise. This could be related to temperature control, cross-contamination, safety and sanitation issues

3. **Establish 'critical limits' for each CCP** – critical limits will vary depending upon the nature of the business, but include minimum and maximum limits, such as the acceptable temperature in which foods should be cooked or chilled
4. **Establish a monitoring system for the CCP's** – the business must establish a method to check that critical limits are not exceeded. Observations and recording data must happen at regular intervals
5. **Establish corrective actions** – the organisation must identify the actions to be taken if a problem occurs. These actions are intended as a precaution and may require more than one corrective task; for example, food being discarded and/or staff retrained
6. **Verify that the HACCP system is working efficiently** – the HACCP system must be re-viewed regularly. Systems must be amended and updated if required
7. **Set up records** – detailed records of results must be kept for auditing purposes and ideas for improvements

Work Health and Safety (WHS)

- There are general laws that help ensure the health, safety and wellbeing of workers and others while in a workplace
- Where a business has more than 20 staff, a work health and safety (WHS) committee must be formed
- Employers must ensure that:
    - The work environment, systems of work, machinery and equipment are safe and properly maintained
    - Chemicals are used, handled and stored safely
    - Adequate workplace facilities are available, such as personal protective equipment (PPE)
    - Information, training, instruction and supervision are provided
    - Workers' health and workplace conditions are monitored
    - Any accommodation provided to workers is safe
- WHS rules also stipulate certain responsibilities of employees – these include using PPE that is supplied, undertaking training in correct equipment use and reporting WHS issues
- It is essential they provide and share information with anyone likely to be directly affected by a WHS matter
- If a WHS committee is established, it is important the committee and management consult when:
    - Identifying hazards and assessing risks
    - Making decisions about ways to eliminate or control risks
    - Proposing changes that may affect the health and safety of workers
    - Making decisions about consulting procedures, resolving safety issues, monitoring workers' health and conditions, and providing information and training
- Workers are responsible for:
    - Taking care of themselves and others
    - Wearing appropriate personal protective equipment e.g. gloves, hairnets, masks, earplugs and glasses
    - Using equipment safely and only in the way it is intended to be used for
    - Notifying and reporting to management any accidents or faulty equipment

Critical Control Points

- A CCP is a location or procedure which, if controlled, can prevent, minimise or reduce a hazard to an acceptable level
- Recipes may have one or more hazards at each process step, but not every process step is a CCP
- Examples of CCP include:
    - Cross contamination
    - Reheating (only reheat once)

    - Cleaning (disinfectant, avoiding chemical contact)
    - Hot and cold holding e.g. Bain Marie (time – 2 hours eat or keep, 4 hours eat no keep, 6 hours throw out)
    - Cooling
    - Mixing (cross contamination – no residue in or on equipment)
    - Cooking (ensuring cooking is above 60 degrees Celsius)
- All of the above factors have been implicated in food poisoning outbreaks relatively recently in Australia
- It is likely that you will have many controlling steps in your process, some of which are controlling hazards we have just mentioned, and others which are not directly associated with control of safety
- CCPS are the steps in the preparation of the food that must be controlled to either eliminate or reduce the hazard to an acceptable level
- CCPs are essential for product safety, as they are the points where control is ultimately affected, however the CCP itself does not implement control
- Instead it is the action which is taken at the CCP which controls the hazard
- HACCP is all about what is critical to product safety, and so the food safety plan is built around CCPs
- Quality control and critical control points are different. Quality control is about creating quality food products (e.g. consistent products) whereas CCPs are about preventing food safety hazards

PRESERVATION

REASONS FOR PRESERVING FOODS E.G. SAFETY, ACCEPTABILITY, NUTRITIONAL VALUE, AVAILABILITY AND ECONOMIC VIABILITY

- Safety:
    - Prevent consumers becoming ill from food borne illnesses
- Availability:
    - Make seasonal produce available all year round e.g. stone fruit
    - Can make seasonal fruit cheaper
- Nutritive value:
    - Can enhance, decrease or add nutritive value
    - E.g. fortified or probiotic yoghurt = added nutritive value
    - E.g. kombucha fermentation adds and enhances value
    - Heat treating can decrease nutritive value
- Economic Viability
    - Reducing variations in sales and availability
    - E.g. buying a fruit that's frozen can be cheaper than buying it fresh
- Flavour/ texture
    - Smoking
    - Drying

CAUSES OF FOOD DETERIORATION AND SPOILAGE:

Environmental factors (infestation, oxygen, light and water)

- Infestation
    - Rodent activity or bug infestation and other animals can occur in foods.
    - Common examples include weevils in flour and grain, mice and rats chewing through food packaging.
- Oxygen, light and water
    - Warm temperatures, air, light and moisture speed up the rate of spoilage from other causes.

    - E.g. in warm environments enzymes and microbes are more active and oxidative reactions occur quickly
- Rancidity
    - Most fats and oils don't store well = develop off flavours and odours known as rancidity
    - Caused by absorption rancidity or oxidative rancidity
    - Absorption = stored next to strong smelling foods, smell is absorbed by fat or oil making it unpleasant to eat
    - oxidative = air oxidises unsaturated fats producing objectionable flavours, three stage process
    - high temperatures, presence of moisture, oxygen and light speed up rancidity
    - vegetable oils deteriorate slowly, animal fats deteriorate quicker
- Importance of water activity in microbial spoilage
    - Micro-organisms require water to maintain life
    - Removal of water does not kill microbes but stops their growth

Enzymatic activity

- Cause ripening and decay of fruits and vegetables
- Foods exposed to air; enzymes present in cells bring out oxidation reaction = colourless compounds are converted into brown-coloured compounds
- Browning does not occur in cooked foods since the enzymes were destroyed by the heat
- E.g. cut open apples and potatoes will brown

Microbial contamination (mould, yeast and bacteria)

- Moulds, yeast and bacteria
- Grow in the food and produce substances which alter colour, texture and odour of the food making it unfit for human consumption
- E.g. souring of milk, growth of mould on bread, rotting of fruit and vegetables
- Can be pathogenic (potential to make consumers very ill) need to be controlled in food manufacturing and processing
- Favourable conditions for microbes:
    - Warm temperatures
    - Available water
    - Suitable food source
    - Oxygen
    - Suitable pH
- Microbes can double in number every 20 minutes if conditions are right

PRINCIPALS BEHIND FOOD PRESERVATION TECHNIQUES, INCLUDING TEMPERATURE CONTROL AND RESTRICTION OF MOISTURE, EXCLUSION OF AIR AND pH

(RACE ACRONYM)

Exclusion (removal) of air

- Most microbes require oxygen to be active
- Removing air makes the environment become unfavourable = microbes become dormant
- Hot filling cans and bottles remove air
- Vacuum packing and gas flushing are processes that exclude air

Removal of moisture

- Both enzymes and microbes need water to be active – not just any water: clean liquid water
- If water is not pure or if it is ice it is unavailable for microbes

- Enzymes can still be active in freezing conditions but are slower
- Evaporated foods still contain quite a high moisture content so may be susceptible to mould growth

Addition of chemicals

- Dissolving other substances in water such as salt and sugar chemically alters the water, making it unavailable to microbes and enzymes
- Adding acids to foods can minimise spoilage by denaturing enzymes and destroying micro-organisms
- Presence of acids reduces the time and temperature of het processing needed to preserve food
- Bacon, tomato salsa, jam and pickles use added chemicals

Control of temperature

- Food is warmed = enzyme and microbes are active and activity increases
- Temperature rises = enzymic reaction rates begin to slow and then fall rapidly as optimum temperature is exceeded (20-40 degrees)
- Microbes have similar optimum temperature = eventually die
- Enzymes denature, and microbes are killed at 60 degrees and above
- Perishable foods are not to be stored in the "danger zone" (5-60 degrees) or spoilage will occur
- Keeping foods below 5 degrees will slow down and make enzymes dormant
- Once food is returned to room temperature or defrosted than the enzymes will continue to work again

PRESERVATION PROCESSES, INCLUDING CANNING, DRYING, PASTURISING, FREEZING AND FERMENTING

Canning

- Involves the application of heat and aims to destroy micro-organisms and their spores
- Heat treated, or sterilised food must be kept in airtight package to prevent contamination
- Metal airtight packaging prevents invasion of microbes as well as makes it harder to be destroyed

Pasteurisation

- Holder process method: product is heated to temperature of 65 degrees for 30 minutes then quickly cooled
- High temperature short time (HTST): product is heated to 72 degrees for 15 seconds then cooled
- E.g. milk

Ultra-High Temperature (UHT)

- Important process used in preservation of milk
- UHT milk does not require refrigeration for storage (until after opening)
- Milk is heated to 140 degrees for a few seconds
- Kills all heat resistant bacteria
- Up tp 2 years storage at room temperature unopened

Freezing

- Microbe growth rate is reduced due to low temperature
- Water is unavailable because it has been converted to ice
- Chemical changes are slowed down because of low temperature
- Before freezing, inedible parts are removed, and it is usual to blanch fruit and vegetable to inactivate enzymes
- Plate freezer:

    - used for large quantities
    - used by commercial/ food service and catering/ retail seller
    - food is packed between hollow metal plates and refrigerant is passed through the plates
    - packaged products are pressed between plates to reach low temperature
    - suitable foods include fish fillets, meat and vegetables
- air blast freezer:
    - involves exposure of food to a blast of very cold air (-240-210 degrees) at high speeds
    - used for foods such as meat, fruit and vegetables
- tunnel freezer:
    - continuous operation for quick freezing on a production line
    - food is placed onto mesh belt or into fluidised bed that moves through a tunnel blasted with cold air
    - used for high volume products on automated production lines
    - suitable foods include peas, beans, baked goods, chopped potatoes, fruits and vegetables
- immersion freezer
    - involves placing the food in the refrigerant such as brine of liquid nitrogen
    - temperatures as low as -196 degrees = foods are snap frozen

Drying

- Air drying
    - Food is subjected to temperatures between 40 – 100 degrees
    - The water inside the food evaporated, increasing the solute concentration within the food product
    - This may cause physical damage to the food in a similar way to freezing, or food could be damaged by heat
    - Food will suffer a loss of structure and the proteins present in the food will denature
    - Most plant and animal tissue will shrink
- Drum Dryers
    - Made from stainless steel and are one to two meters in diameter
    - They are heated with steam, while the food products form a thin layer on the drum surface and are dried as the drum rotates
    - The dried product is scraped off the drum and the process is repeated
    - The dried foods may then be ground into a powder
- Spray driers
    - This process is used to dry liquid products
    - The food is sprayed in small droplets from the top of very tall structures and is suspended by hot air rising from below
    - It settles as it dries and is packaged as a dry powder
- Tunnel drying
    - Used extensively for fruits and vegetables
    - Foods move slowly through a long (10-15 metre) tunnel as hot air is blasted down the tunnel to dry the food
    - It is common practice for some sun-dried foods to be “finished off” in tunnel driers
- Freeze drying
    - Food is frozen and the moisture in the food product removed by allowing the ice to sublime under a vacuum
    - Subliming – direct conversion of ice to water vapour, without going through the liquid water stage
    - This is beneficial to foods being processed as they avoid heat damage caused by conventional driers

- Foods retain their volume and have a porous texture, which allows food to rehydrate more easily than conventionally dried products
- Moulds and bacteria will continue to grow in foods when as little as 13 to 20 percent moisture is present
- To combat this growth, manufacturers aim to dry products to the point where only 5-6 percent moisture is present

Fermentation

- The process involves the biochemical breakdown of particular food components, causing a change to the food's chemical composition
- Fermentation of food and beverage products occurs when carbohydrates are converted to acids or alcohol through the action of micro-organisms – carbon dioxide is often a by-product of this process

PACKAGING STORAGE AND DISTRIBUTION

FUNCTIONS OF PACKAGING AND TYPES OF MATERIALS AVAILABLE

- Provides **convenience**
- **Protection** of the product
- Provides a **container** for food products
- **Preserves** food
- **Informs** the consumer and promotes/markets the product

Choosing the best packaging

- Salt and pepper packaged in jars with built in grinding mechanisms
- Coca-Cola in distinctive bottle shape
- Leggo's pasta sauce come in brand distinctive square jar

Type of Packaging

- Combination packaging
  - Primary packaging: layer of packaging that comes into direct contact with the food product
    - E.g. muesli bar wrapper or jam jar
  - Secondary packaging: the layer that surrounds a group of primary-packaged food products
    - E.g. box containing six muesli bars
  - Tertiary packaging: used to secure multiples of secondary packaging for bulk handling and distribution
    - E.g. large cardboard boxes used to hold many boxes of a particular product

Packaging material

- Glass
  - Bottles and jars used for jams or pasta sauces
- Plastics
  - Plastic films to package fresh meat
  - Flexible plastic for bags and pouches used for oats or rice
  - Many kinds of plastics with different purposes
- Paper and board
  - Paper bags used for sugar or flower
  - Paperboard to package tea bags and egg cartons

    - Laminates such as multi-ply board boxes used for long-life products such as milk, custard or juice
- Metals
    - Aluminium foils used for chocolate bars
    - Aluminium and steel cans used for canned fruits and vegetables
    - Metallised plastics used for bags of potato chips
- Composite containers comprise of more than one type of packaging material
    - May be board-based canister with a metal or moulded lid, or a board-based product with foil laminate
    - E.g. Milo

CURRENT DEVELOPMENTS IN PACKAGING, INCLUDING ACTIVE PACKAGING; MODIFIED ATMOSPHERE PACKAGING; SOUS VIDE

Modified Atmosphere Packaging (MAP)

- Used to extend the shelf life of fresh food
- MAP techniques substitute the air or gas inside a package with a protective gas mix
- The gas helps the product stay fresh for as long as possible and retards the growth of microorganisms that may cause food to spoil
- The ideal mixture of gases incl. Oxygen, Nitrogen or Carbon dioxide can be added to ensure that the food reaches optimum condition
- Barrier specific packaging
    - The barrier properties of this packaging materials is designed to allow some gases into the packaging at different rates and exclude others
    - Must be transparent and have anti-fogging properties to prevent condensation on the inside of the package
    - Used for salad mixes and pre-cut fruit/vegetables
- Vacuum packaging
    - Involves removing the air from inside the package to create a vacuum, so that the packaging seals the food
    - Cost effective
    - Used for cheeses, meat (salami, bacon, ham), coffee, sun-dried tomatoes
- Gas packing
    - Replacing the 'headspace' with gases before the product is sealed
    - Packaging material must not be permeable or porous to maintain the correct gas balance
    - Used for fresh pasta, snack foods (pretzels, chips, popcorn)
    - When packaging chips, nitrogen replaces oxygen, keeping the packet inflated, thus protecting food
- Active packaging
    - Packaging system used to modify the environment within the package as it changes during storage
    - Active packaging films are used to hold food and provide a barrier to outside influences
    - Small reactive pouches are placed inside to control internal environment
        - Remove or add gases or remove odours
        - Seen inside naan bread, tortillas and nori sheets
    - Sachets or pads of absorbent materials are used when packaging fresh meat and poultry to absorb excess moisture that may escape during storage
- Sous vide
    - Method of preservation by partial cooking followed by vacuum sealing, then chilling
    - Used in hospitals, nursing homes and restaurant chains
    - Allows food to be cooked ahead of time then reheated when needed

- The packaging used is a polyester film that is able to withstand freezing as well as high temperatures needed for reheating
- Shelf stable for 6 weeks
- They are lightweight, inexpensive, easy to use and store and the colour, flavour and texture are retained during cooking

Innovations in packaging design

- Edible packaging
- Intelligent and smart packaging
- QR code readers
- Biodegradable and plant-based packaging

STORAGE CONDITIONS AND DISTRIBUTION SYSTEMS AT VARIOUS STAGES OF FOOD MANUFACTURE

Storage

- Perishable and non-perishable raw materials need to be stored when they initially arrive at the processing plant
    - Require controlled-atmosphere storage incl. refrigeration, freezers and dry storage to ensure they are in optimal condition
- Products that have undergone some form of processing may also require storage before further operations take place
    - Such as hot holding of products prior to canning
- Storing of the finished product is also required before it is distributed
- Fridge storage 0-5˚C
- Freezer storage -18 to -20˚C
- Dry storage must be well ventilated, have controlled humidity levels and the temp. should not exceed 24˚C
    - Exposure to sunlight should also be avoided

Distribution

- Refers to the method used to take raw materials from the farm or processing plant to the food service or catering service and catering industry, food retailer or consumer
- Distribution might involve several stages
- Manufacturer must carefully consider what packaging to use so that it is compatible with the product's distribution method
- Secondary and tertiary packaging are important to prevent damage to a product's primary package and contents
- Contamination or loss of quality may occur if refrigerated food is left on a loading dock for an extending period of time
- Manufacturers need to be particularly careful with storage and distribution of items packaged in glass
    - If a glass jar breaks, the contents could contaminate nearby food posing a risk to consumers