Food additives

• What are food additives?
  – Food additives are substances which are added to manufactured foods and dishes in small amounts to improve colour, flavour, texture or to make the food stay safe for longer

• Functions of food additives
  – To enhance the safety and quality of food products by inhibiting the growth of micro-organisms
  – To extend the shelf life by protecting the food against oxidation
  – To improve the flavour, colour or texture of the food
Food labelling and food additives

• All additives must be listed on food labels
• The names (or the identification number) and the functions of the additives used in a prepackaged food must be listed on the food label
• Additives must appear on the food label in descending order of quantity (greatest amount first)
• International Numbering System for food additives
  – It is an internationally agreed numerical system for identifying food additives
• E number
  – Additives are given the prefix “E” if they have been accepted as safe for use within the European Union
Food labelling and food additives

2 labelling formats of food additives:

- **Functions and identification numbers** of food are listed on the food label.

- **Functions and names** of food are listed on the food label.

**Ingredients:**
- Water, sugar, tea, lemon juice, flavours, acidity regulator (330 and 331), vitamin C, antioxidant (304).

**Ingredients:**
- Organic pomegranate concentrate, organic cane sugar, organic pomegranate juice, apple pectin, ascorbic acid (vitamin C) & citric acid (acidity regulators).
Food additives

• 3 groups of food additives:
  – **Natural**: obtained from natural sources, e.g.
    • colouring made from carotenes (E160a(ii))
  – **Synthetic** (nature identical): made in a laboratory to be chemically the same as certain natural materials, e.g.
    • synthetic colouring of carotenes (E160a (i))
  – **Artificial**: synthetic compounds that do not occur in nature, e.g.
    • saccharin (E954), a low-calorie sweetener
Types of food additives and their functions

• The main functional classes of food additives are:
  – Colourings
  – Flavourings and flavour enhancers
  – Sweeteners
  – Emulsifiers and stabilisers
  – Preservatives
  – Antioxidants
Colourings

• Colours are used to:
  – Make food look more attractive and replace the colours lost during the processing of food
  – Maintain consistency between different batches of production

Ingredients:
Pork, egg protein, milk protein, salt, soy protein, pork collagen, yeast extract, flavour enhancer (E621), acidity regulatory (E339), antioxidant (vitamin C), colour (E120), colour retention agent (E250), sweetener (E950, E955), spice

Use of colouring (E120 Carmines) in pre-packed ham
Flavourings and flavour enhancers

- Flavourings and flavour enhancers are used to:
  - Increase and improve the taste of foods, e.g.
    - Monosodium glutamate (MSG) is a well known flavour enhancer to make the flavour of food stronger
  - Replace the flavours lost during the processing of food

Ingredients:
preserved mustard, salt, flavour enhancer (E621 Monosodium glutamate), chilli, rapeseed oil, spices, white sugar, acidity regulator (E330 citric acid).

Use of flavour enhancer (E120 Carmines) in pickled tuber mustard
Sweeteners

• Sweeteners enhance the sweetness in food
  – Usually much sweeter than natural sugar
  – Used in tiny amounts to sweeten drinks and other foods

• They are very low in energy so they are often used in low-calorie drinks and reduced sugar products aimed at people who are trying to lose weight

• Examples of commonly used sweeteners:
  – Acesulfame K (E950)
  – Aspartame (E951)
  – Saccharin (E954)
  – Sucralose (E955)
Sweeteners

Comparison between normal coke and low-calorie coke

Normal coke

Ingredients:
- carbonated water, **sugar**, colour (150d), acidity regulator (338), caffeine and other flavourings

Low-calorie coke

Ingredients:
- carbonated water, colour (150d), acidity regulators (338, 331), **sweeteners** (951, 950, 955), flavourings, preservative (211), caffeine

Use of sugar in normal coke

Use of aspartame (951), acesulfame K (950) and sucralose (955) in low-calorie coke
Emulsifiers and stabilisers

• Emulsifiers and stabilisers are used to
  – Improve the consistency of food during processing and storage
  – Mix ingredients like oil and water that normally separate

• Example of emulsifier:
  – Lecithin in egg yolk is a natural emulsifier that holds oil and water together and prevents them from separating out
Emulsifiers and stabilisers

- The oil and vinegar (which contains water) in mayonnaise are prevented from separating by the egg yolk.

**Ingredients:**
- Soybean oil, water, eggs, vinegar, sugar, salt, egg yolks,
- Natural flavour (contains mustard), lemon juice concentrate, preservative (E385),
- Dried garlic, dried onions, paprika.
Preservatives

• Preservatives are used to prevent or slow down the growth of micro-organisms

• Preservatives avoid wastage of food by extending their storage period (shelf-life)

• Examples of preservatives:
  – Salt, sugar, vinegar are common household preservatives
  – Sulphur dioxide is used to prevent discolouration of food
  – Nitrates and nitrites are used for curing of meat
Antioxidants

• What is antioxidant?
  – Any substance that protect food from deterioration caused by oxidation (e.g. browning of food)

• Antioxidants are used to:
  – Prevent fat-soluble vitamins (vitamin A and D), oils and fats in food from going rancid
    • Rancid is the development of an unpleasant smell and taste due to the reaction between oxygen and fat
  – Prevent browning of cut fruits e.g. apples and pears when they are exposed to air
Antioxidants

• Examples of antioxidants:

  – Vitamin C (also known as ascorbic acid) is one of the most widely used natural antioxidants

**Experiment**

1. Cut the banana, leave some slices in air and immerse other slices into lemon juice
2. Observe the colour change after 5 and 60 minutes

Ascorbic acid in lemon juice inhibits enzymatic browning
Common preservatives and antioxidants used:

**Sulphur dioxide and sulphites**

- Functions of Sulphur dioxide
  - Antimicrobial action: it inhibits the growth of bacteria and moulds but not yeasts
  - Antioxidant: it also inhibits browning reactions

- Sulphur dioxide appears on food labels under several names:
  - Sulphur dioxide (E220)
  - Sodium sulphite (E221)
  - Sodium bisulphite (E222)
  - Sodium metabisulphite (E223)
  - Potassium metabisulphite (E224)
  - Potassium sulphite (E225)
Common preservatives and antioxidants used: \textit{Sulphur dioxide and sulphites}

- Sulphur dioxide is commonly used to preserve a wide range of foods, e.g.
  - Inhibit the growth of yeasts and bacteria in dried fruits, pickled vegetables and meat
  - Delay the discolouration in meat, fruits and vegetables caused by oxidation
  - Prevent further fermentation of sugar by residual microorganisms in wine

\begin{center}
\begin{tikzpicture}
  \node (sugar) at (0,0) {Sugar};
  \node (yeasts) at (2,0) {Yeasts};
  \node (carbon_dioxide) at (4,0) {Carbon Dioxide\ +\ Alcohol};

  \draw[->] (sugar) -- (yeasts);
  \draw[->] (yeasts) -- (carbon_dioxide);

  \node at (1,0) {Fermentation by yeasts};
\end{tikzpicture}
\end{center}

- What is fermentation?
  - Fermentation is the breakdown of sugar into an alcohol or an acid by microorganisms, e.g. bacteria and yeasts.
Examples of food with sulphur dioxide/ sulphites added:

- **Ingredients:** Mangoes, sugar, salt, preservative (E223)

- **Ingredients:** Mangoes, sugar, sodium metabisulphite

- **Ingredients:** Selected mangoes, sugar & preservative (sulphur dioxide)

- **Ingredients:** Dried apricots, sulphur dioxide added as a preservative

Use of sulphur dioxide and sodium metabisulphite (E223) in dried mangoes and apricots
Use of sodium metabisulphite and sulphite in pickled vegetables

Use of sodium sulphite in preserved butter beans
Common preservatives and antioxidants used: Sulphur dioxide and sulphites

• Health effects:
  – Sulphur dioxide is generally of low acute and chronic toxic effects
  – Sulphur dioxide may induce allergic reactions e.g. asthmatic attacks, headache and nausea in susceptible individuals
  • People with history of allergy should read food labels of pre-packaged food carefully to avoid intake of certain preservatives
Common preservatives and antioxidants used: **Sulphur dioxide and sulphites**

- In Hong Kong, Sulphur dioxide is not permitted to be used in **fresh or chilled meat**
  - Sulphur dioxide stops the oxidative process of meat and retain the desirable fresh meat colour

![Diagram showing colour changes of meat after exposure to air with and without sulphur dioxide used](image)

**Without sulphur dioxide used**

- Oxidation

**Colour changes of meat after exposure to air**

**With sulphur dioxide used**

- Sulphur dioxide prevents oxidation of meat pigment

**Colour changes of meat after exposure to air**
Illegal use of sulphur dioxide in beef

Vendor given suspended prison sentence for selling beef with sulphur dioxide added

A 52-year-old woman was sentenced to 2 months of imprisonment, suspended for 3 years for selling fresh beef with sulphur dioxide added.

The Centre for Food Safety (CFS) tested a fresh beef sample from a fresh provision shop in Hip Wo Street, followed a food complaint, and found that the sample contain Sulphur dioxide. A CFS spokesman said that it is an offence to add Sulphur dioxide to fresh or chilled meat. The maximum penalty is a $50,000 fine and 6 months of imprisonment.

Source: local newspapers (integrated report), November 2014
Common preservatives and antioxidants used: Nitrates and nitrites

• What are nitrates and nitrites?
  – Nitrates are naturally occurring compounds
  – Nitrates and nitrites compounds are added to cured meat (e.g. sausages, ham, bacon, luncheon meats) to preserve the red colour of meat and to inhibit the growth of bacteria
  – They appear on food labels under several names:

    Potassium nitrite (E249)    Sodium nitrite (E250)

    Sodium nitrate (E251)    Potassium nitrate (E252)
Examples of food with nitrates and nitrites added:

**Ingredients:**
- Pork, egg protein, milk protein, salt, soy protein, pork collagen, yeast extract, flavour enhancer (E621), acidity regulatory (E339), antioxidant (vitamin C), colour (E120), **colour retention agent (E250)**, sweetener (E950, E955), spice

**Ingredients:**
- Pork, chicken, water, cheddar cheese, onion, tapioca starch, soy protein, dextrose, salt, sugar, flavour [salt, spices, paprika extracts, acidity regulator (575), spices, antioxidant (300, 301), flavour, glucose syrup, flavour enhancer (621, 631), dextrose, vegetable oil], garlic, spices, flavour enhancer (621), emulsifier (450, 451), milk protein, colour (102, 124), **colour retention agent (E250)**

Use of sodium nitrite (E250) in ham and sausage
Examples of food with nitrates and nitrites added:

Use of Sodium nitrite in luncheon meat

Ingredients: Pork, ham, starch, salt, sugar, spices, colour retention agent (sodium nitrite)
Common preservatives and antioxidants used:  
**Nitrates and nitrites**

- **Health effects:**
  - Under normal consumption, nitrites are unlikely to cause acute health effects.
  - Long term excessive intake of nitrites may increase the risk of cancer.
    - Ingested nitrite will be converted to nitrosamines in the stomach.
    - Nitrosamines are known to be carcinogenic.

\[
\begin{align*}
\text{Nitrite} & \quad \xrightarrow{\text{Acidic condition (e.g. in the stomach)}} \quad \text{Nitrosamines} \\
\text{OR} & \quad \xrightarrow{\text{High heat (e.g. cooking)}}
\end{align*}
\]
What is carcinogen?

Carcinogen is a substance that can cause cancer, e.g.

- aflatoxins in contaminated peanuts is a carcinogen associated with liver cancer;
- certain nitroso compounds e.g. nitrosamines, resulted from ingested nitrate is associated with stomach cancer
Nitrates are used as fertiliser in many countries.

Nitrates are also naturally found in vegetables e.g. spinach, cabbage, etc.

Improper storage of cooked vegetables lead to excessive growth of micro-organisms and increase the subsequent conversion of nitrate to nitrite in the vegetables.
Common preservatives and antioxidants used: Nitrates and nitrites

Facts or Myths?
Reheat cooked vegetables is carcinogenic?

- Conversion of nitrate to nitrite in vegetables:
  - Nitrate is naturally converted to nitrite by enzymes in vegetables
  - Bacterial action on vegetables causes accumulation of nitrite before and after cooking
Common preservatives and antioxidants used: **Nitrates and nitrites**

Facts or Myths?
Reheat cooked vegetables is carcinogenic?

- Key steps to reduce nitrate/nitrite intake from leafy vegetables:
  - Store fresh and cooked vegetables in refrigerator
  - Cook vegetables soon after chopping
  - Blanch vegetables in boiling water

To reduce the conversion of nitrate to nitrite by enzymes or bacteria
Common preservatives and antioxidants used: **Acetic acid**

- Usually appears on food labels under several names:
  
  - Acetic acid (260)
  - Vinegar (4% acetic acid)
  - Sodium acetate (262(i))
  - Potassium acetate (261(i))
  - Calcium acetate (263)

- Added to mayonnaise, pickles to prevent microbial growth and contribute to flavour
Examples of food with acetic acid added:

Use of acetic acid in sauces:

**Ketchup**

**Ingredients:**  
Water, tomato paste, white sugar, salt, modified corn starch, *acidity regulator (E260)*, flavouring, onion powder, naturally present sulphites

**Chicken sauce**

**Ingredients:**  
Water, sugar, red chilli, garlic, salt, thickener (E1422), *acidity regulator (E260)*

**Sauce for beef ribs**

**Ingredients:**  
White sugar, fermented soybean paste, soy sauce, water, tomato paste, salted plums, salted chilli peppers, soybean oil, modified corn starch, dehydrated garlic, sesame oil, colour (E150c), *acid (E260)*, spices, flavour enhancers (E631, E627)
Examples of food with **acetic acid** added:

- **Ingredients:**
  soybean oil, water, eggs, **vinegar**, sugar, salt, egg yolks, natural flavour (contains mustard), lemon juice concentrate, preservative (E385), dried garlic, dried onions, paprika

  **Use of vinegar in mayonnaise**

- **Ingredients:**
  Cucumbers, sugar, water, **distilled vinegar**, salt, **acetic acid**, calcium chloride, alum, polysorbate 80, natural spice, flavours

  **Use of vinegar and acetic acid in pickled cucumber**